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

REPLY TO ATTN OF: GP

April 5, 1971

MEMORANDUM

TO: KSI/Scientific & Technical Information Division
Attn: 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. : 3,470,304

Corporate Source : Lewis Research Center

Supplementary Corporate Source :

NASA Patent Case No.: XLE-04026

Gayle Parker

Enclosure:
Copy of Patent

FACILITY FORM 602

N71-23267 (ACCESSION NUMBER) | (THRU)
4 (PAGES) | 00 (CODE)
(NASA CR OR TMX OR AD NUMBER) | 14 (CATEGORY)

INDUCTION FURNACE WITH PERFORATED TUNGSTEN FOIL SHIELDING

Filed Feb. 16. 1967

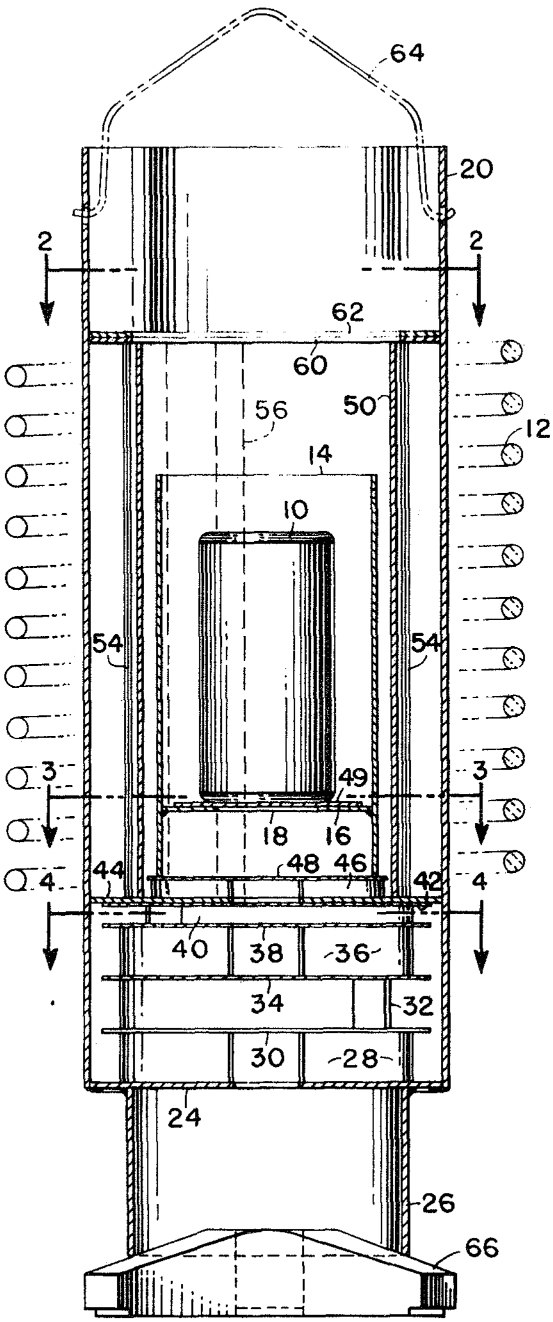

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FIG. 1

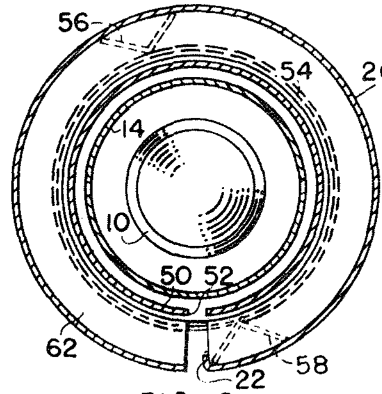

FIG. 2

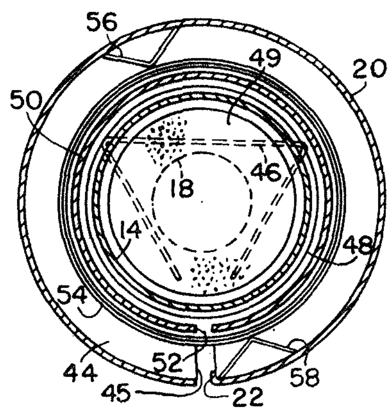

FIG. 3

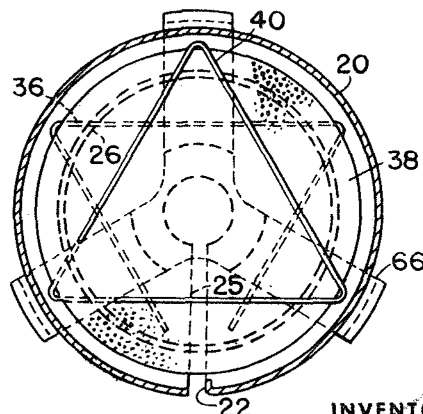

FIG. 4

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United States Patent Office

3,470,304

Patented Sept. 30, 1969

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3,470,304
INDUCTION FURNACE WITH PERFORATED TUNGSTEN FOIL SHIELDING

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Filed Feb. 16, 1967, Ser. No. 617,770
Int. Cl. H05b 5/16
U.S. Cl. 13—26 6 Claims

ABSTRACT OF THE DISCLOSURE

An induction heater having tungsten foil shielding between its coil and the specimen which is to be heated. The foil is perforated to minimize susception, and it is loosely wound into a tubular configuration about the susceptor or specimen.

Origin of the invention

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.

Background of the invention

This invention is concerned with the induction heating of metallurgical specimens to elevated temperatures in an induction coil furnace. The invention particularly relates to heating such specimens to 5000 to 6000° F. without reactions between refractory materials.

Induction coil furnaces make use of insulating refractory materials in the form of ceramics as well as precision made parts which are very close fitting. It has been found that certain test specimens react with the insulating material at the elevated temperatures to which these specimens are heated. Also, these conventional furnaces are constructed in such a manner that certain gases and atmospheres cannot be added during heating because of the danger of reaction with the ceramics at the very high temperatures which would reduce or volatilize the ceramic materials.

Certain of the ceramic insulators having high temperature capabilities are radioactive or toxic and are dangerous to operating personnel. Also, this material breaks down even when used only in vacuum because of thermal cycling and the accompanying thermal expansion and contraction. The sensitivity of ceramic insulation to damage from thermal gradients prevents use of rapid heating and cooling cycles in the furnace. Shielding present-day induction furnaces is complicated and costly with delays and equipment downtimes being encountered. Also, the ceramic insulators utilized in conventional furnace designs sometimes melt or outgas making attainment of high vacuum impractical when operating at very high temperatures.

Summary of the invention

These problems and difficulties have been solved by an induction heater constructed in accordance with the present invention. A split cup containing loosely coiled tungsten foil is utilized in the present invention instead of precision radiation shields and spacers used in prior art furnaces. This split cup forms a holder for either a susceptor cup or a billet which is to be inductively heated.

Objects of the invention

It is, therefore, an object of the present invention to provide an induction furnace having a minimum number

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of component parts which do not require close dimensional tolerances.

Another object of the invention is to provide a high temperature induction furnace which may be used with various gases or atmospheres.

Still another object of the invention is to provide an induction furnace which is readily adaptable to rapid heating and cooling cycles.

These and other objects of the invention will be apparent from the specification which follows and from the drawings wherein like numerals are used throughout to identify like parts.

Description of the drawings

FIG. 1 is a vertical section view of an induction furnace constructed in accordance with the present invention;

FIG. 2 is a plan view of the furnace taken along the line 2—2 in FIG. 1 showing the novel arrangement of the specimen, susceptor cup, split sleeve, foil shielding and container cup in an induction heater constructed in accordance with the invention;

FIG. 3 is a sectional view taken along the line 3—3 in FIG. 1 showing the manner in which the specimen is shielded in the furnace; and

FIG. 4 is a sectional view taken along the line 4—4 in FIG. 1 showing the relative positions of the supports and heat shields.

Description of the preferred embodiment

Referring now to the drawing, there is shown in FIG. 1 a specimen **10** which is to be inductively heated by a coil **12** of an induction furnace in a manner well known in the art. The specimen **10** is contained in a susceptor cup **14** which, in turn, is positioned in the induction coil **12**. The susceptor cup **14** is of tungsten and has a floor **16** upon which the specimen **10** rests. A centrally disposed opening **18** in the floor **16** enables an inert gas to pass through the susceptor cup **14** when the induction furnace is operated in an environment containing such a gas.

The susceptor cup **14** and specimen **10** must be properly shielded and insulated from the coil **12** and other furnace parts at high operating temperatures between 5000° and 6000° F. to prevent overheating and the resulting damage to the various furnace components. This is accomplished in the present invention by enclosing the specimen **10** and the susceptor cup **14** in a split container cup **20** which is also fabricated from tungsten sheet and then positioning the cup **20** in the coil **12**. Susception in the container cup **20** is minimized by a slot **22** extending along its entire length. The cup **20** has a generally cylindrical configuration as shown in the drawing, and its outside diameter is smaller than the inside diameter of the coil **12** to facilitate insertion.

A tungsten plate **24** having a radially extending slot **25** forms the bottom of the container cup **20**. A slotted cylindrical support **26** of tungsten is secured to the bottom of the plate **24** as shown in FIG. 1.

The split container cup **20** is removed from the coil **12**, and the bottom edge of the support **26** is placed on a flat surface remote from the furnace. A tungsten support **28** having a triangular shape is placed on the plate **24** at the bottom end of the split container cup **20**. The triangular support **28** is separated at one corner to inhibit susception.

A tungsten foil disk **30** is placed on the triangular support **28**. The disk **30** has a diameter slightly smaller than the inside diameter of the container cup **20** and a thickness of one mil.

An important feature of the invention lies in the fact that the foil disk **30** is perforated to minimize susception. This perforation is accomplished by placing the foil between two abrasive sheets, such as 50D garnet paper, and passing this assembly through a pair of pressure rolls.

Various specimens **10** which are to be heated will differ in size. Likewise, the susceptors **14** have different lengths to accommodate specimens of various lengths. Each specimen **10** is matched with a susceptor **14** having the proper length.

The susceptor **14** and specimen **10** should be located approximately at the center of the split container cup **20** for optimum heating. Consequently, the number of triangular supports and foil disks required will vary. Also, triangular supports having different widths may be used.

For example, in the embodiment shown in FIG. 1, a second triangular support **32** which is the same as the support **28** is placed in contact with the disk **30**. A second foil disk **34** is then placed on the triangular support **32**.

Still another triangular support **36** is placed on the disk **34**, and a similar disk **38** is placed on the opposite surface. A smaller triangular support **40** is placed on the foil disk **38**. Another perforated foil disk **42** is placed on the triangular support **40**.

It will be noted from FIG. 1 that the triangular support **40** is considerably narrower than the other triangular supports **28, 32** and **36**. FIG. 4 shows that the triangular supports are staggered when they are placed on top of one another in order to insure stability. With this arrangement the foil shields **30, 34, 38** and **42** act as heat barriers while the triangular supports **28, 32, 36** and **40** properly position the susceptor cup **14** and the specimen **10** within the split container cup **20**.

A circular tungsten plate **44** having a thickness of about .020 inch and a radially extending slot **45** is then placed over the foil disk **42** for added rigidity. Another triangular support **46** is placed on this plate. The thickness of the triangular support **46** is approximately the same as that of the triangular support **40**, and the length of each of its legs is shorter than the lengths of the corresponding legs of the other triangular supports. Another perforated tungsten foil disk **48** having a reduced diameter is placed on the support **46**.

A perforated disk **49** of one mil tungsten foil is placed over the opening **18** in the bottom plate **16** of the susceptor cup **14**. A specimen **10** is then placed in the susceptor cup **14** on the foil disk **49**, and the assembly is ready for positioning in the split container cup **20**. A pair of lifting hooks or the like engage opposed holes in the susceptor cup **14** near the uppermost end. The susceptor cup **14** and specimen **10** therein are picked up by the lifting hooks and properly centered in the split container cup **20**.

A split sleeve **50** made from a sheet of tungsten having a thickness of about 0.020 inch is then inserted into the container cup **20** around the susceptor cup **14** and triangular support **46**. A slit **52** inhibits susception in the split sleeve **50**. This slit is produced by separating the opposed edges of the sleeve **50** when it is formed from tungsten sheet.

One of the novel features of the invention is the utilization of tungsten foil **54** for shielding and insulating the susceptor cup **14**. This foil **54** has a thickness of one mil and is perforated in the manner previously described to inhibit susception. The foil **54** is loosely wound to a cylindrical configuration and placed about the split sleeve **50** which maintains the foil out of contact with the susceptor cup **14**.

A pair of chevron spacers **56** and **58** in the form of bent strips of tungsten are positioned between the foil shield **54** and the inside surface of the split cup container **20** on diametrically opposed sides of the specimen **10** as shown in FIGS. 2 and 3. These spacers prevent the foil shield **54** from unwrapping and contacting the split container cup **20**. The contact between the foil shield **54** and the inner surface of the split container cup **20** is further minimized by providing an inwardly turned flange on one edge of the slit **22** in the split container cup **20** as shown in FIGS. 2 to 4.

A split ring **60** of tungsten is placed about the periphery of the upper edge of the sleeve **50** to cover the space between the sleeve and the split container cup **20** containing the foil shield **54**. The split ring **60** is maintained in position by another split ring **62** which engages the upper surface of the split ring **60**.

After all the components are assembled in the manner shown in FIG. 1, the entire assembly is positioned in the center of the coil **12**. This is accomplished by utilizing a pair of lifting hooks **64** shown in FIG. 1. The legs of the hooks engage suitable holes which extend through the split container cup **20** adjacent the upper surface.

The assembly is accurately positioned within a coil **12** by utilizing a three-legged base plate **66** which rests on the bottom or floor of the furnace. A tapered upper surface on the base plate **66** engages the bottom edge of the support **26**. The upper end of the split container cup **20** is then covered by a perforated foil disk which is preferably attached to the furnace cover which encloses the coil **12**. The base plate **66** is preferably stainless steel while all of the other components of the furnace are tungsten. The majority of the tungsten structural elemens have a thickness of .020 inch. The foil has a thickness of one mil as pointed out above.

While a preferred embodiment of the improved furnace shielding has been shown and described, it will be appreciated that various structural modifications may be made without departing from the spirit of the invention or the scope of the subjoined claims. For example, the entire assembly can be suspended within the coil **12** by providing a suitable support for the hooks **64**. Also, when the specimen **10** is in the form of a billet it may be heated directly without the use of the susceptor cup **14**. In this case the split sleeve **50** is placed around the billet, and the foil shield **54** encircles the sleeve as shown in the drawings.

What is claimed is:

1. In a high temperature induction furnace having a coil for receiving a specimen to be heated, the improvement comprising

layers of perforated tungsten foil adjacent the specimen for heat shielding the same, and

means for supporting said foil layers when the specimen is positioned in the coil.

2. Apparatus as claimed in claim **1** including a susceptor cup for supporting the specimen in the coil.

3. Apparatus as claimed in claim **2** wherein the susceptor cup and thin foil are of the same material to prevent contamination of the specimen.

4. In a high temperature induction furnace having a coil for receiving a specimen to be heated, the improvement comprising

layers of thin foil adjacent the specimen for heat shielding the same, and

means for supporting said foil layers when the specimen is positioned in the coil comprising a split container cup having a slot extending along the entire length.

5. Apparatus as claimed in claim **4** including heat shields at one end of the split container cup.

6. In a high temperature induction furnace having a coil for receiving a specimen to be heated, the improvement comprising

a susceptor cup for supporting the specimen in the coil,

layers of perforated foil adjacent the specimen for heat shielding the same, both said susceptor cup and said perforated foil being of the same material to prevent contamination of the specimen, and

means for supporting said perforated foil layers when the specimen is positioned in the coil.

(References on following page)

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U.S. Cl. X.R.

219—10.49