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HIGH TEMPERATURE FURNACE

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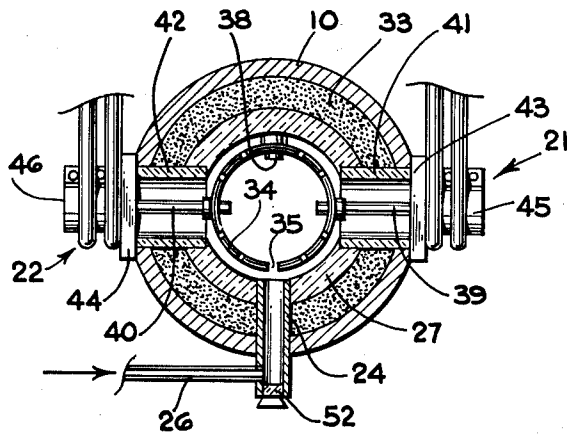


FIG. 3

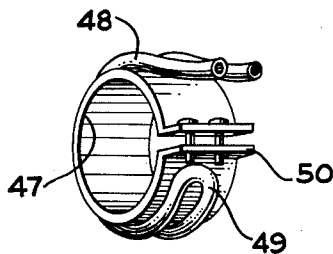


FIG. 4

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HIGH TEMPERATURE FURNACE

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6 Claims. (Cl. 13—22)

This invention relates generally to furnaces and more particularly to an improved high temperature furnace for materials testing laboratory work and the like.

A primary object of this invention is to provide a small and compact furnace capable of attaining temperatures of the order of 2500 degrees centigrade and yet relatively inexpensive to manufacture and operate as compared to presently available furnaces of similar heating capacity.

Another object is to provide a furnace of the above type which is readily accessible so that specimens to be tested may be quickly and easily inserted or removed.

Still another object is to provide a furnace which may be easily disassembled and thus readily modified for particular applications.

Briefly, these and many other objects and advantages of the present invention are attained by providing outer and inner coaxial shells housing a central graphite heating element. Between the inner wall of the outer shell and the outer wall of the inner shell there is provided packed carbon powder for insulation. Suitable laterally aligned openings are provided in the outer and inner shells through which electrodes of lesser diameter extend to connect directly to the heating element. These electrodes serve as the physical support for the heating element as well as the current source, thus minimizing heat transfer between the heating element and the outer and inner shells.

The heating element itself is of cylindrical shape and includes staggered lateral slots in opposite ends to define circuitous resistance paths. Because of the excellent thermal insulation afforded by the outer and inner cylindrical shell construction with the powdered carbon and the insulated electrode support for the heating element, relatively little electrical power is necessary to attain the desired high temperatures. Since the current flow is therefore relatively small, large power supplies are not necessary with consequent savings in both manufacturing and operating costs.

The outer shell itself includes top and bottom cover plates having central removable portions. The removable portion of the bottom cover serves as a hearth plate support, which may be raised and lowered for inserting or removing specimens to be heated. A simple stand employing a rack and pinion may be used for this purpose.

Preferably top and side sight tubes are provided to enable observation of a specimen under test. An inert gas such as helium is introduced into the interior of the inner shell through these sight tubes and is arranged to flow past glass windows in the tubes thus maintaining them clear for observation.

A better understanding of the invention and various additional features and advantages will be had by now referring to the accompanying drawings illustrating a preferred embodiment, in which:

Figure 1 is an over-all perspective view of the improved furnace;

Figure 2 is an enlarged elevational view partly in cross-

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section taken in the direction of the arrows 2—2 of Figure 1;

Figure 3 is another cross-section taken in the direction of the arrows 3—3 of Figure 2; and,

Figure 4 is a perspective view of one electrode clamp.

Referring first to Figure 1 the furnace comprises generally an outer cylindrical shell 10 which may be machined from aluminum. The cylindrical shell 10 includes a top cover plate 11 having a removable central portion 12. Similarly the lower end of the cylindrical shell 10 includes a bottom cover plate 13 having a central removable portion 14 forming the support for a hearth plate 15. As shown, the support 14 is mounted on a rack 16 arranged to be driven up and down, as indicated by the two-headed arrow, by pinion (not shown) housed within a frame 17 and arranged to be rotated by a handle 18 in either direction. The frame 17 as well as the outer cylindrical shell 10 are secured to a vertical stand 19 extending upwardly from a base support 20. The arrangement is such that specimens placed on the hearth plate 15 may be raised into the furnace itself, the removable center portion 14 serving simultaneously to close the bottom opening of the furnace.

The interior of the furnace is arranged to be heated by a resistance heating element energized from a pair of electrodes designated generally by the numerals 21 and 22 extending from opposite sides of the outer shell 10. Top and side sight tubes 23 and 24 are provided to enable a specimen to be viewed during a heating operation. An inert gas is introduced through the sight tubes by the inlet lines 25 and 26.

Referring now to Figures 2 and 3, the various components making up the furnace assembly will be described in detail. As shown in Figure 2, there is provided an inner shell 27 formed of graphite and serving as a radiation barrier. This inner shell is provided with a top cover 28 having a central opening 29 supporting the lower end of the top sight tube 23. The lower end of the shell 27 includes a telescoping section 30 arranged to slide telescopically within an annular recessed portion 31 in the lower end of the shell 27. The lower end of the telescoping section 30 may rest or otherwise be secured to the bottom cover 13 about the periphery of the bottom opening 32. By this arrangement, thermal expansion and contraction of the outer shell can be accommodated by relative telescoping movement of the section 30 with respect to the shell 27.

The inner cylindrical shell 27 is of lesser diameter than the outer shell 10 and defines therewith an annular space filled with insulation material, preferably in the form of powdered carbon 33. This insulation material extends over the cover 28 and is firmly packed.

Within the inner shell 27 there is provided a graphite heating element 34. This element is cylindrical in shape as can best be seen in Figure 3 and is provided with a series of lateral slots extending from opposite circumferential ends and terminating short of passing entirely through the lateral side to define a circuitous current path. The width of the various slots such as the slot 35 may be varied during manufacture to provide a sufficient opening for the sight tube 24 so that specimens disposed within the cylindrical heating element may be observed.

In accordance with an important feature of the present invention, the graphite element is supported by the electrodes 21 and 22 themselves. For example, in Figure 2 these electrodes are shown as physically and electrically connected to opposite circumferential points 36 and 37 of the graphite heating element. The element may also be supported to the inside of the inner radiation barrier 27, as by additional supports, such as indicated at 38, disposed 90 degrees from the supports 36 and 37.

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Portions of the electrodes themselves pass through aligned lateral openings in the outer shell 10 and the inner shell 27 as indicated at 39 and 40. These openings are lined with suitable graphite sleeve members 41 and 42 coaxially surrounding the electrode portions 39 and 40 to leave an annular insulating air space. The outer ends of the electrode portions 39 and 40 are supported in asbestos supporting blocks 43 and 44 mounted to the exterior of the outer shell 10. Suitable terminal portions 45 and 46 connecting to the electrode portions 39 and 40 extend from these blocks.

In order to provide a secure electrical connection to the electrodes and yet maintain sufficient thermal insulation, electrode clamps are employed such as shown in Figure 4. In Figure 4 the clamp comprises a split sleeve of copper 47 to which is brazed copper tubing 48 turned back on itself as at 49. The copper tubing connects to a water cooling system for maintaining the clamp sleeve 47 below a critical temperature. The physical connection to the power supply may be effected at the clamp portion 50. By this arrangement, a very secure electrical connection to the electrodes is assured and the electrodes themselves are maintained relatively cool at their outer ends. The asbestos blocks provide a considerable amount of heat insulation between the outer shell 10 and the electrical terminal portions 45 and 46, while the graphite sleeves 41 and 42 in cooperation with the annular air space insure adequate thermal and electrical insulation between the electrodes and the inner and outer shells.

As best seen in the upper portion of Figure 2 and the lower portion of Figure 3, the sight tubes 23 and 24 are provided with glass windows 51 and 52 disposed adjacent the inlets 25 and 26 for the inert gas introduced into the interior of the furnace. It will be evident that the sight tubes themselves serve as conduits for introducing this gas. The gas escapes from the interior by leaking out about the upper and lower cover plates and through the lateral openings within which the electrodes extend, inasmuch as the system is not hermetically sealed. By having the inert gas such as helium flowing past the glass windows 51 and 52, these windows are kept clear to insure that a clear view is always available during operation of the furnace.

If desirable, the hearth plate 15 may support a graphite block 53 having a square cavity cut therein and a series of tungsten rods 54 extending thereacross. A crucible 55 may then rest on the tungsten rods and a specimen to be treated or melted placed in the crucible. By this arrangement, maximum insulation is afforded between the hearth plate 15 and the heated specimen in the crucible 55.

In the operation of the foregoing apparatus, the hearth 15 is initially lowered from the furnace to the position shown in Figure 1 and a suitable specimen to be heat tested placed thereon. The water cooling circulation system is started and inert gas caused to flow into both the inlet lines 25 and 26 and through the sight tubes to the interior of the furnace. The hearth plate 15 may then be raised by means of the rack and pinion into the furnace opening 32, the removable central portion 14 closing the bottom opening when the specimen is in position.

With the specimen positioned within the cylindrical graphite heating element 34 current may then be supplied from a suitable power supply through this element. The current is preferably split to follow circuitous paths over one-half portions of the circumference of the cylindrical graphite heating element to the other electrode so that parallel paths are provided. By grounding the outer and inner cylinders so that the 90 degrees spaced graphite heating element supports such as indicated at 38 in Fig. 3 are at ground potential, the potential difference between either one of the electrodes and the outer shell 10 will be one-half of the total potential drop between the electrodes.

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By controlling the amount of current from the power supply, the temperature within the inner shell and graphite heating element can be controlled. Temperatures as high as 2500 degrees centigrade can be readily obtained and as described heretofore, the specimen undergoing a test can be observed both from the top and the side through the sight tubes 23 and 24 respectively.

After testing, the specimen may be easily removed by simply lowering the hearth 15 by rotation of the handle 18.

As a consequence of the structure of the present invention, it is a simple matter to disassemble and expose the interior of the furnace. For example if it were desired to change the heating element, the removable center portion 12 could be simply lifted from the top of the furnace and the graphite cover 28 simultaneously removed together with the sight tube to expose directly the inner portion of the radiation barrier 27. Not only therefore is the interior of the furnace readily accessible but in addition modifications of the furnace to meet particular problems can be readily effected.

As a consequence of the use of the cylindrically shaped graphite heating element and the particular design of the outer and inner shells defining an annular insulation space incorporating powdered carbon, excellent insulation is provided and high temperatures can be obtained with less current than would normally be necessary. As a consequence, the operation of the furnace costs considerably less than conventional furnaces heretofore used.

It is to be understood, of course, that many changes and modifications that fall within the scope and spirit of the present invention will readily occur to those skilled in the art. The high temperature furnace is therefore not to be thought of as limited to the specific embodiment set forth for illustrative purposes.

What is claimed is:

1. A high temperature furnace comprising, in combination: an outer cylindrical shell; an inner cylindrical shell of diameter less than the diameter of said outer shell to define an annular space between the interior wall of said outer shell and the exterior wall of said inner shell; thermal insulation means disposed in said annular space; a resistance heating element disposed within said inner shell and spaced radially inwardly from the interior wall of said inner shell, said outer and inner shells having aligned lateral openings; electrode means passing from the exterior of said outer shell through said aligned openings to connect to and physically support said resistance heating element; at least one sight tube passing laterally through the walls of said outer and inner shells to render specimens disposed adjacent said resistance heating element within said inner shell visible; a transparent member in said sight tube; and means for introducing an inert gas adjacent to said transparent member and through said tube to the interior of said inner shell.

2. A high temperature furnace comprising, in combination: an outer cylindrical shell; an inner cylindrical shell of diameter less than the diameter of said outer shell to define an annular space between the interior wall of said outer shell and the exterior wall of said inner shell; thermal insulation means disposed in said annular space; a resistance heating element disposed within said inner shell and spaced radially inwardly from the interior wall of said inner shell, said outer and inner shells having aligned lateral openings; electrode means passing from the exterior of said outer shell through said aligned openings to connect to and physically support said resistance heating element, said inner shell constituting a radiation barrier formed of two telescoping cylindrical sections; and sleeve means surrounding a portion of said electrode means and passing within said aligned openings to secure the upper of said telescoping sections to said outer shell, said outer shell including a bottom cover plate having a central cut out portion providing a bottom opening of reduced diameter, the lower of said telescoping sections

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seating on said bottom cover plate, said sections thereby accommodating thermal expansion and contraction of said outer shell by relative telescoping movements with respect to each other.

3. The subject matter of claim 2, including hearth plate means; and elevating means for lifting said hearth plate means into said bottom opening whereby specimens placed on said hearth plate are positionable within said inner shell simultaneously with closure of said bottom opening.

4. The subject matter of claim 3, including at least one sight tube passing laterally through the walls of said outer and inner shells to render specimens placed on said hearth plate visible; a transparent member in said sight tube; and means for introducing an inert gas adjacent to said transparent member and through said tube to the interior of said inner shell.

5. A high temperature furnace comprising, in combination: an outer cylindrical shell including a bottom cover plate having a central cut out portion providing a bottom opening of reduced diameter; an inner cylindrical shell coaxially positioned within said outer shell and of a diameter less than said outer shell to define an annular space between the interior wall of said outer shell and the exterior wall of said inner shell; powdered carbon disposed in said annular space; a graphite heating element disposed within said inner shell and spaced radially inwardly from the interior wall of said inner shell; a hearth plate means; elevating means for lifting said hearth plate means into said bottom opening whereby specimens placed on said hearth plate means are positionable within said inner shell adjacent to said graphite heating element simultaneously with closure of said bot-

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tom opening; and electrode means, said outer shell and inner shell having aligned openings in their side walls through which said electrode means extend, the inner ends of said electrode means being secured to said graphite heating element and the outer ends of said electrode means being mounted to the exterior of said outer shell whereby said electrode means serve the dual function of supplying current to said graphite heating element and physically supporting said heating element so that said element is electrically and thermally insulated from said inner shell and said outer shell.

6. The subject matter of claim 5, including sleeve means surrounding a portion of said electrode means and passing within said aligned lateral openings to secure the upper end of said inner shell to said outer shell, said sleeve means defining an annular air space surrounding the portions of said electrodes passing therethrough and connecting to said heating element, to provide said electrical and thermal insulation.

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