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HIGH TEMPERATURE HEAT SOURCE

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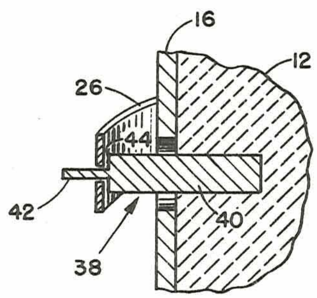

FIG. 2

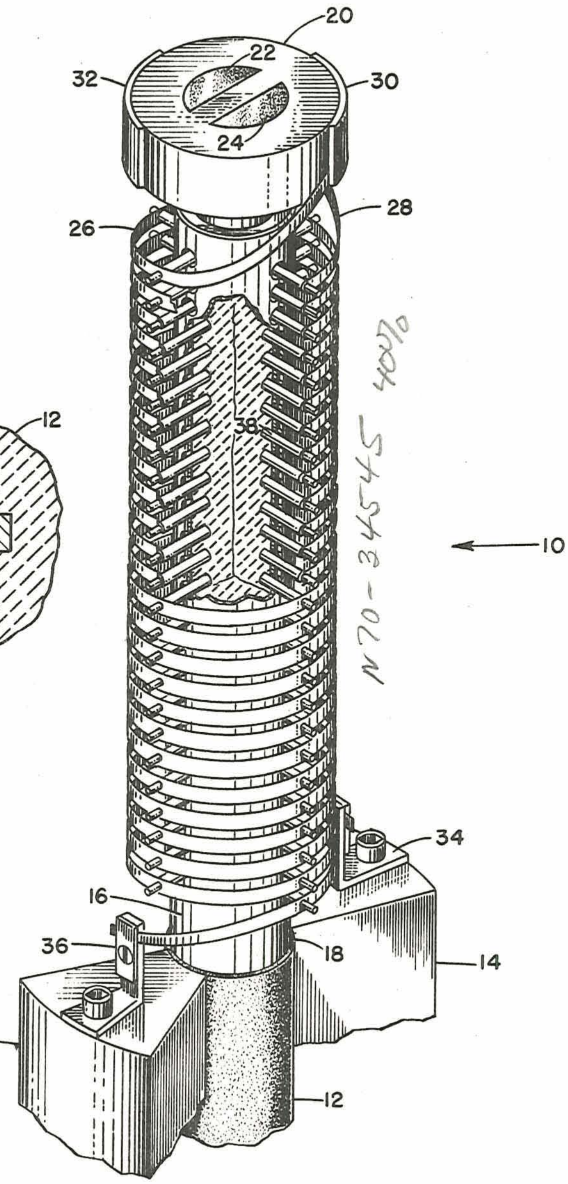

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FIG. 1

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HIGH TEMPERATURE HEAT SOURCE

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

The present invention is concerned with a high temperature source of thermal radiation and is primarily directed to means for heating emitter electrodes in thermionic devices. This invention is particularly concerned with a heat source which requires a low electrical current for operation and has a very low resultant magnetic field.

Various high temperature heat sources are presently available, and each type has certain disadvantages. For example, electron beam heating is not readily utilized for heating large surfaces and usually integrates the emitter into the heater circuitry. Wire heater elements are not only difficult to support but also restricted in size, and the temperature difference between the wire and object being heated is quite large. Tungsten, tantalum, and molybdenum ribbon elements have been used, but the required support mechanisms have made it necessary to limit the operating temperatures and to use heavy currents. Tubular heaters utilize heavy currents while plasma arcs likewise require heavy currents and have high magnetic fields. Induction heaters have the inherent disadvantage of high electromagnetic fields.

The aforementioned problems arising from the use of the above-listed devices of the prior art have been solved by the heater of the present invention which comprises a high temperature heat source that utilizes a pair of spaced heating elements in the form of ribbons that are curved to a helical configuration about a common center line. This provides a broad radiating surface which enables the object being heated to approach very closely the temperature of the ribbons. A plurality of support members extend radially outward from this common center line for slidably engaging the heating elements at spaced intervals to maintain them at a desired radial distance from the common center line while accommodating thermal expansion. These support members further prevent sagging of the heating elements at elevated temperatures while providing restraint against axial and circumferential displacement.

It is, therefore, an object of the present invention to provide a high temperature heat source having means for reducing the adverse effects of thermal expansion and stresses while maintaining the integrity of the material at high operating temperatures under continuous use.

Another object of the invention is to provide a highly efficient heat source with a resultant magnetic field of negligibly small magnitude.

Other objects and advantages of the invention will be apparent from the specification which follows and from drawings in which like numerals are used throughout to identify like parts.

In the drawings:

FIG. 1 is a perspective view, with parts broken away, illustrating the various structural features of a high temperature heat source constructed in accordance with the present invention; and

FIG. 2 is an enlarged sectional view of a portion of the heat source shown in FIG. 1 showing the detailed arrangement of the supports for the heating elements.

2

Referring now to the drawings, there is shown a high temperature heat source **10** that is constructed in accordance with the invention. The heat source **10** utilizes a centrally disposed support in the form of a ceramic post **12** that extends upwardly from a source of electrical current such as a pair of spaced bus bars **14** and **15** as shown in FIG. 1. A tubular radiation shield **16** such as a refractory metal sleeve fits over the center post **12** and extends upwardly from a shoulder **18** thereon that is adjacent the bus bars **14** and **15**. The shoulder **18** positions this sleeve and prevents its axial displacement toward the bus bars **14** and **15**. As shown in FIG. 2, the center post **12** contacts the inner surface of the radiation shield **16** which, in turn, protects the center of the heat source **10** from the high temperatures of the surrounding structure and increases heater efficiency by reflecting heat outwardly.

A generally circular cap **20** of an electrically conducting material is mounted on the uppermost portion of the center post **12** as shown in FIG. 1. A pair of upwardly directed protrusions **22** and **24** on the center post **12** extend through mating contoured openings in the cap **20** to prevent its rotation about the axis of the heat source **10**.

According to the present invention, a pair of elongated heating elements **26** and **28** are curved to a helical configuration about the center post **12** and extend from the cap **20** to the bus bars **14** and **15**. A pair of spaced clips **30** and **32** engage the upper ends of the elements **26** and **28** as shown in FIG. 1. The clips **30** and **32** are removaby mounted on the cap **20** at diametrically opposed positions by screws or other suitable means and maintain the ends of the elements **26** and **28** in electrical contact with each other. The lower ends of the elements **26** and **28** are secured to angle brackets **34** and **36** respectively which, in turn, are mounted on the bus bars **14** and **15**.

The elements **26** and **28** are in the form of ribbons of an electrically conducting material such as tungsten, tantalum, molybdenum or other refractory metals. These ribbons have a broad outer surface for maximum heat radiation as their temperatures are elevated by the passage of an electrical current furnished by the bus bars **14** and **15**. This current is conducted up one of the ribbons, such as **26**, from the bus bar **14** to the clip **30** where it passes to the other ribbon **28** at the clip **32** through the cap **20**. The current is then conducted downwardly to the bus bar **15** through the other ribbon, and the resultant magnetic fields about the ribbons that are produced by the passage of this current cancel one another. Because the electrical potential of the bus bars **14** and **15** is relatively low, in the order of approximately fifty volts, the ribbons may be spaced relatively close together without arcing thereby providing maximum flux cancellation and heat radiation surface area.

An important feature of the invention is the provision of a plurality of elongated supports **38** which engage the heating elements **26** and **28** at intervals spaced closely enough to prevent sagging. The supports **38** are of an electrically conducting material such as tungsten, tantalum, molybdenum and other refractory metals and are rigidly mounted in the center post **12** as is shown in FIG. 2. Each support **38** includes a cylindrical body **40** extending radially outward from a common center line along the axis of the center post **12** through a clearance hole in the radiation shield **16**. The diameter of each clearance hole is adequate to eliminate electrical shorting and to electrically isolate the radiation shield **16** from the supports **38**.

A tip **42** extends outwardly from the body **40** of each support **38** through the adjacent heating element **26** or **28** as shown in FIGS. 1 and 2 to provide restraint against axial and circumferential displacement of these elements.

Each of the heating elements **26** and **28** is free to slide along the tip **42** in the direction of the axis of the support **38** to accommodate thermal expansion of the heating element. The tip **42** is cylindrical and of reduced diameter which forms a shoulder **44** at the intersection of the tip **42** with the body **40**. A slight clearance is normally provided between the heating element and this shoulder as shown in FIG. 2. Movement of the helically curved ribbons in a radial direction relative to their common center lines along the tip **42** is limited by its engagement with the shoulder **44**. This positions each segment of the heating elements **26** and **28** at a predetermined radial direction from the common center line within a limited range of variation.

While only one embodiment of the invention has been shown and described, various structural modifications may be made to the disclosed heat source without departing from the spirit of the invention or the scope of the subjoined claims. For example, while FIG. 1 shows the supports **38** engaging the ribbons **26** and **28** at spacings of ninety degree arcs, it is contemplated that these arcs may be made smaller or larger depending upon the material of the ribbons and the size of the heat source **10**. Also while only two ribbons have been shown, it is contemplated that three bus bars carrying three-phase current may be connected by three separate ribbons, each of which constitutes a leg of a balanced three-phase circuit thereby providing maximum magnetic flux cancellation.

What is claimed is:

1. High temperature heat source, comprising
a centrally disposed member,
shielding means mounted on said centrally disposed member for reflecting heat outwardly,
spaced heating elements helically curved about said shielding means and spaced outwardly therefrom, and
a plurality of supports extending radially outward from said centrally disposed member through said shielding means to prevent the sagging of said heating elements and for restraining said heating elements from axial and circumferential displacement, each of said supports having an outwardly directed tip portion in sliding engagement with one of said heating elements thereby enabling said heating element to move radially outward from said centrally disposed member along the axis of said support to accommodate thermal expansion and a shoulder portion adjacent the innermost end of said tip portion for engaging said heating element to limit the sliding movement thereof toward said centrally disposed member.

2. In a high temperature heat source of the type having an apertured heating element curved to a helical configuration about a center post, the improvement comprising
rigid members extending radially outward from the center post toward the heating element,
each of said rigid members having an outwardly directed tip portion extending through one of the apertures in the heating element for providing restraint against axial and circumferential displacement of the heating element while accommodating thermal expansion of the same by enabling the heating element to slide along said tip portion, and
each of said rigid members having a shoulder portion adjacent the innermost end of said tip portion for engaging the heating element to limit the sliding movement thereof toward the center post.

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