CONVENTION. By one or more persons and/or

COMMONWEALTH OF AUSTRALIA
Patents

CONVENTION APPLICATION FOR A PATENT

We (1)

CABOT CORPORATION,
of 125 High Street,
Boston, Massachusetts 02110,
United States of America,

hereby apply for the grant of a Patent for an invention entitled: (2)

"METHOD OF SALVAGING AND RESTORING USEFUL PROPERTIES TO USED AND RETIRED METAL ARTICLES"

which is described in the accompanying complete specification. This application is a Convention application and is based on the application numbered (3) 587,041

for a patent or similar protection made in (4) United States of America, on 16th June, 1975,

Our address for service is Messrs. Edwd. Waters & Sons, Patent Attorneys, 50 Queen Street, Melbourne, Victoria, Australia.

DATED this 9th day of June 1976

CABOT CORPORATION,

10 JUN 1976

PATENT OFFICE

THE COMMISSIONER OF PATENTS.

Edwd. Waters & Sons, Melbourne.
COMMONWEALTH OF AUSTRALIA

Patents Act 1952-1969

DECLARATION IN SUPPORT OF A CONVENTION APPLICATION FOR A PATENT OR PATENT OF ADDITION

In support of the Convention Application made by

CABOT CORPORATION

(herinafter referred to as the applicant) for a Patent for an invention entitled:

METHOD OF SALVAGING AND RESTORING USEFUL PROPERTIES TO USED AND RETIRED METAL ARTICLES

I, (1) Robert Vartan Meghrebian

of 125 High Street, Boston Massachusetts,

United States of America

do solemnly and sincerely declare as follows:

1. I am authorised by the applicant for the patent to make this declaration on its behalf.

2. The basic application as defined by Section 141 of the Act was made in (2) United States of America on the (3) day of June 1976, by

KENNETH C. ANTONY

3. The said KENNETH C. ANTONY

of 4700 N. Parkway Dr., Kokomo, County of Howard, Indiana, United States of America

is the actual inventor of the invention and the facts upon which the applicant is entitled to make the application are as follow:

The applicant is the assignee of the said KENNETH C. ANTONY

4. The basic application referred to in paragraph 2 of this Declaration was the first application made in a Convention country in respect of the invention the subject of the application.

DECLARED at Boston, Massachusetts, U.S.A. this day of May 1976.

CABOT CORPORATION

To: THE COMMISSIONER OF PATENTS.
APPLICATION

COMPLETE SPECIFICATION

LODGED IN RESPECT OF

APPLICATION FOR PATENT

NOTIFICATION OF LODGMENT AND ACKNOWLEDGMENT OF DOCUMENTS

Name of applicant:  CALLOT CORPORATION

The following were lodged at the Patent Office on 12-6-1976:

- Fee $20
- Application for patent
- Declaration in support
- Complete specification
  - description 8 sheets including
  - drawings 1 sheet
  - claims 7 in number
- True copy of complete specification including drawings
- Additional copy of claims
- Certified copy of basic specification and translation

Address for service: L.B. & Sons

for Commissioner of Patents

F. D. ATKINSON, Government Printer, Canberra
DOCUMENTS LODGED WITH THIS APPLICATION ARE UNSUITABLE FOR REPRODUCTION AND MAY BE INSPECTED AT THE PATENT OFFICE A.C.T.
Commonwealth of Australia
Patents Act 1952-69

Complete Specification
(Original)

Application Number: 147971/66
Lodged: 10/9/66
Int. Class: C 22 F 001/10, C 22 F 001/11, C 22 F 001/16

Complete Specification Lodged: 10/9/66
Accepted: LODGED BEC 460/86 (5)
Published: 15/3/77

Priority:
U.S. 1614/75, 587,041

Related Art:

Name of Applicant: CABOT CORPORATION

Address of Applicant: 125, HIGH STREET, BOSTON, MASSACHUSETTS, U.S.A.

Actual Inventor: KENNETH G. ANTONY

Address for Service: EDWD. WATERS & SONS,
50 QUEEN STREET, MELBOURNE, AUSTRALIA, 3000.

Complete Specification for the invention entitled: "METHOD OF SALVAGING AND RESTORING USEFUL PROPERTIES TO USED AND RETIRED METAL ARTICLES"

O.S. 5/6/78

The following statement is a full description of this invention, including the best method of performing it known to □ US
This invention relates to methods of salvaging and restoring useful properties to used and retired metal articles and particularly to a method of restoring physical and mechanical properties to articles used at elevated temperatures which have exceeded their creep life and have been retired or discarded from service.

It is well-recognised that many metal parts, subject to high temperature, will over a period of time be subject to permanent creep damage in the form of creep-induced grain boundary voids and, consequently, are removed from service and considered scrap. Typical of such parts are, for example, turbine blades used in jet aircraft motors. This is, of course, a major item of cost in this particular field of use, among others.

It has now been discovered that these creep-induced defects can be eliminated without affecting the geometry of the metal part and, in many cases, with general overall improvement in properties to equal or exceed the properties of the part as originally made.

It has now been found that creep-induced micro defects can be eliminated and stress rupture properties restored at or above original equipment levels by hot isostatic processing (HIP) the metal objects which have been removed from service because of over temperature conditions and/or creep damage.

Preferably, the parts to be restored are hot isostatically pressed in an inert atmosphere such as argon or helium gas inside a high pressure autoclave at temperatures in the range of about 1800°F. to about 2300°F., depending upon the metal being treated and at pressures in the general range 5,000 to 50,000 p.s.i., again depending upon the metal and its condition.
The invention can perhaps best be understood by reference to examples of its practice applied to metal parts which had been removed from service because of over-temperature conditions.

In order to determine the effectiveness of the practice of this invention, the dovetail properties and air-foil properties of a new, unused blade (identified as As-Cast) made of 713C alloy were compared with a used, over-temperatures blade and with used, over-temperatures blades treated according to this invention. The properties are summarized in Table I below:
### TABLE I

<table>
<thead>
<tr>
<th>Blade History</th>
<th>Dovetail Section</th>
<th>Airfoil Section</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RT Tensile</td>
<td>Stress-Rupture</td>
</tr>
<tr>
<td></td>
<td>.2 YS (ksi)</td>
<td>1400°F/100ksi (hrs)</td>
</tr>
<tr>
<td>As-Cast</td>
<td>121</td>
<td>-</td>
</tr>
<tr>
<td>Over-Temperated</td>
<td>107</td>
<td>2.3</td>
</tr>
<tr>
<td>HIP'ed</td>
<td>101</td>
<td>1.0</td>
</tr>
<tr>
<td>HIP'ed + Heat Treatment A</td>
<td>132</td>
<td>21.5</td>
</tr>
<tr>
<td>HIP'ed + Heat Treatment B</td>
<td>123</td>
<td>6.0</td>
</tr>
<tr>
<td>Specification Minimum</td>
<td>100</td>
<td>(3)*</td>
</tr>
</tbody>
</table>

*Elongation minimum - RA not specified

This data clearly show that original equipment properties have been restored (actually exceeded) in over-temperature blades by the hot isostatic pressing and heat treating according to the process of this invention.
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</tr>
<tr>
<td></td>
<td>1400°F/1800°F</td>
<td>1500°F/22 ksi</td>
</tr>
<tr>
<td>(.2 YS, UTS, RA)</td>
<td>100ksi, 22 ksi</td>
<td>100ksi, 22 ksi</td>
</tr>
<tr>
<td>As-Cast</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over-Temperatured</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIP'ed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIP'ed + Heat Treatment A</td>
<td></td>
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</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>Specification Minimum</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Elongation minimum - RA not specified

This data clearly show that original equipment properties have been restored (actually exceeded) in over-temperature blades by the hot isostatic pressing and heat treating according to the process of this invention.
In this particular example, the blades were hot isostatically pressed in a high temperature, high pressure autoclave in an atmosphere of argon at 2250°F and a pressure of 15,000 p.s.i.

Heat treatment A consisted of the following steps:
2250°F; 1/2 hour; Rapid air cool

Heat treatment B consisted of the following steps:
2250°F; 1/2 hour; Rapid air cool
1600°F; 2 hour; air cool

The effectiveness of HIP-salvaging in eliminating creep-induced micro defects is illustrated in the accompanying drawing. The density of micro defects in the as-cast blade was actually greater than the over-temperured blade which presumably contained creep-induced micro defects as well as as-cast micro defects. This discrepancy accentuates the variability associated with cast products. The important point, however, is that despite this variability, HIP-processing eliminated micro defects regardless of source.
CLAIMS
The claims defining the Invention are as follows:

1. A method of salvaging and restoring physical properties to used over-temperatured metal parts comprising hot isostatically pressing said part at temperatures and pressures sufficient to eliminate creep-induced micro defects.

2. The method as claimed in claim 1 wherein said metal parts are hot isostatically pressed in an inert atmosphere.

3. The method as claimed in claim 1 wherein said metal parts are hot isostatically pressed at temperatures between about 1800°F and 2300°F.

4. The method as claimed in claim 1 wherein said metal parts are hot isostatically pressed at pressures in the range 5,000 to 50,000 p.s.i.

5. The method as claimed in claim 1 wherein the metal parts are hot isostatically pressed at temperatures in the range 1800°F to 2300°F and pressures in the range 5,000 to 50,000 p.s.i.

6. The method as claimed in claim 2 wherein the metal parts are hot isostatically pressed at temperatures in the range 1800°F to 2300°F and pressures in the range 5,000 to 50,000 p.s.i.
7. A method of salvaging and restoring physical properties to used over-temperatured metal parts substantially as hereinbefore described.

DATED THIS 18TH MAY, 1976

CABOT CORPORATION

ND/IT

EDWD WATERS & SONS
PATENT ATTORNEYS
50 QUEEN STREET,
MELBOURNE, VICTORIA
AUSTRALIA.
Relative densities of microdefects in as-cast, over-temperated and HIP-salvaged blades at 50X.

According to this invention.
Relative densities of microdefects in as-cast, over-tempered and HIP-salvaged blades at 50X.
END