

(19)



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11) Publication number:

0 329 378 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: **16.06.93** (51) Int. Cl.⁵: **F27B 5/04**, F27D 1/12,
F27D 1/00

(21) Application number: **89301381.3**

(22) Date of filing: **14.02.89**

(54) **Vacuum heat treating furnace.**

(30) Priority: **15.02.88 JP 32046/88**

(43) Date of publication of application:
23.08.89 Bulletin 89/34

(45) Publication of the grant of the patent:
16.06.93 Bulletin 93/24

(84) Designated Contracting States:
DE FR GB IT

(56) References cited:
EP-A- 0 248 674
FR-A- 1 496 743
GB-A- 2 192 260
US-A- 1 693 378
US-A- 4 113 426

(73) Proprietor: **Research Development Corpora-
tion of Japan**
5-2, Nagatacho 2-chome
Chiyoda-ku Tokyo(JP)

(72) Inventor: **Ishimaru,Hajime**
Uenomuro 2079
Tsukuba-city Ibaragi(JP)

(74) Representative: **Davies, Christopher Robert et
al**
Frank B. Dehn & Co. Imperial House 15-19
Kingsway
London WC2B 6UZ (GB)

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid (Art. 99(1) European patent convention).

EP 0 329 378 B1

Description

The present invention relates to a vacuum heat treating furnace, more specifically to a vacuum heat treating furnace capable of being highly stable against heat treatments, including baking treatment to be applied on the component parts of particle accelerators and conducting said heat treatment at high efficiency.

Conventionally vacuum heat treating furnaces, in which a thermal shield enclosure and a heater designed to heat the inner space of said enclosure is provided in a vacuum chamber, have been known. In such conventional vacuum heat treating furnaces, the vacuum chamber is normally composed of steel materials with high melting points, including common steel and stainless steel.

These steel materials possess high heat radiation rate and low thermal conductivity, and hence sufficient space is provided between the vacuum chamber and the thermal shield enclosure disposed therein so that these steel materials can withstand the heat transferred from the hot heat treating portion. A cooling piping is also provided to cool the wall of the vacuum chamber.

For the aforementioned reasons, in the conventional vacuum heat treating furnaces, the vacuum chamber attained larger size, and a large amount of cooling water had to be introduced into the cooling piping; it inevitably became costly.

Viewed from one aspect the invention provides a vacuum heat treating furnace having a thermal shield enclosure defining an inner heat treatment region, supported by an insulating supporting element and located inside a vacuum chamber having a connection for a vacuum exhaust system, so that said inner heat treatment region is spaced from the vacuum chamber wall, an electric heater for heating said heat treatment region and an electric power supply connection to said electric heater, characterised in that said vacuum chamber is formed of aluminium or of an aluminium alloy and the inner wall surface of said vacuum chamber is provided with a smooth finish.

At least in preferred embodiments, the invention may provide a vacuum heat treating furnace which overcomes the defects of the conventional devices in terms of size and cost, and is capable of achieving the downsizing of the vacuum chamber and the elimination or simplification of the cooling system through improvement of the material of the vacuum chamber. The furnace is highly stable against heat treatments, including baking treatment, and can conduct said heat treatment as high efficiency.

An embodiment of the invention will now be described, by way of example only, with reference to the drawings, in which:

Fig. 1 is a vertical sectional view of one of the embodiments of a vacuum heat treating furnace according to the present invention:

Figs. 2 and 3 are partially sectional views of the transformed version of the cooling system of the vacuum heat treating furnace as illustrated in Fig. 1

Referring now in detail to the drawings, the embodiments of the present invention will be shown, and detailed descriptions given to this invention.

Fig. 1 is a vertical sectional view of one of the embodiments of the vacuum heat treating furnace according to the present invention.

In this example, a thermal shield enclosure 4 supported by an adiabatic supporting element 3 made of ceramic or other material is provided within a vacuum chamber 2 having a connection portion 1 to a vacuum exhaust system. The external surface of this thermal shield enclosure 4 is isolated from the inner wall surface 2a of the vacuum chamber 2 via space 5.

Inside the thermal shield enclosure 4 a heat treatment region 6 is provided, and an electric heater 7 composed of tungsten wire, nichrome wire or the like and designed to heat this heat treatment region 6 is embedded in the wall of the thermal shield enclosure 4. This heater 7 is linked to an electric power supply system 8.

In the vacuum heat treating furnace according to the preferred embodiment, the vacuum chamber 2 is formed of aluminium metal material (aluminium or aluminium alloy whose main ingredient is aluminium), and the inner wall surface of said vacuum chamber 2 is smoothly finished. It is preferable to provide the inner wall surface of the vacuum chamber 2 with a specular finish.

Pertaining to the aluminium metal material as described above, the melting point is about 600 °C, lower than that of about 1200 °C of the steel material which has been employed for the vacuum chamber in the conventional heat treating furnaces. However, the heat radiation rate on the surface area of aluminium metal material is in the order of 0.04, and said aluminium metal material offers markedly less heat absorption than the conventional vacuum chamber materials, such as soft steel (a radiation rate of 0.5) and stainless steel (a radiation rate of 0.4). As for thermal conductivity also, while the conventional soft steel is 167 kJ/mh °C (40 kcal/mh °C) and stainless steel 63 kJ/mh °C (15 kcal/mh °C), the aluminium material according to the preferred embodiment is 711 kJ/mh °C (170kcal/mh °C), which indicates that the latter provides improved release of the heat absorbed.

In the vacuum chamber 2 made of such aluminium metal material, smooth finish of the inner wall surface helps to reduce the quantity of heat

transferred from the thermal shield enclosure 4 through space 5 to the vacuum chamber 2 resulting from heater 7. The heat transferred onto the inner wall surface 2a of the vacuum chamber 2 quickly shifts in the thickness direction of the wall of the vacuum chamber 2 due to the high thermal conductivity of the aluminium metal material, and can be released from the external surface of the vacuum chamber 2.

The lower melting point of the aluminium metal material does not adversely affect the thermal resistance strength vacuum chamber 2. Accordingly, the flow rate of the cooling water used in the cooling system comprised of a cooling water piping 9 designed to cool the vacuum chamber 2 can be reduced, and the capacity of the cooling water pump (not shown) can also be made smaller, thereby permitting the simplification of the cooling system.

As illustrated in Fig. 2, since it is also possible to make the cooling water piping 9 smaller, it is possible to embed said cooling water piping 9 in the wall of the vacuum chamber 2.

Furthermore, as indicated in Fig. 3, sufficient cooling effect can be obtained by merely providing radiating fins 10 on the external wall surface of the vacuum chamber 2.

Additionally, cooling water piping may be provided to cool the high temperature area comprising of heat treatment region 6 and thermal shield enclosure 4. Furthermore, cooling absorbing equipment may be provided in vacuum chamber in order to absorb pollution materials generated from the high temperature area, which impede thermal efficiency of the vacuum heat treating furnace.

The vacuum heat treating furnace according to the present invention has been accomplished by adopting aluminium metal material for the vacuum chamber, having low heat radiation and high thermal conductivity, although said material has been conventionally thought unsuitable for material of a vacuum heat treating furnace because of its lower melting point.

In the vacuum heat treating furnace according to the preferred embodiment, a combination of the thermal characteristics of aluminium metal material, whose heat radiation is 1-digit lower than the conventional steel materials and whose thermal conductivity is markedly higher, and smoothly finished inner wall surface of the vacuum chamber can improve the heat resistance of the vacuum chamber and make the space between the vacuum chamber and the thermal shield enclosure inside said chamber to be less than the conventional types. This could reduce the size and weight of the vacuum chamber or widen the heat treatment region within the thermal shield enclosure wall. Since the quantity of heat transferred from the thermal

shield enclosure to the vacuum chamber becomes less, it becomes possible to substantially simplify or eliminate the cooling system which is used to cool the vacuum chamber. Furthermore, the improved thermal efficiency of the vacuum heat treating furnace can help to save the power applied on an electric heater.

Claims

1. A vacuum heat treating furnace having a thermal shield enclosure defining an inner heat treatment region, supported by an insulating supporting element and located inside a vacuum chamber having a connection for a vacuum exhaust system, so that said inner heat treatment region is spaced from the vacuum chamber wall, an electric heater for heating said heat treatment region, and an electric power supply connection to said electric heater, characterised in that said vacuum chamber is formed of aluminium or of an aluminium alloy and the inner wall surface of said vacuum chamber is provided with a smooth finish.
2. A vacuum heat treating furnace as claimed in claim 1 wherein cooling means in the form of cooling liquid conduits or fins are associated with the vacuum chamber.
3. A vacuum heat treating furnace as claimed in claim 2 wherein cooling liquid conduits are embedded in the wall of the chamber.

Patentansprüche

1. Vakuumofen für thermische Behandlungen mit
 - einer Hitzeschildverkleidung, welche einen inneren Bereich für thermische Behandlungen festlegt, welche durch ein isolierendes Tragelement getragen ist, und welche innerhalb einer Vakuumkammer mit einem Anschluß für ein Vakuumablaßsystem derart angeordnet ist, daß der innere Bereich für thermische Behandlungen von der Vakuumkammerwand beabstandet ist,
 - einem elektrischen Erhitzer zum Erhitzen des Bereichs für thermische Behandlungen, und
 - einer Elektrizitäts-Versorgungsverbindung zu dem Erhitzer,

dadurch gekennzeichnet,

daß die Vakuumkammer aus Aluminium oder aus einer Aluminiumlegierung besteht, und daß die innere Wandoberfläche der Vakuumkammer eine glatte Oberflächenbeschaffenheit aufweist.

2. Vakuumofen für thermische Behandlungen nach Anspruch 1, worin der Vakuumkammer Kühlungseinrichtungen in Form von Kühlflüssigkeitsleitungen oder Rippen zugeordnet sind. 5
3. Vakuumofen für thermische Behandlungen nach Anspruch 2, worin die Kühlflüssigkeitsleitungen in die Wand der Kammer eingebettet sind. 10

Revendications

1. Four pour traitement thermique sous vide ayant une enceinte de protection thermique définissant une région interne de traitement thermique, supportée par un élément de support d'isolation et située à l'intérieur d'une chambre à vide ayant un raccordement pour un système de pompage à vide, de sorte que ladite région interne de traitement thermique est éloignée de la paroi de la chambre à vide, un dispositif électrique de chauffage pour chauffer ladite région interne de traitement thermique et un raccordement pour l'alimentation électrique dudit dispositif électrique de chauffage, caractérisé en ce que ladite chambre à vide est formée d'aluminium ou d'un alliage d'aluminium et la paroi interne de ladite chambre à vide présente une surface polie. 15
20
25
30
2. Four pour traitement thermique sous vide selon la revendication 1, dans lequel des moyens de refroidissement sous la forme d'ailettes ou de canalisations pour un fluide de refroidissement sont associés à la chambre à vide. 35
3. Four pour traitement thermique sous vide selon la revendication 2, dans lequel les canalisations pour le fluide de refroidissement sont incorporées dans la paroi de la chambre. 40

45

50

55

FIG. 1

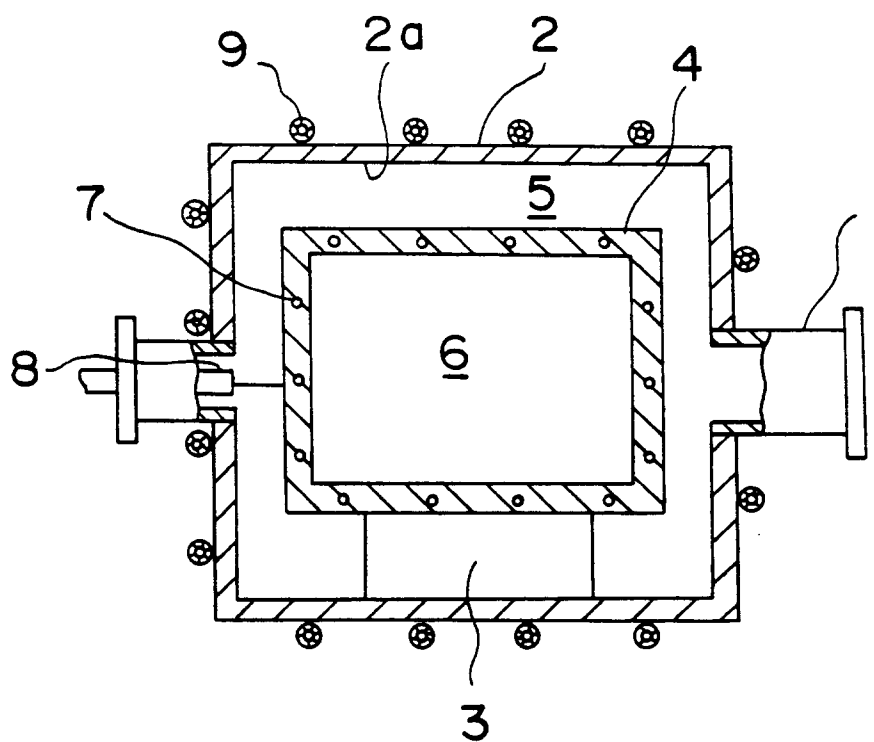


FIG. 2

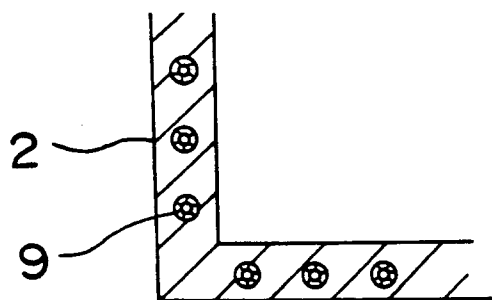


FIG. 3

