

Jan. 3, 1967

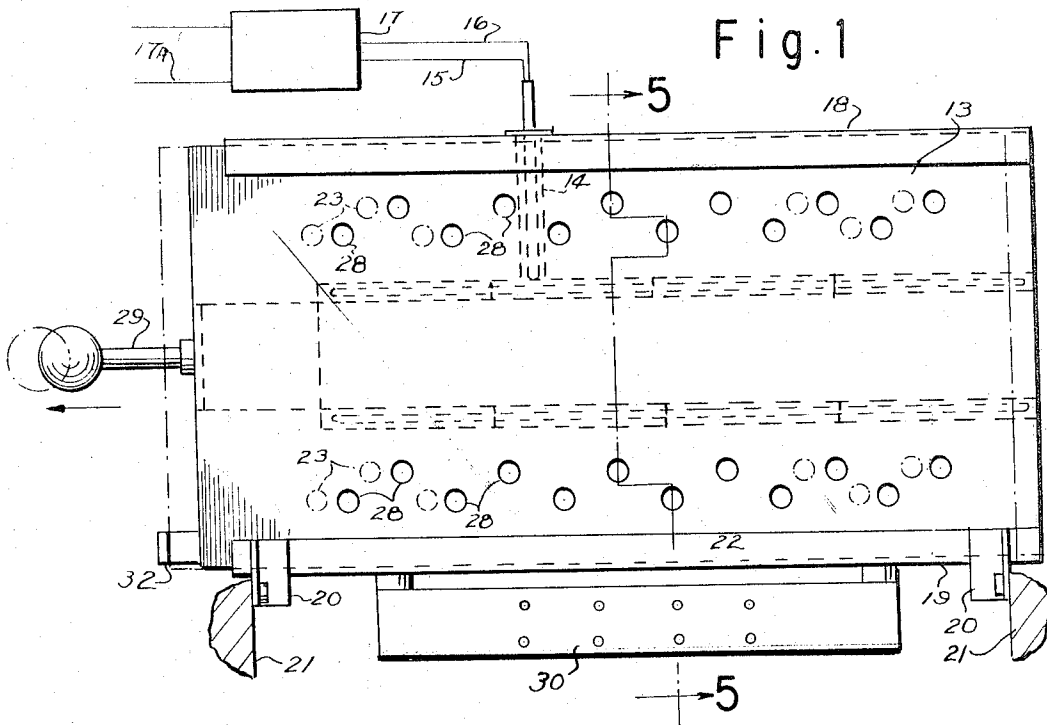
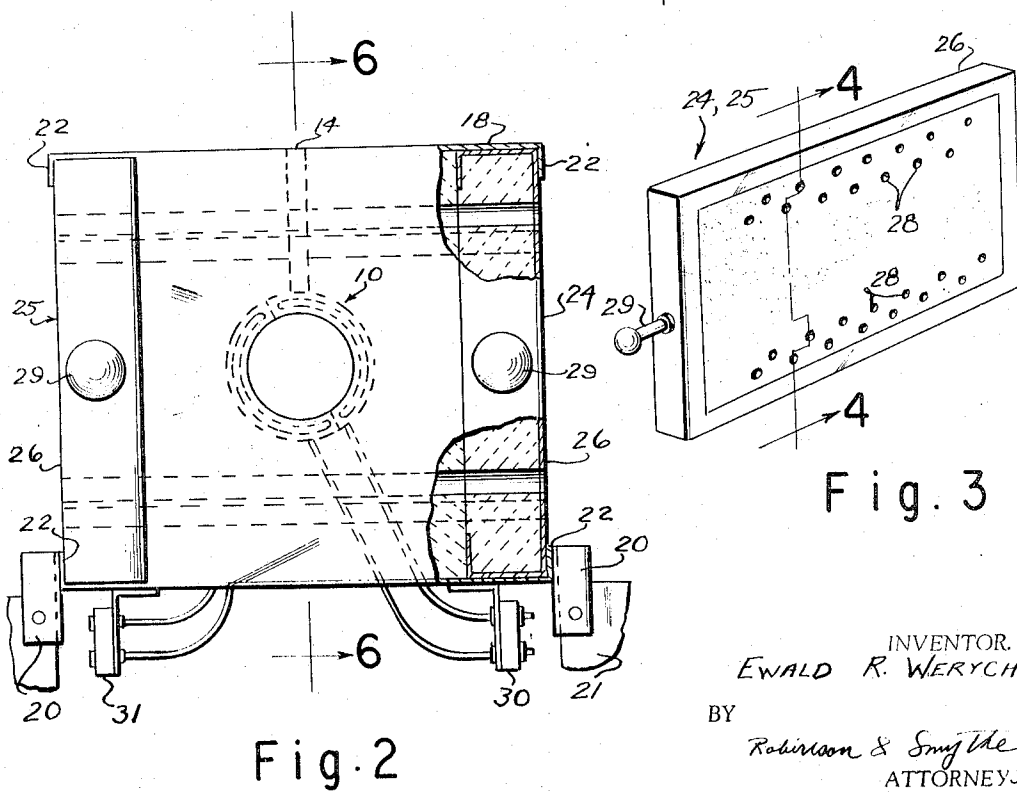
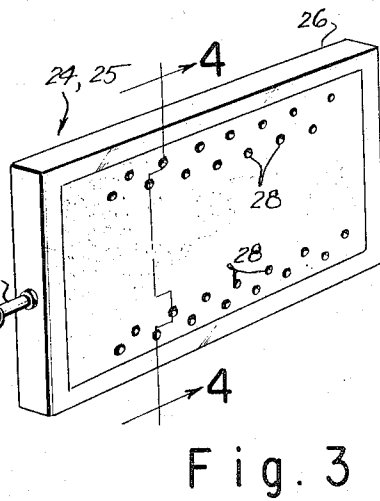
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FURNACE

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2 Sheets-Sheet 1



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Fig. 4

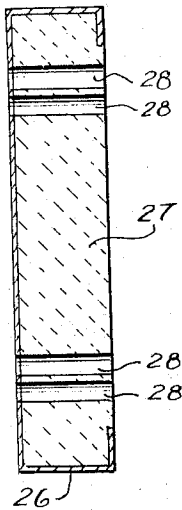


Fig. 5

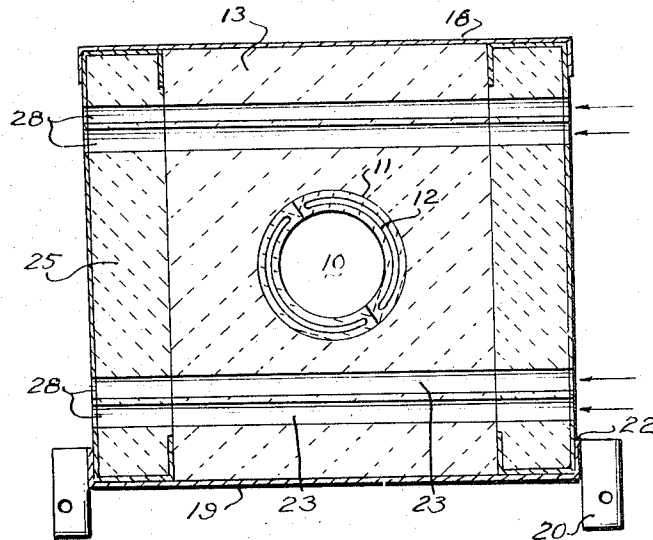
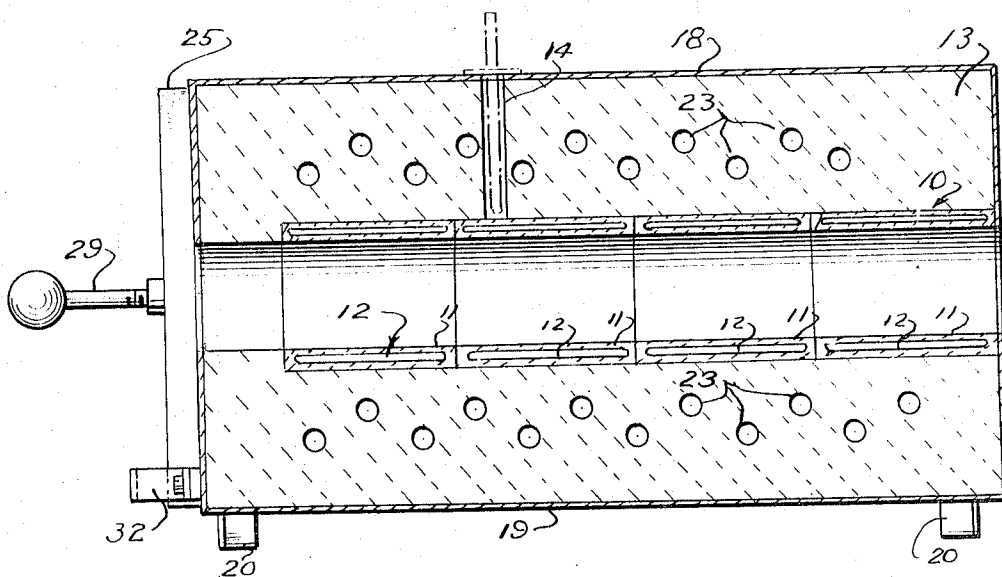


Fig. 6

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4 Claims. (Cl. 13—22)

This invention relates to furnaces and particularly to an improved furnace having the capability of providing a wide range of temperatures within a relatively small tolerance of temperature variation throughout said range.

In the processing of semiconductors as well as other articles, furnaces are required which have a wide range of operation, e.g., between temperatures lower than 100° C. and up to and above 1500° C. Such furnaces must be capable of providing so-called "flat zones" of temperature within such a wide range. Furthermore, such furnaces must be capable of being held within relatively narrow tolerances, e.g., $\pm 1/2^\circ$ C. over extended lengths of said "flat zones." It has been found that temperatures have been much more difficult to control at the low end of such a wide range of temperatures than they are at the high end of such range.

The principal object of this invention is to provide a furnace in which the heat losses therefrom can be controlled to such an extent that a relatively narrow tolerance can be achieved over a wide range of temperatures.

Another object of the invention is to provide such a furnace in which a balance of heat loss and power requirements enables the furnace to reach stabilization within a tight control coupled with a rapid recovery of temperature after it has been disturbed by loading of the furnace.

Another object of the invention is to provide such a furnace in which the natural heat losses of the furnace are capable of being increased in a controlled manner.

Still another object of the invention is to provide such a furnace in which adjustable means is employed to vary the heat losses from the furnace in a fashion such that the furnace performs satisfactorily at all operating temperatures between the minimum and maximum of a desired widespread range.

In one aspect of the invention, a furnace may comprise tubular chamber means which may have mating halves of hollow cylindrical members of refractory material containing electrical heating elements embedded within the refractory members. Furnace chamber need not necessarily be tubular in order to be effective. Furnace could be heated by other forms of heating units or elements.

In another aspect of the invention, the tubular chamber means may be embedded within a mass of insulating refractory material such as refractory brick work, reducing the heat loss from the tubular chamber means. In order to operate the instrumentation that controls the heat supplied to the tubular chamber means, temperature responsive means, such as thermocouple means, may be provided within the insulating mass so that it accurately reflects the temperature within the tubular chamber means.

In still another aspect of the invention, transversely extending, spaced passages may extend through the insulating mass, above and below the tubular chamber means, for the passage of air therethrough to increase the heat loss from the chamber means, particularly near the low end of the desired range of temperatures required.

In a still further aspect of the invention, panels of refractory material may be mounted for manual or automatic sliding movement on each side of the furnace. These panels may be provided with transverse through passages which will align with the transverse passages

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through the furnace proper when the panels are slidingly moved along the furnace sides. The construction is such that the transverse passages through the furnace itself may be opened varying degrees to control the heat loss from the tubular chamber means.

The above, other objects and novel features of the invention will become apparent from the following specification and accompanying drawings which are merely exemplary.

In the drawings:

FIG. 1 is a side elevational view of a furnace to which the principles of the invention have been applied;

FIG. 2 is an end view of the furnace shown in FIG. 1;

FIG. 3 is a perspective view of a panel forming one element of the invention;

FIG. 4 is a sectional view taken substantially along line 4—4 of FIG. 3;

FIG. 5 is a sectional view taken substantially along line 5—5 of FIG. 1; and

FIG. 6 is a sectional view taken substantially along line 6—6 of FIG. 2.

Referring to the drawings, the principles of the invention are shown as applied to a furnace including a tubular chamber 10 that may be made up of aligned tubular elements 11 arranged in abutting relation. Each element 11 may be composed of a ceramic material having embedded therein a separate electrical resistance means 12. The tubular chamber 10 may be surrounded by a mass of insulating material 13 which may comprise refractory bricks or the equivalent. Referring to FIG. 2, the mass 13 may be made in two mating half sections 13A and 13B, each half section including angle members 13C for supporting the refractory brick work.

The refractory insulating material 13 may be provided with a passage 14 extending radially from the tubular chamber 10 to the exterior of the furnace. In passage 14 there may be located a temperature responsive element such as a thermocouple, the conductors 15, 16 of which may lead to a control unit 17, the output 17A of which may control various instrumentation for controlling the current supplied to the electrical resistance means 12.

The refractory insulating mass 13 may be provided with top and bottom sheet metal frame members 18 and 19, members 19 being welded or otherwise fastened to feet 20 which, in turn, may be attached to supports 21. The frame members 18, 19 may extend beyond the sides of the mass 13 and may include facing flanges 22 forming tracks along opposite sides of the mass 13.

The mass of refractory bricks 13 may be provided with through passages 23 extending transversely of the tubular chamber 10, both above and below it. These passageways permit ambient air to flow through the refractory mass 13 thereby to increase the heat loss of the mass 13. In order to provide an accurate control of the heat loss from the mass 13, panels 24 and 25 are slidingly mounted in the tracks formed by the flanges 22 on the members 18 and 19.

Referring to FIG. 3, the panels 24, 25 may comprise a frame 26 of a width to slidingly fit the tracks formed by flanges 22. Frame 26 may be filled with a refractory material 27 through which passages 28 may extend. Passages 28 are so located that they will become aligned with the through passages 23 in the mass 13 as the panels 24, 25 are moved along the tracks formed by the flanges 22.

A handle 29 may be attached to each panel 24, 25 so that it can, with facility, be adjustably located along its corresponding track. In FIG. 1, the panels 24, 25 are shown in full closed position preventing ambient air from flowing through passages 23. In FIG. 6, the panels

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24, 25 are shown in full open position providing free flow of ambient air through the passages 23. It is evident that the panels 24, 25 can be slidably adjusted in their tracks to provide infinite variation of the opening of passages 23 thereby to control the heat loss from the furnace.

Each of the elements 11 includes its own heating element 12, and the conductors from such elements 12 are connected to a power terminal board 30 which may be on the righthand side of the furnace, or on the lefthand side as shown at 31, or any other convenient location externally supported.

In order to limit the movement of the panels 24, 25, a stop bracket 32 may be attached to the bottom flanges 22 on each side of the furnace.

Although the various features of the improved furnace have been shown and described in detail to fully disclose one embodiment of the invention, it will be evident that changes may be made in such details and certain features may be used without others without departing from the principles of the invention.

What is claimed is:

1. In a furnace, a chamber formed of ceramic members having heating means therein; an insulating mass surrounding said chamber; air passage means extending through said insulating mass on at least one side of and spaced from said chamber to increase the heat loss from said mass; means for varying the cross sectional dimension of said passage means, said means comprising slidable panel means including other air passage means that align with the air passage means in said insulating mass when said panel means is slidably moved; temperature responsive means; and means connected to said temperature responsive means for controlling the temperature within said chamber.

2. In a furnace, a chamber formed of tubular ceramic members having electrical heating elements embedded therein; a mass of ceramic insulating material surrounding said tubular chamber; air passage means extending through said insulating material transversely of, above and below said tubular chamber; track means on opposed side faces of said mass of insulating material; and slidable panel means in each track means, said panel means including ceramic material having air passage means arranged to become aligned with the air passage

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means extending through said insulating mass when said panel means is slidably moved in said track means.

3. In a furnace, a chamber formed of tubular ceramic members having electrical heating elements embedded therein; a mass of ceramic insulating material surrounding said tubular chamber; air passage means extending through said insulating material transversely of, above and below said tubular chamber; track means on opposed side faces of said mass of insulating material; slidable panel means in each track means, said panel means including ceramic material having air passage means arranged to become aligned with the air passage means extending through said insulating mass when said panel means is slidably moved in said track means; temperature responsive means within said mass of insulating material and responsive to the temperature in said tubular chamber; and means connected to said temperature responsive means for controlling the energy supplied to said electrical heating elements.

4. In a furnace according to claim 1, wherein said ceramic members have electrical heating elements embedded therein, and said air passage means extend through said insulating mass transversely of and on opposing sides of and spaced from said chamber.

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