NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

REPLY TO
ATTN OF: GP

April 5, 1971

TO: USI/Scientific & Technical Information Division
Attention: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General
Counsel for Patent Matters

SUBJECT: Announcement of NASA-Owned
U.S. Patents in STAR

In accordance with the procedures contained in the Code GP to Code USI memorandum on this subject, dated June 8, 1970, the attached NASA-owned U.S. patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U.S. Patent No. : 3,409,730

Corporate Source : Lewis Research Center

Supplementary
Corporate Source :

NASA Patent Case No.: XLE-03432

G Parker

Gayle Parker

Enclosure:
Copy of Patent

FACILITY FORM 602

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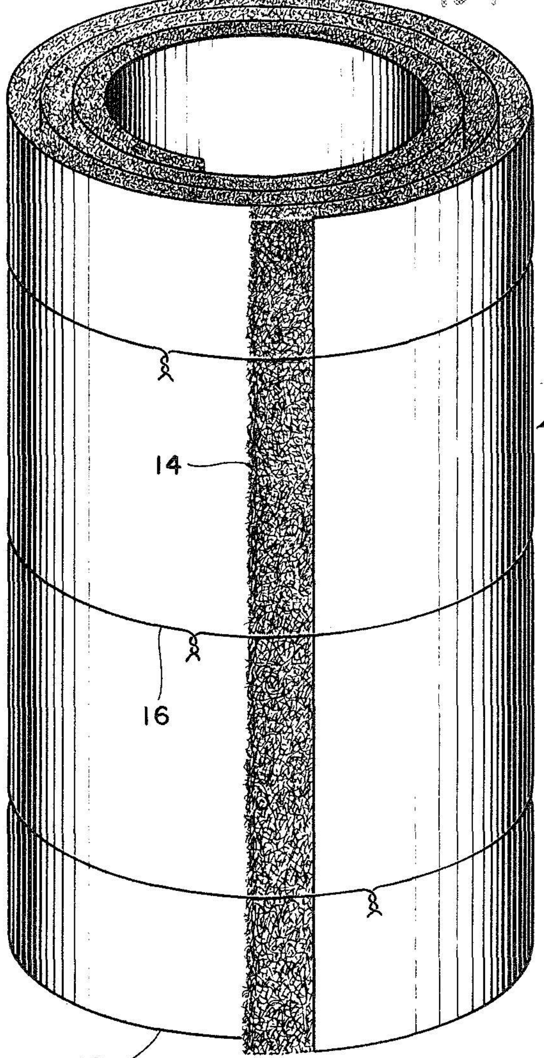
Nov. 5, 1968 B. T. EBIHARA 3,409,730

THERMAL RADIATION SHIELDING

Filed June 17, 1966

N71-24145 40970

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# 3,409,730
# THERMAL RADIATION SHIELDING

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Filed June 17, 1966, Ser. No. 559,349
7 Claims. (Cl. 13—35)

## ABSTRACT OF THE DISCLOSURE

Spaced radiation barriers of refractory metal foil encircle an induction furnace. A mat of refractory metal fibers maintain the spacing between these radiation barriers.

*Statement of government ownership*

The invention described herein was made by an employee of the United States Government and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties thereon or therefor.

This invention is concerned with increasing the operating range of an induction furnace. More particularly, the invention relates to improved thermal radiation shielding for an induction furnace or other high temperature device.

The operating range of an induction furnace having a limited power supply and cooling capacity can be improved by more efficient shielding of the coil, furnace components, and surrounding atmosphere from the radiant heat that escapes from the metal being inductively heated. Ceramics have been customarily used as insulating materials in induction furnaces, but a ceramic material is limited to low service temperatures because of its melting point, resistivity, or chemical incompatibility.

For higher temperature applications multiple shielding with a composite of refractory metal sheets and ceramic oxide has been used to about 4500° F. However, most ceramics are sensitive to thermal shock which prevents rapid cycling of the temperature. Also, certain oxides having higher temperature capabilities above 3000° F. are toxic and radioactive. Because of these shielding and insulating problems, the operation of such induction furnaces at temperatures around 5500° F. has been extremely limited.

Tungsten has been proposed as a shielding material, but the greater care required in the handling and fabrication of this material complicates both the design and manufacture of the insulation. Tungsten is hard and brittle at room temperatures, and its fabrication requires experienced personnel as well as special machines and tools. When heated above 2000° F. by welding or otherwise tungsten becomes extremely brittle from recrystallization.

These problems have been solved by thermal radiation shielding constructed in accordance with the present invention. This shielding utilizes refractory metal foil laminated or alternated with clean refractory metal fine fibers. This insulation makes use of the principle of multiple radiation barriers to reduce the transfer of heat. The fibers serve as a low-conductivity spacer between these barriers.

It is, therefore, an object of the present invention to provide an improved thermal radiation shielding which utilizes all metal construction in the form of both foil and fibers.

Another object of the invention is to provide improved thermal radiation shielding for insulating an induction furnace which exhibits a minimum of susception in an induction field and has low thermal inertia together with insensitivity to thermal shock.

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A further object of the invention is to provide a light and compact shielding which can be fabricated by inexperienced personnel without special tools or equipment.

These and other objects of the invention will be apparent from the specification which follows and from the drawing.

The drawing is a perspective view of refractory metal foil and fiber mat composite shielding in a cylindrical configuration.

Referring now to the drawing, there is shown a composite form of improved thermal radiation shielding **10** constructed in accordance with the invention. The composite shielding structure **10** is spirally wrapped in the form of a cylinder to the desired thickness. The cylindrical shield **10** is adapted to encircle an induction furnace to contain the radiation from the furnace until it approaches the melting temperature of the shielding material. If desired, the diameter of the shielding **10** can be made small enough so that it will fit inside the furnace coil.

The shielding **10** includes a radiation shield **12** in the form of metal foil. The adjacent wraps of the foil **12** are separated by a spacer **14**.

Tungsten foil is used for the radiation shield **12**. One to two mils tungsten foil has been satisfactory for the shield **12**, and the thinness of the foil prevents or strongly inhibits electrical susception in the induction field of the furnace. While tungsten is the preferred material for the foil shield **12**, other materials, such as rhenium, tantalum, molybdenum, or platinum, can be used so long as the material is made into thin flexible foil sheets.

This shield **12** has a relatively short outgassing time when used in vacuum furnaces. This outgassing is primarily caused by absorbed gas on the surfaces rather than that absorbed deeply within the material.

The spacer **14** is in the form of a fine metal fibrous mat, and for optimum results at extremely high temperatures the metal fibers in the mat must be of the same metal as the foil in the shield **12** to achieve chemical compatibility. Tungsten fibers having a diameter of one to two mils have been found to be highly satisfactory for this purpose. These fibers are especially useful as spacers because of their low conductivity between the layers of foil caused by the loose packing of the fibers.

After the foil **12** and spacer mat **14** have been rolled into the insulating composite **10** a plurality of binding wires **16** are utilized to retain the cylindrical shape for subsequent mounting adjacent an induction furnace. This construction achieves an assembly of multiple radiation barriers and a minimum of space. This compactness is important in increasing the efficiency of the furnace induction coils while making possible closer coupling. Also the foil and fibrous mat are extremely light in weight.

Thermal radiation shielding constructed in accordance with the invention was tested in a vacuum induction furnace having a cylindrical interior 3.5 inches in diameter and 8 inches long to ascertain its value. A tungsten specimen having a diameter of two inches and a length of six inches was enclosed by a cylindrical shield **10**. The furnace produced a final temperature of 5850° F. on the specimen.

Because of its simplicity, the insulation composite **10** can be fabricated very easily by inexperienced personnel without special tools or equipment. The bulk density of the shielding reduces the thermal inertia for faster heat up and cool down time of the furnace. Also, the temperature can be cycled rapidly without high thermal stress.

While a preferred embodiment of the invention has been shown and described, it will be appreciated that various modifications can be made to the thermal radiation shielding without departing from the spirit of the invention or the scope of the subjoined claims. For example, while the lamination of foil **12** and fibers **14** is shown in the drawing as being wrapped spirally in a cylindrical shape to the desired thickness, it will be appreciated that the various layers can be wrapped concentrically prior to banding.

What is claimed is:

1. Thermal radiation shielding for an induction furnace to heat a specimen to an extremely high temperature comprising:
   - spaced refractory metal radiation barriers encircling the induction furnace adjacent thereto, and
   - spacers having a low thermal conductivity interposed between said radiation barriers to maintain the spacing therebetween, said spacers being fibers of the same refractory metal as said radiation barriers.

2. Thermal radiation shielding as claimed in claim 1 wherein the radiation barriers are foil.

3. Thermal radiation shielding as claimed in claim 2 wherein the refractory metal foil is extremely thin to inhibit electrical susception in the induction field of the furnace.



4. Thermal radiation shielding as claimed in claim 3 wherein the foil has a thickness of about one to two mils.

5. Thermal radiation shielding as claimed in claim 1 wherein the fibers have a diameter of about one to two mils.

6. Thermal radiation shielding as claimed in claim 5 wherein the fibers are in the form of mat.

7. Thermal radiation shielding as claimed in claim 6 wherein the fibrous mat composes tungsten fibers to enable the specimen to be heated to about 5500° F.


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