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HEAT-TREATMENT OF NICKEL-CHROMIUM ALLOYS

Harold Ernest Gresham, Little Eaton, and Douglas Wilson Hall, West Monkseaton, England, assignors to Rolls-Royce Limited, Derby, England

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8 Claims. (Cl. 148—21.9)

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This invention relates to a method of processing nickel-chromium alloys containing a hardening element and being capable of being hardened by a precipitation heat treatment.

Hitherto the heat treatment of these alloys has consisted of soaking at 1020 to 1100° C. cooling or quenching and then ageing at 650 to 850° C.

With an alloy sold under the trade name Nimonic 80 (substantially nickel 80 per cent, chromium 20 per cent with small percentages of titanium and iron) the normal heat treatment is to soak for 8 hours at 1050° C., cool in air or quench in oil and then to heat for at least 16 hours at 700° C. followed by air cooling or quenching.

This is done in order to develop high hot tensile strength and good creep resistance properties.

The applicants have discovered very unexpectedly that the creep properties of these alloys are very considerably increased if before the above stated heat treatment is carried out the alloy is given a preliminary heat treatment from 650° C. to 895° C.

Preferably the preliminary heat treatment is for a time between five and thirty hours and the last part may be at a lower temperature than the first part. The temperature may be dropped by an amount not exceeding 200° C., preferably between 150° C. and 200° C. This drop may be a gradual one or be made by one or more steps.

It is generally convenient to cool the alloy after this preliminary heat treatment and before the normal heat treatment but this is not essential.

Examples of the effect of this heat treatment are as follows:

Eight specimens of Nimonic 80 were prepared. Four were given the usual heat treatment, and four were given the usual heat treatment preceded by one consisting of 6 hours at 850° C. and 16 hours at 700° C.

Creep tests to fracture were carried out at 700° C. with a stress of 23 tons per square inch. The times to fracture were:

Usual Heat Treatment	Preliminary heat treatment according to this invention plus usual heat treatment
Hours 57½ 42 22½ 40½ Mean 40½	Hours 75½ 62 30 37 51

It will be seen that the effect of the heat treatment according to this invention is to increase the life of the material under these conditions by 25 per cent or more.

An alloy as proposed by the applicants and Marcus Alan Wheeler in our patent application filed November 20, 1946, Ser. No. 711,204, con-

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taining aluminum 1.0 to 9.0 per cent, chromium 13 to 23 per cent, cobalt exceeding 10 but not exceeding 35 per cent, titanium 0.01 to 5.0 per cent, remainder and at least 30 per cent nickel under a stress of 15 tons at 800° C. gave a creep life to fracture of 50 hours after the heat treatment proposed in the provisional specification namely soaking 1020–1100° C. for from 8 to 30 hours, quenching and ageing at 650° to 850° C. from 8 to 30 hours. When given first the preliminary heat treatment according to this invention followed by the said proposed heat treatment it gave under the same test conditions a life of 72 hours.

What we claim is:

1. In the processing of nickel-chromium base alloys containing a hardening element and capable of being hardened by precipitation heat treatment, the step of subjecting the alloy to a two-stage heat treatment by first heating it during several hours at 650 to 895° C. and thereafter subjecting it during 8 to 30 hours to soaking at 1020 to 1100° C., then cooling and finally ageing at 650 to 850° C.

2. The process of claim 1 in which the preliminary heat treatment is carried through 5 to 30 hours.

3. The process of claim 1 in which the preliminary heat treatment is carried through 5 to 30 hours and the temperature is lowered during the latter part of the preliminary treatment.

4. The process of claim 1, in which the alloy is cooled between the preliminary and the normal heat treatment.

5. The process of claim 1, in which titanium is the hardening element.

6. The process of claim 1, in which titanium and iron are the hardening elements.

7. The process of claim 1 as applied to a nickel-chromium alloy containing substantially 80 per cent nickel, 20 per cent chromium and small percentages of titanium and iron.

8. The process of claim 1, as applied to a nickel-chromium alloy containing 13 to 23 per cent chromium, more than 10 and up to 35 per cent cobalt, 0.01 to 5 per cent titanium and 1 to 9 per cent aluminum, the remainder being nickel.

HAROLD ERNEST GRESHAM.
DOUGLAS WILSON HALL.

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