United States Patent

[11] 3,548,062

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[21] Appl. No. **832,640**
[22] Filed **June 12, 1969**
[45] Patented **Dec. 15, 1970**

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[54] **GAS PRESSURE BONDING FURNACE**
7 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **13/20,** 13/31
[51] **Int. Cl.** **F27d 7/06**
[50] **Field of Search** 219/390, 400; 13/20, 31; 263/49

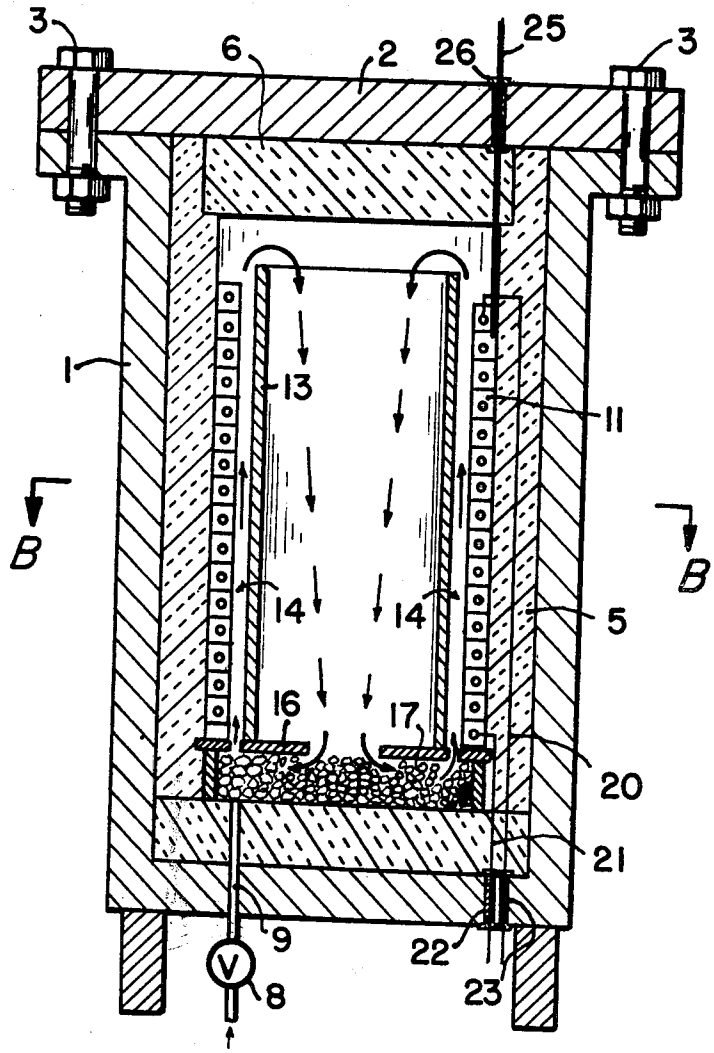
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ABSTRACT: A furnace and process for heating and cooling assemblies while maintaining them at substantially uniform temperatures. The furnace comprises an outer sealable shell capable of containing superatmospheric pressures. Within the shell there is an insulating wall. Electrical heating means are disposed adjacent the insulating wall. A baffle is disposed between the workspace of the furnace and the heating means forming a convection channel with the insulating wall. The convection channel is in communication with the workspace at the top and bottom of the furnace. During heating of the furnace, superatmospheric gases move through the convection channel and thence through the interior of the furnace maintaining the temperature throughout the furnace substantially uniform.



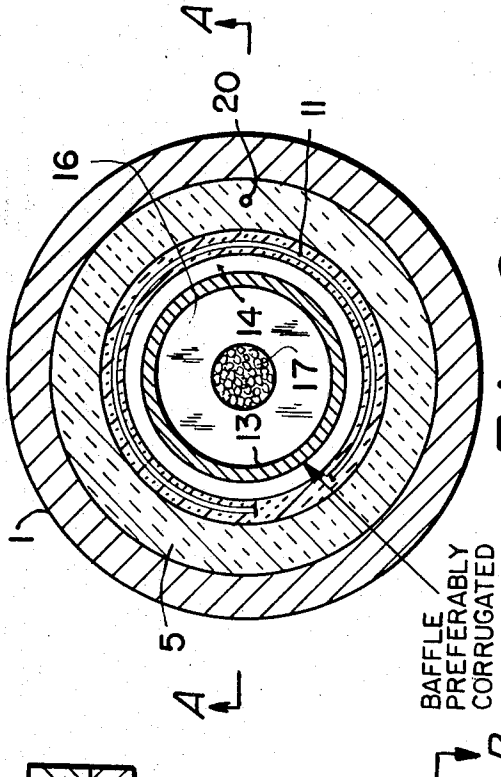


Fig. 2

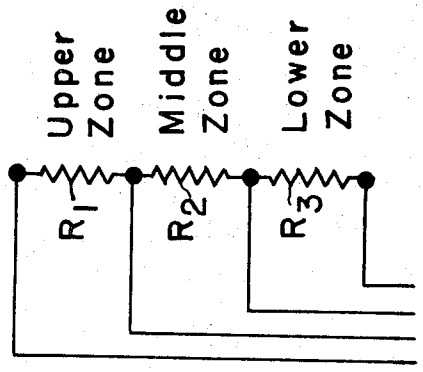


Fig. 3

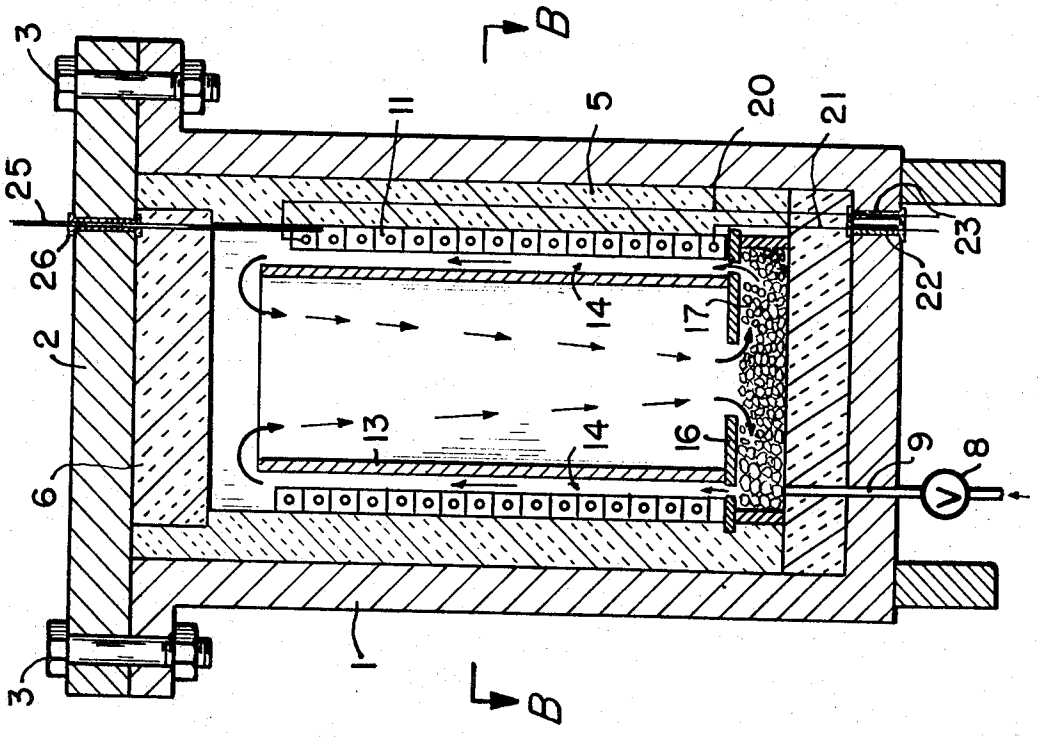


Fig. 1

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GAS PRESSURE BONDING FURNACE

This invention pertains primarily to furnaces for gas pressure bonding or welding of metal assemblies. In these furnaces, the assemblies are heated in the presence of gases at superatmospheric pressures to temperatures below their melting point. To avoid warping caused by differential thermal expansion of the assemblies or workpieces, it is essential that the temperature throughout the furnace be substantially uniform during the heating, holding and cooling of the furnace. Often elongated assemblies must be positioned vertically in the furnace. Hence, it is necessary to have elongate furnace chambers having a long vertical axis. It is extremely difficult to provide substantially uniform temperatures in these furnaces because of the tendency of the hotter gases to rise to the upper end of the elongate furnace chamber.

In the past, every effort was made to reduce the gas circulation around the workpiece and the temperature of the furnace interior was controlled by a plurality of individually controllable electric-heating elements spaced in zones vertically along the furnace walls. The multiple-heating elements required extensive control equipment and also required numerous electrical leads each of which had to pass through the shell of the furnace making sealing more difficult. Notwithstanding the elaborate heating and controlling equipment, the prior art furnaces had to be heated and cooled very slowly in order to maintain the temperature substantially uniform throughout the workpiece or assembly.

Furnaces according to the teachings of my invention have the advantage of providing substantially uniform temperatures throughout an elongate interior with a reduced number of heating elements and a corresponding reduced amount of control equipment. In fact, in some instances, it is possible to eliminate multiple zone heating altogether. It is a further advantage of my invention that the elongate furnace can be heated and cooled more rapidly than prior furnaces thereby increasing the number of assemblies that can be bonded by use of the furnace in a given period of time.

Briefly, according to this invention, there is provided a furnace having a shell which is sealable and can contain gases at superatmospheric pressures. Adjacent the shell is a heat insulating lining. Heating means are disposed adjacent to the insulating wall and spaced about it. The heating means are shielded from the workspace of the furnace and the workpiece by a baffle arranged to channel a flow of gases during heating along the periphery of the furnace and thence through the interior of the furnace. Hence, my invention is a drastic departure from the prior art gas bonding furnaces wherein gas flow was as much as possible suppressed.

Also according to this invention, there is provided a new method of heating assemblies or workpieces comprising the steps of placing the workpieces in a sealed enclosure with superatmospheric gases, heating said gases within one portion of the enclosure and channeling the heated gases about the workpiece at a rate sufficiently fast such that the gases adjacent the workpiece have substantially uniform temperatures. In this manner the workpiece, while being heated, will have a substantially uniform temperature.

FIG. 1 is a vertical section view of a furnace according to this invention taken along lines A–A in FIG. 2;

FIG. 2 is a plan view in section of a furnace according to this invention taken along lines B–B in FIG. 1; and

FIG. 3 is a schematic wiring diagram which illustrates a multiple zone heating system.

Before describing the drawings in detail, it should be understood that they illustrate one furnace embodying the concepts of this invention, and are given by way of explanation and not by way of limitation. In FIGS. 1 and 2, a furnace is shown with an outer metal shell 1 which is cylindrical, closed at the base and open at the top. A flange is provided about the top of the cylindrical shell. A metal cover 2 can be disposed over the opening. Means 3 are provided for securing the cover to the flange of the outer shell whereby the cover and shell will cooperate to provide a sealable furnace which can contain superatmospheric pressures. A gasket (not shown in the drawings) may be disposed between the cover 2 and the shell 1. Within the shell and directly adjacent its inner edge there is an insulating lining 5. There is also a removable insulating cover 6. The insulating lining and cover may consist of, for example, insulating fire brick, asbestos board and so on. A valve means 8 is provided attached to an orifice 9 leading to the interior of the furnace. Through the orifice and valve the furnace can be evacuated and then filled with gases suitable for gas pressure bonding. Electrical-heating elements 11 are disposed about the interior of the insulating brick lining. They are preferably wrapped circumferentially about the interior of the furnace and may comprise, for example, Nichrome wire. A baffle 13 is placed between the interior of the furnace and the heating means to form a convection channel 14. The channel is in communication at both its upper and lower ends with the workspace of the furnace. The bottom of the workspace of the furnace 16 has an opening or openings therein. The bottom in the particular embodiment shown in placed on a bed of particulate refractory aggregate 17. The electrical leads 20 and 21 must pass through gastight bushings 22 and 23. A thermocouple 25 is disposed in the furnace and also passes through gastight bushing 26. The number of thermocouples and electrical leads required vary depending on the size of the furnace. It is, of course, desirable to minimize the number of openings passing through the shell which must be sealed.

FIG. 3 is a schematic wiring diagram showing a circuit wherein the heating element is divided into more than one zone. Heat introduced in the upper zone of the furnace is less than the heat introduced in the middle and lower zones. A control apparatus is provided to maintain the current through each of the resistors, R_1, R_2 and R_3 approximately uniform. The resistance in R_1 is, of course, less than R_2 which is, in turn less than R_3. Actually because of the advantages of this invention, simple single zone heating elements can be used. According to a preferred aspect of this invention, the baffle means is corrugated. It is also preferred that the outer shell, insulating lining and the baffle be tubular and concentric with the shell.

During heating, the furnace is filled with gas at superatmospheric pressures. Gas is heated in the channel between the baffle and the insulating wire by the electrical heating elements. The heated gas raises to the top of the channel and enters the top of the furnace workspace through an opening provided over the baffle. This movement starts a continuous flow of gas upwardly through the channel and downwardly through the furnace interior. As the gas passes through the furnace interior, it transfers its heat to the workpiece or assembly being bonded. The gas flow is maintained sufficiently rapid so that the upper portions of the workpiece are not heated more rapidly than the lower portions of the workpiece. Some heating, of course, is performed on the workpiece by radiation directly from the baffle. During cooling the direction of the gas flow is reversed. I have found that a corrugated baffle in which the corrugations run vertical is especially effective at promoting gas flow through the channel and down through the interior of the furnace during heating.

While I do not completely understand the scientific basis of my invention, I believe the success thereof may have to do with the nature of gases under superatmospheric pressures. As pressures are increased, gases flow more and more like liquids. The flow of the superatmospheric gas distributes the heat more uniformly about the workpiece than could be expected by gas at standard pressure.

Having described my invention with the particularity required by the patent laws, what is desired to have protected by letters patent is set forth in the following claims.

I claim:

1. A furnace in which the temperature in the interior of the furnace can be maintained substantially uniform during heating and cooling consisting of means for sealing the furnace and maintaining gases at superatmospheric pressures therein, means for introducing gas under superatmospheric pressures to said furnace, means for heat insulating the furnace, means

for heating the furnace disposed about the periphery of the furnace interior, means for channeling a draft caused by thermal buoyancy of gases past the heating means and thence through the central furnace interior.

2. An elongated furnace for gas pressure bonding metal assemblies having a vertical longitudinal axis in which the temperature can be maintained in the workspace of the furnace substantially uniform along the longitudinal axis during heating and cooling consisting of an outer metal shell which can be sealed and can contain gases at superatmospheric pressures, means for introducing gas under superatmospheric pressures to the furnace, an insulating wall disposed within and adjacent the metal shell, heating means disposed adjacent to the insulating wall, baffle means disposed between the workspace of the furnace and the heating means forming a convection channel with the insulating wall, said convection channel in communication with the workspace of the furnace at both ends of the elongated vertical workspace, whereby during heating of the furnace gases move upwardly due to thermal buoyancy through the convection channel and downwardly through the workspace distributing the heat introduced by the heating means uniformly throughout said workspace.

3. A furnace according to claim 2 in which the shell, insulating wall and baffle means are substantially tubular and concentric.

4. A furnace according to claim 2 in which the baffle means is corrugated.

5. A furnace according to claim 2 in which the heating means comprises electrical resistance elements wrapped circumferentially around the furnace and spaced vertically.

6. A furnace according to claim 5 in which the heating element comprises at least two individually controllable sections vertically spaced.

7. A method of heating a workspace while maintaining substantially uniform temperature throughout the workpiece comprising the steps of:

1. placing the workpiece in a sealed enclosure with superatmospheric gases,
2. heating said gases within a portion of said enclosure, and
3. channeling a draft of said heated gases caused by thermal buoyancy about the workpiece at a rate sufficiently fast such that the temperature of the gases adjacent the workpiece are substantially uniform.