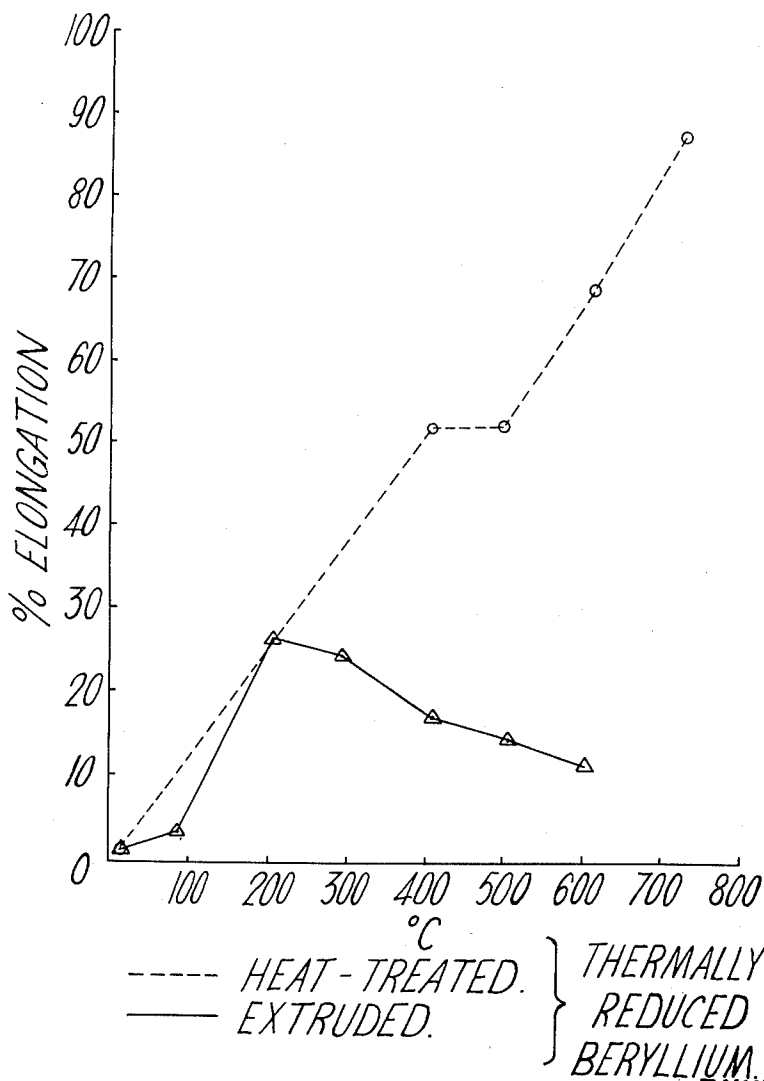


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PROCESS FOR THE PRODUCTION OF BERYLLIUM
HAVING INCREASED DUCTILITY
AT HIGH TEMPERATURES
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HAVING INCREASED DUCTILITY AT HIGH
TEMPERATURES

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6 Claims. (Cl. 148-13)

The invention relates to the production of beryllium
having increased ductility at high temperatures.

The metal beryllium has properties which could make
it of considerable use in a wide number of fields. In
particular it has a low neutron capture cross-section and
is therefore of considerable interest in the nuclear field.
Under some conditions it is, however, very brittle and
difficult to fabricate. Beryllium has low ductility at low
temperatures. The ductility increases as the temperature
rises reaching a maximum in the region of 300° C. to
400° C. after which it decreases. At temperatures in the
region of 700° C. it may increase again, but not signifi-
cantly.

The present invention provides a process for the produc-
tion of beryllium having increased high temperature duc-
tility, in particular having increased ductility between
about 300° C. and about 700° C.

The present invention provides a process for the produc-
tion of beryllium having increased high temperature duc-
tility in which thermally reduced beryllium or like equiv-
alent beryllium is heated to a temperature above 600° C.,
held at a temperature within the range of 600° and 850°
C. for a suitable period of time and then cooled to room
temperature.

The effect of the process is different from that of an-
nealing since after the stresses in the metal have been re-
lieved a continuing increase in ductility is obtained as the
metal is held at the temperature of treatment.

Another difference between an annealing process and
that of the invention is that while annealing may be ap-
plied in general to beryllium the process of the invention
can be applied successfully only to some beryllium namely
to beryllium of the nature produced by thermal reduction.
Thus, while the process is applicable to thermally reduced
beryllium, it is ineffective when applied to beryllium pro-
duced by the electrolytic process. Whether a sample of
beryllium is a like equivalent to thermally reduced beryl-
lium in that the process of the invention can be success-
fully applied is a matter which may be determined by
test.

The reason for the increase in ductility in beryllium
heat-treated in accordance with the process of the inven-
tion is not clearly known but it is considered that it is
probably due to precipitation of impurities and that iron
and at least one other impurity possibly aluminum are
involved. In this connection it is to be noted that the
iron-content of beryllium as produced by the reduction of
BeF₂ by Mg is typically of the order of 1000 p.p.m. or
0.1%, while the iron content of beryllium produced by
the electrolysis of a BeCl₂-NaCl melt is typically of the
order of only 200-400 p.p.m. Whatever the reason,
whether or not a sample of beryllium is for the purpose of
this invention beryllium of the nature produced by thermal

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reduction is ascertainable by the means of a simple test.

The degree of high-temperature ductility obtained de-
pends upon the time and temperature employed in the
heat treatment. Heating for at least 12 hours produces
a marked result at all temperatures at which the beryllium
is held within the range. The time taken in any instance
to attain a particular degree of ductility depends upon the
temperature which is preferably at least 700° and more
preferably in the range between 750° C. and 850° C.
While a shorter time may suffice it may be found advan-
tageous to heat for at least 24 hours and even for more
than 72 hours. Thus at a temperature of 600° C. the
beryllium may be heated with advantage for several weeks.

The heat treatment is carried out in an atmosphere inert
to beryllium, e.g. argon or vacuum, in any suitable fur-
nace. After the heat treatment the beryllium is cooled
slowly in any manner convenient. It has been found
convenient to cool the beryllium in the same environment
as that in which the heat treatment was carried out.

The process of the present invention is illustrated in the
following example.

EXAMPLE

Thermally reduced beryllium, having the analysis
shown in Table I, was heat treated at 780° C. for 120
hours and cooled to room temperature over 120 hours.

Table I

Alloy:		Average of 3 analyses, p.p.m. in weight
30	Iron -----	993
	Aluminum -----	663
	Silicon -----	843
	Magnesium -----	9
	Manganese -----	70
35	Nickel -----	220
	Copper -----	10
	Chromium -----	110
	Oxygen -----	240
	Beryllium carbide -----	400
40	Beryllium -----	Remainder

The figure shows the variation of elongation at varying
temperatures of beryllium having the analysis shown in
Table I, extruded at 1050° C. and tested at this stage,
compared with the same material, which, after extrusion,
has been heat treated in accordance with the invention.
The extruded beryllium, which has now been subjected to
the process of the present invention, shows a maximum
ductility at about 200° C. after which the ductility falls
slightly to about 300° C. and then more sharply to about
600° C. The same material, heat treated after extrusion,
in accordance with the invention, shows a progressively in-
creasing ductility up to 700° C.

It is considered that the increased ductility after heat
treatment according to the present invention would be of
particular benefit in the fabrication of beryllium at tem-
peratures above 400° C. and in any high temperature use
of beryllium where high creep or tensile ductility is re-
quired.

We claim:

1. A process for the production of beryllium having
materially increased ductility on the order of at least
about 25% in the temperature range 300-700° C. from
beryllium reduced by thermal reduction, which comprises
heating the thermally reduced beryllium to a temperature

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above 600° C., maintaining the temperature within the range of about 600–850° C. for a period of time at least about 5 hours, and permitting the treated beryllium to cool to room temperature.

2. A process in accordance with claim 1, wherein the temperature is maintained within the selected temperature range for a period of time of at least about 12 hours.

3. A process in accordance with claim 1, wherein the temperature is maintained within the selected temperature range for a period of time of at least about 24 hours.

4. A process in accordance with claim 1, wherein the temperature is maintained within the selected temperature

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range for a period of time of at least about 72 hours.

5. A process in accordance with claim 1, wherein the temperature to which the beryllium is heated and that at which it is maintained is at least about 700° C.

6. A process in accordance with claim 1, wherein the heat treatment is carried out in an atmosphere inert to beryllium.

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