(12) UK Patent Application (19) GB (11) 2 117 412 A

(21) Application No **8209576**
(22) Date of filing **31 Mar 1982**
(43) Application published
12 Oct 1983
(51) **INT CL**[3]
C22C 1/02
(52) Domestic classification
C7D 8A2 8J 8Q 8R 8W
9A2 9D2A 9D2B 9D2C
(56) Documents cited
None
(58) Field of search
C7D
(71) Applicant
Rolls-Royce Limited,
(Great Britain),
65 Buckingham Gate,
London,
SW1E 6AT
(72) Inventors
Geoffrey William Meetham,
John David Gibbons
(74) Agent and/or address for service
J. C. Purcell,
Company Patents and Licensing Dept.,
Rolls-Royce Limited,
P.O. Box 31,
Moor Lane,
Derby,
DE2 8BJ

(54) Making an alloy by remelting powder of selected particle size

(57) Powder produced superalloys have a sensitivity to small inclusions which vitiates to some extent their otherwise good properties. Cast materials on the other hand appear to be able to tolerate these small inclusions. In the present invention a molten alloy is atomised, preferably by inert gas or hydrogen, and the product classified to provide powder having a selected range of particle sizes. That powder is compacted into an ingot which is then remelted, possibly by vacuum arc or electron beam.

The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

GB 2 117 412 A

2117412

Fig.1.

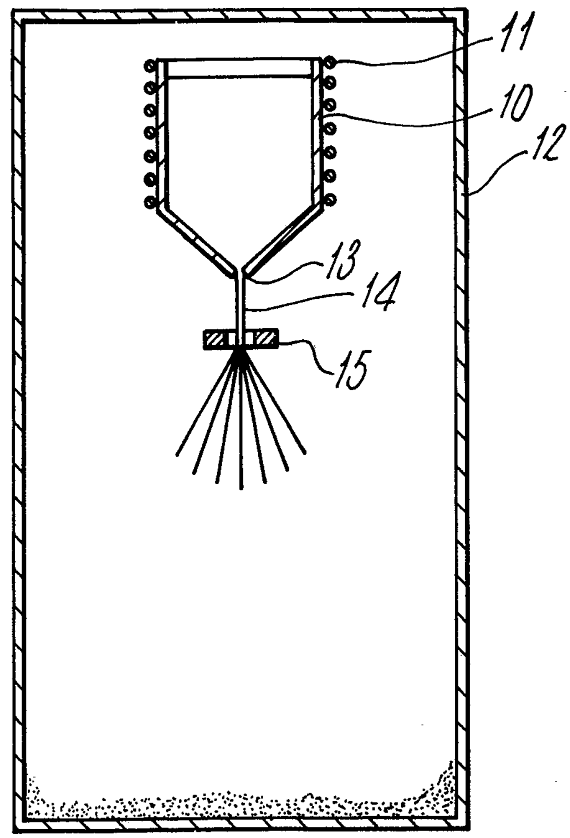
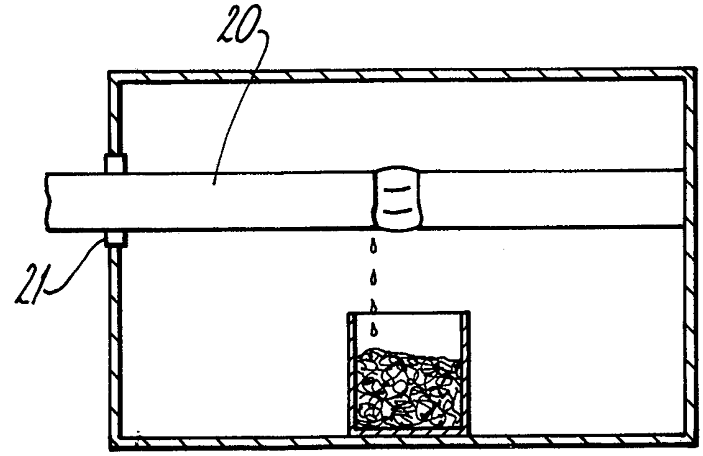


Fig.2.



SPECIFICATION

A method of making an alloy

This invention relates to a method of making an alloy. In the pursuit of better properties for the superalloy material used in the hot parts of gas turbine engines, one development has been the use of powder materials. These materials are formed by melting the alloy in question, then causing it to solidify in the form of a fine powder. This may be done using various methods such as fragmenting a stream of the molten metal.

Because of the small size of the particles of powder their solidification occurs very rapidly, and there is therefore very little of the chemical segregation which occurs during normal casting processes. The powder is normally sieved before being used, and this limits the size of inclusions to that of the individual powder particles. It is then usual to compact the powder to form a blank for the final objects to be produced.

The powder metallurgy route thus promises to enable the production of objects in a material which is of uniform properties (because of the lack of segregation), with only small inclusions (larger inclusions are rejected in the sieving process).

While these desirable features are usually present in a powder-produced object, the material has unfortunately been found to be much less defect tolerance than the conventional cast/forged material. Therefore, the very small inclusions which do remain in the final material have been found to have a substantial effect on the properties of the final material, reducing the fatigue properties in particular so that their high strength and other good properties cannot be utilised to the full.

The present invention provides a method of manufacture in which the good properties of the powder produced material may be substantially retained while the defect tolerance of conventional cast/forged material is incorporated.

According to the present invention a method of making an alloy comprises melting the alloy, causing it to solidify in the form of a powder, selecting a proportion of the powder within a predetermined range of particle sizes, compacting the selected proportion to form a billet, and remelting and resolidifying the billet in such a manner as to avoid the introduction of refractory inclusions or substantially segregation of constituents.

Remelting and resolidifying the billet may be carried out using for instance an electron beam melting process or a vacuum arc process.

The production of the powder may be carried out by argon atomisation or by hydrogen atomisation or by other processes.

The invention will now be particularly described, merely by way of example with reference to the accompanying drawings in which:—

Fig. 1 illustrates the production of powder material,

Fig. 2 shows the billet being remelted and resolidified.

Referring first to Fig. 1, the alloy concerned is held in a refractory vessel 10 and is maintained in a molten state by induction heating coils 11 surrounding the vessel 10 and providing the necessary electrical field. In order to avoid oxidation of the molten metal the vessel 10 and the remaining apparatus is contained in a chamber 12 in which a vacuum or an inert atmosphere is maintained.

The alloy used could be one of a wide variety of superalloys, but one example is the alloy known as Astroloy and comprising:—

	% by Weight
Chromium	15
Titanium	3.5
Aluminium	4
Cobalt	17
Molybdenum	5
Nickel	balance

In order to atomise the alloy, a fine nozzle 13 is provided in the vessel 10 from which the alloy falls in a thin stream 14. The stream 14 is broken up and the alloy atomised by argon supplied from nozzles 15. Once the metal is atomised the very fine particles thus produced solidify very rapidly because of their high surface areu relative to their volume.

The solidified particles thus produced are caught in the chamber 12. It is then necessary to grade the powder to remove particles above a certain size, whether these be of metal or of refractory or other inclusions resulting from earlier stages of the metal processing. Typical powder sizes used are up to 150 microns in diameter.

The powder is then degassed, sieved, canned and compacted by hot isostatic pressing, extrusion or other appropriate process. In this way consolidated powder billets are produced.

This next stage is illustrated in Fig. 2. One of the consolidated powder billets shown at 20 is mounted horizontally through a vacuum seal 21. An electron beam gun 22 is used to heat the billet 20 which rotates at a controlled rate and moves horizontally to maintain its position over the water cooled copper ingot mould 23 into which the droplets of molten metal fall. The current applied to the electron gun is controlled so as to provide the melting rate required to produce the necessary chemical homogenity in the ingot produced. The whole process is carried out in an evacuated chamber 24.

Eventually the mould 23 will be filled with the remelted metal, which will hold together as a cohesive piece, but which will require further compaction and forging before use. However, the material thus produced will have the advantages of small size of inclusion (due to the sieved powder starting stock) and consistent composition due to the rapid solidification involved, together with the tolerance of small defects provided by the fact that the final process is essentially a cast/forge process.

It would be possible to envisage alternatives to all the steps of the process referred to above. Thus there are a number of alternative powder alloy producing methods available, for example the hydrogen atomisation process known to those skilled in the art. Various methods for grading and compacting could be used, and one particular replacement for the electron beam melting process would be a vacuum arc melting process.

Claims

1. A method of making an alloy comprising melting the alloy, causing it to solidify in the form of a powder, selecting a proportion of the powder within a predetermined range of particle sizes, compacting the selected proportion of powder to form a billet, and remelting and resolidifying the billet in such a manner as to avoid the introduction of inclusions or substantial segregation of the constituents.

2. A method as claimed in claim 1 and in which said remelting and resolidification is carried out using an electron beam process.

3. A method as claimed in claim 1 and in which said remelting and resolidification is carried out using a vacuum arc process to melt said billet.

4. A method as claimed in any one of the preceding claims and in which said powder is produced by atomising a stream of molten metal with inert gas.

5. A method as claimed in claim 4 and in which said inert gas is argon.

6. A method as claimed in any one of claims 1—3 and in which said powder is produced by a hydrogen atomisation process.

7. A method substantially as hereinbefore particularly described with reference to the accompanying drawings.

8. An alloy made by the method of any one of the preceding claims.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1983. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.