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HIGH SPEED INFRARED FURNACE
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3,427,435

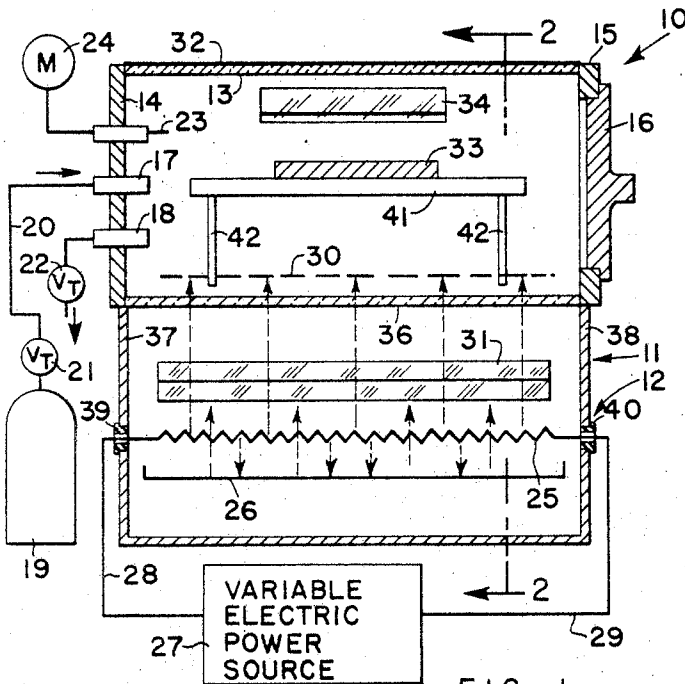


FIG. 1

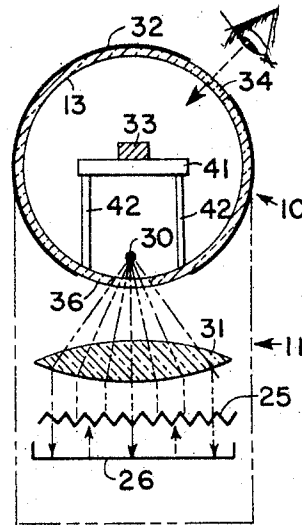


FIG. 2

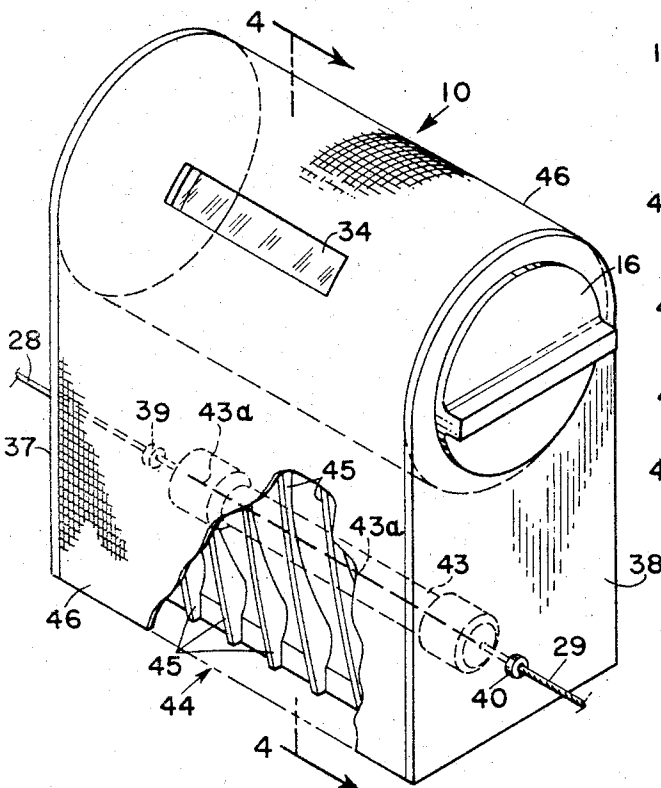


FIG. 3

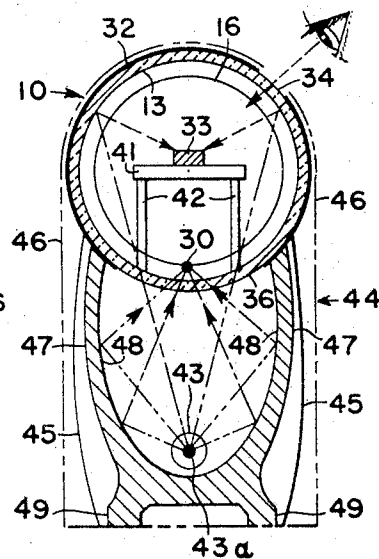


FIG. 4

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HIGH SPEED INFRARED FURNACE

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9 Claims

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ABSTRACT OF THE DISCLOSURE

A high speed furnace including a tubular chamber having a heat reflective inner surface and provided with an elongated heat transmitting window and a viewing window, and an elongated heat source positioned parallel to the window of the tubular chamber and means for focussing the heat rays emitted from the heat source along a line inside the tubular chamber and adjacent to the heat transmitting window to bring the interior of the chamber to a high temperature.

Origin of the invention

The invention described herein was made in the performance of work under a NASA contract and is subject to the provisions of Section 305 of the National Aeronautics and Space Act of 1958, Public Law 85-568 (72 Stat. 435; 42 U.S.C. 2457).

Description of the invention

This invention relates to furnaces generally and is directed more particularly to a high speed furnace useful for brazing or heat treating operations.

Two of the most widely known and used furnaces of the prior art are those utilizing fuel gas or radio-frequency (R-F) induction heating. The R-F induction type furnaces are unsuitable for certain heat treating operations because of the magnetic and electric fields imposed upon the object being treated. Furthermore, when an R-F induction furnace is used for brazing, it is difficult to view the objects being brazed because of the arrangement of the R-F induction coil which is disposed around the furnace. Another disadvantage of the R-F induction furnace is the complexity and cost of the equipment required to generate the R-F energy. Gas furnaces in general have the disadvantage of relatively long heat-up and cool-down times.

Accordingly, it is an object of the invention to provide a new and novel brazing and heat treating furnace having short heat-up and cool-down times.

It is another object of the invention to provide a high speed furnace operable over a wide temperature range.

Still another object of the invention is to provide a high speed furnace in which the object being heat treated or brazed may be observed during a heat treating or brazing operation.

It is a further object of the invention to provide a furnace of the above type which operates at high efficiency.

Yet another object of the invention is to provide a high speed furnace including a source of heat rays which may be energized from readily available A-C line power.

It is an additional object of the invention to provide a new and novel furnace in which heat rays emitted by a variable temperature heat source are focused along a line lying inside and parallel to a heat transmitting window disposed in the wall of a chamber. The interior surface of the chamber is highly reflective to scatter the heat rays thereby bringing the interior temperature of the chamber to the desired value.

Other objects and advantages of the invention will be-

come apparent from the following description and accompanying drawing in which:

FIG. 1 is a sectional view of one embodiment of the invention;

FIG. 2 is a cross sectional view taken along the line 2-2 of the structure of FIG. 1;

FIG. 3 is a partially cutaway view of a preferred embodiment of the invention; and,

FIG. 4 is a cross sectional view taken along the line 4-4 of the structure shown in FIG. 3.

Referring back to FIG. 1, it will be seen that a furnace embodying the invention may include a chamber 10, a focusing means 11, and heat ray source 12. The chamber 10 comprises a horizontally disposed hollow cylinder such as quartz tube 13 provided at one end with an end closure 14 and at the other end with a peripheral ring 15 having an access door 16 removably retained therein. The end members 14 and 15 and the access door 16 may be made of any suitable metal or nonmetal which can withstand temperatures on the order of those required for brazing operations.

Because it is desirable to conduct many brazing and heat treating operations in an inert atmosphere, inlet and outlet ports 17 and 18 are provided in the end wall 14 so that the chamber 10 may be purged with an inert gas, as for example argon. The inlet port 17 is connected to a tank of suitable gas 19 through a line 20 having a valve 21 disposed therein. The outlet port 18 is vented to the atmosphere through a suitable valve 22. By opening the valves 21 and 22, inert gas will be directed into the chamber 10 through the inlet port 17. This causes the atmospheric gas contained in the chamber 10 to exhaust through the outlet port 18 and the valve 22. When the chamber 10 is sufficiently purged of atmospheric gas, the valves 21 and 22 may then be closed.

In order to monitor the interior temperature of the chamber 10, a thermocouple 23 may be inserted into the chamber through the end wall 14. The thermocouple is connected to a suitable meter 24 which indicates the interior temperature of the chamber 10.

The heat ray source 12 for the furnace may comprise, by way of example, an electrical-resistance heat 25 which radiates energy in the near infrared region, together with a reflector 26 positioned, as shown, below the heater 25. The reflector 26 which may be plated or highly polished metal reflects heat rays from the heater 25 toward the focusing means 11 and the chamber 10.

For the purpose of energizing the electrical-resistance heater 25, there is provided a variable electric power source 27 which is connected to the heater 25 by means of leads 28 and 29. The variable electric power source 27 may be, for example, a variable transformer energized from commercial A-C power. By adjusting the voltage applied to the heater 25, the interior temperature of the chamber 10 may be set to the desired value as indicated on the meter 24.

In order to focus the heat rays emitted by the heater 25 and those reflected by reflector 26 along a focal line 30 lying immediately inside the quartz tube 13 and parallel to the longitudinal axis thereof, the focusing means 11 is provided. In the embodiment shown in FIG. 1, the focusing means 11 comprises an elongated lens 31 of bi-convex cross section. As will be understood by those skilled in the art, the heat generated along the focal line 30 will be very intense.

To the end that this intense heat will be randomly dispersed to bring the interior of the chamber 10 to a high temperature, a highly heat reflective surface is provided for the interior of the chamber 10. This is accomplished in the present embodiment of the invention by plating or coating the exterior of the quartz tube with a layer of

suitable opaque mirroring material which will cause the quartz tube to become an inwardly reflecting mirror. The mirrored surface reflects heat back into the interior of the chamber 10 at high efficiency. The opaque material used in the present embodiment of the invention is gold which, advantageously, is highly resistive to oxidation.

In order that an object 33 being heat treated or brazed may be observed during the operation, an elongated viewing window 34 is provided in the chamber 10. This window is formed by preventing the opaque plating material from being deposited on the area where the window is desired. A heat ray transmitting window 36 is provided in the quartz tube adjacent to the lens 31. This window extends longitudinally for approximately the full length of the quartz tube 13 and is formed in the same way as window 34. The window 36 allows the heat rays being focused by the lens 31 to be transmitted into the chamber 10 with relatively little energy loss and to be focused along the line 30.

The structure of FIG. 1 is completed by support members 37 and 38 which are attached to the end wall 14 and the peripheral ring 15, respectively. Insulating bushings 39 and 40 are provided in the support members 37 and 38, respectively, to electrically insulate the leads 28 and 29. The lens 31, the heater 25 and the reflector 26 are retained in spaced relationship to one another and to the chamber 10 by means of brackets (not shown) attached to the support members 37 and 38. A table 41 provided with legs 42 may be used to support the object 33 being heat treated or brazed.

FIG. 2 is a cross sectional view of the structure shown in FIG. 1 taken along the line 2—2 and parts corresponding to those of FIG. 1 are identified by like numerals. As shown in FIG. 2, the layer of gold 32 plated on to the quartz tube 13 includes void areas 34 and 36 which serve as viewing and heat ray transmitting windows, respectively. The bi-convex lens 31 focuses the heat rays from the heater 25 and the reflector 26 along the line 30 immediately inside the heat transmitting window 36. The heat rays then scatter randomly within the quartz tube 13 and are reflected from the interior surface thereof to bring the interior temperature to the desired value.

A partially cutaway, pictorial view of a preferred embodiment of the invention is shown in FIG. 3. The chamber 10 of the structure shown in FIG. 3 is substantially the same as the chamber shown in FIGS. 1 and 2 as may be seen in the cross sectional view of FIG. 4. Parts in FIGS. 3 and 4 which correspond to those shown in FIGS. 1 and 2, respectively, are identified by like numerals.

In the structure shown in FIG. 3, the heat ray source may comprise, by way of example, a tubular, infrared, quartz lamp 43, the longitudinal axis of which coincides with a primary focal line 43a of an elongated, upwardly opening, trough-like reflector member 44 which rest on a pair of longitudinally extending standards 49. The reflector member 44 may be cast from a suitable metal such as aluminum and may be provided with suitable cooling fins 45 as shown in the cutaway portion of FIG. 3. To protect the chamber 10 and the reflector member 44 from damage and to prevent injury to personnel working with the furnace, a suitable wire mesh 46 encloses the chamber and the reflector.

Referring to FIG. 4, it will be seen that the reflector member 44 may be provided with upwardly extending walls 47 which are curved to provide an elongated elliptical surface 48 within the reflector member 44. The walls 47 extend far enough so that when the chamber 10 is positioned in the elongated opening provided by the upper ends of the walls 47, the conjugate focal line of the elliptical inner surface 48 of the reflector 44 will lie immediately inside the heat ray transmitting window 36 of the quartz tube 13. The interior elliptical surface of the reflector member 44 is polished or plated to provide a highly heat reflective finish.

Because the quartz lamp 43 is coaxial with the primary

focal line 43a of the elliptical reflective surface of the reflector body 44, heat rays emitted from the quartz lamp are focused along the reflector 44 conjugate focal line 30 which lies inside the chamber 10. From the focal line 30, the heat rays randomly scatter and are reflected from the mirrored surface of the quartz tube 32. In this manner, the interior of the quartz tube is raised to a high temperature suitable for conducting heat treating or brazing operations. Because of the highly reflective interior surfaces of the quartz tube 32 and the reflector member 44, the furnace embodying the invention operates at very high efficiency and the exterior surfaces of the quartz tube 32 and the reflector member 44 remain relatively cool.

With the preferred embodiment shown in FIGS. 3 and 4, the quartz lamp 43 is energized from a variable electric power source 27 through the leads 28 and 29 as was the heater 25, as shown in FIG. 1. Chamber temperatures in the range between 200° F. and 2000° F. have been achieved in the preferred embodiment by appropriately adjusting the voltage applied to the quartz lamp 43 from the variable electric power source 27.

From the foregoing it will be seen that the invention provides a new and novel furnace in which heat rays from a heat ray source are focused along a line lying within an elongated chamber. The interior of the chamber is provided with a highly reflective surface to scatter the heat rays, thereby resulting in the interior of the chamber being brought rapidly to the desired temperature.

It will be understood that changes and modifications may be made to the above-described furnace without departing from the spirit and scope of the invention as set forth in the claims appended hereto.

What is claimed is:

1. A heat treating and brazing furnace comprising:

an elongated chamber having a heat reflective inner surface and having an elongated heat ray transmitting window in a wall thereof;

an elongated heat ray source;

means for supporting said heat ray source in spaced relationship to said heat ray transmitting window externally of and parallel to said chamber; and

focusing means for focusing the heat rays radiated from said heat ray source along a line within said chamber adjacent to and paralleling said window whereby said heat rays are randomly scattered within said chamber to heat the interior thereof.

2. The furnace as set forth in claim 1 wherein said chamber comprises a quartz tube having the exterior thereof coated with a mirroring material except for two circumferentially spaced longitudinal strips which serve as respective heat ray transmitting and viewing windows.

3. The furnace of claim 2 in which the mirroring material is gold.

4. The furnace of claim 2 in which said heat ray source comprises a tubular, infrared, quartz lamp energized from a source of variable electric power.

5. The furnace set forth in claim 4 wherein said focusing means comprises an elongated, trough-like reflector member having upwardly extending walls and a highly reflective, elliptical, interior surface, the tubular quartz lamp lying on the primary focal line of the reflector member and the chamber being supported by the upwardly extending walls, the heat transmitting window being located between the upwardly extending walls of the reflector member and, the conjugate focal line of the elliptical reflective surface lying within the chamber.

6. The furnace as set forth in claim 1 in which said heat ray source comprises an elongated, electrical resistance heater and including a variable electric power source connected to the electrical resistance heater to energize the same.

7. The furnace of claim 6 wherein said focusing means comprises an elongated lens of bi-convex cross section;

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means for supporting said lens parallel to the chamber between the heat transmitting window of the chamber and the electrical resistance heater which is supported in spaced relationship thereto.

8. The furnace of claim 1 in which said heat ray source comprises a tubular, infrared, quartz lamp energized from a source of variable electric power.

9. The furnace set forth in claim 8 wherein the focusing means comprises an elongated, trough-like reflector member having upwardly extending walls and a highly reflective, elliptical, interior surface, the tubular quartz lamp lying on the primary focal line of the reflector member and the chamber being supported by the upwardly extending walls, the heat transmitting window being located between the upwardly extending walls of the re-

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flector member and, the conjugate focal line of the elliptical reflective surface lying within the chamber.

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