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FURNACE HAVING VARIABLE AIR PASSAGES THEREINTO

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2 Sheets-Sheet 2

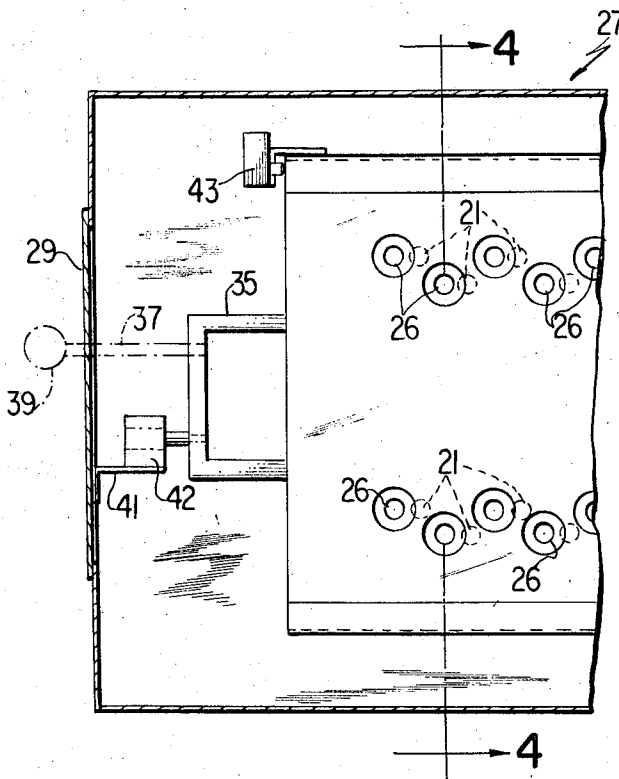


FIG. 3

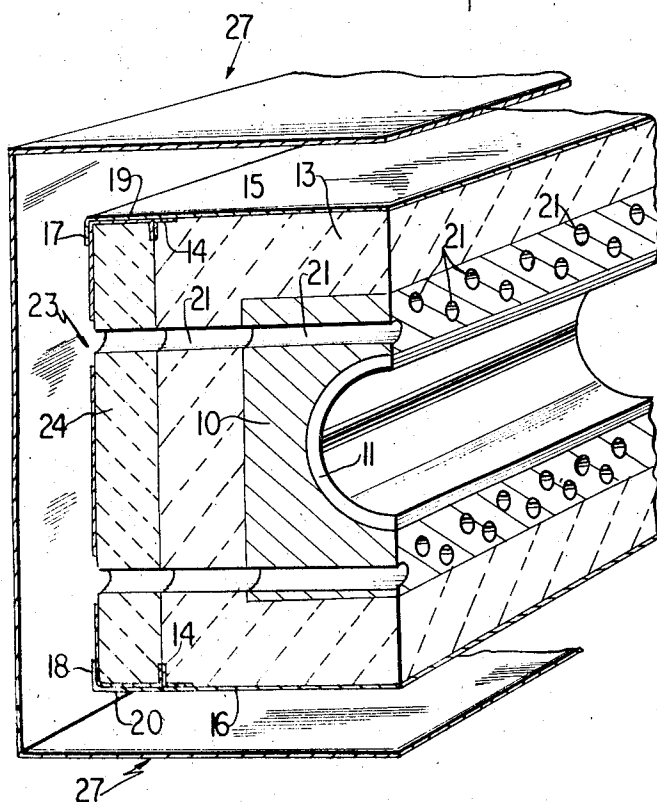


FIG. 4

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**FURNACE HAVING VARIABLE AIR
PASSAGES THEREINTO**

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ABSTRACT OF THE DISCLOSURE

A furnace combination having a chamber including an insulating mass surrounding the chamber and having an air passage therethrough including control means for varying the dimension of the passage.

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, for example, 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 wide range. Furthermore, such furnaces must be capable of being held within relatively narrow tolerances, for example, plus or minus one-half a degree centigrade over extended lengths of said "flat zones." It has been found that temperatures are much more difficult to control at the lower end of such a wide range of temperatures than they are at the high end thereof.

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.

A further object of the invention is to provide such a furnace having an outer casing therefor spaced from the refractory material of the furnace, and a supply of air under pressure to the space between the outer casing or housing and the furnace proper to facilitate the control of heat losses from the furnace.

A still further object of the invention is to provide such a furnace in which a limit switch is actuated by the adjustable means that varies the heat losses to energize fan means to supply air to facilitate the heat losses.

In one aspect of the invention, a furnace may comprise chamber means which may have mating halves of hollow refractory material in which electrical heating elements have been embedded.

In another aspect of the invention, the chamber means may be embedded within a mass of insulating refractory material, such as refractory brickwork, for reducing the heat loss from the chamber means. In order to operate the instrumentation that controls the heat supplied to

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the 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 chamber means.

In still another aspect of the invention, transversely extending, spaced passages may be provided through the insulating mass, both above and below the 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 through the insulating mass when the panels are slidably 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 chamber means.

In another aspect of the invention, a housing may be provided for enclosing the chamber means as well as the refractory mass and sliding panels. The housing may comprise walls spaced from the walls of the refractory mass and sliding panels. The housing may include door means for providing access to the interior of the furnace as well as a manually operable handle for independently actuating the sliding panel means.

In a still further aspect of the invention, an electric motor may be attached to the outside of one of the sides of the housing with its output shaft extending through said side wall. A fan may be attached to the output shaft of the motor, and it may be located within the space between one side wall of the housing and the outside of one of the sliding panels of the furnace. A vent may be provided in the housing for exhausting the air that is forced through the transverse passages in the sliding panels and the refractory mass.

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 perspective view of a furnace to which the principles of the present invention have been applied;

FIG. 2 is a perspective exploded view of portions of the furnace shown in FIG. 1;

FIG. 3 is a side elevational view, partly in section, of a portion of the furnace shown in FIG. 1; and

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

Referring to the drawings, the principles of the invention are shown as applied to a furnace including a chamber 10 (FIG. 4) that may be made of ceramic material having embedded therein electrical resistance means 11. The electrical resistance means 11 may be connected to a plug 12 (FIG. 2) that may be mounted on a wall of the furnace. The chamber 10 may be surrounded by a mass of insulating material 13 which may comprise refractory brick or the equivalent. Each corner of the refractory mass 13 may be provided with an angle member 14, and top and bottom sheet metal plates 15 and 16 may be bolted or otherwise secured to the angle members 14. The top and bottom sheet metal plates 15 and 16 may extend outwardly beyond the end of mass 13 and may include flanges 17 and 18 which provide, with the angle members 14, ways 19 and 20 along the side of the mass 13 for a purpose to be described later.

Referring to FIGS. 2 and 4, transverse, aligned passages 21 may extend through the refractory material forming the chamber 10 and the mass 13. There may be a series of these transverse passages above and below

the article-receiving portion of the chamber 10 for the purpose of varying the heat losses from the furnace.

In order to vary the effectiveness of the transverse passages 21, panels 22 and 23 may be mounted for sliding movement within ways 19 and 20 on each side of the refractory mass 13. Each of the panels may be composed of refractory material 24 encased within sheet metal panel elements 25. Through passages 26 may be provided in the panels 22 and 23 such that they can be made to align with the transverse passages 21 extending through the refractory of the chamber 10 and the mass 13. The construction is such that with the panels 22 and 23 at one point along their paths of movement within ways 19 and 20, ambient air will be prevented from passing through the transverse passages 21, and in another position along ways 19 and 20, the through holes 26 of the panels 22 and 23 will become aligned with the transverse passages 21, thereby permitting ambient air to pass transversely through the refractory of the chamber 10 and the mass 13, thus causing an increase in the heat loss from chamber 10. Positions between the last two mentioned positions of the panels 22 and 23 will provide different degrees of opening of the passages 21.

A sheet metal housing or outer casing 27 may surround the furnace and the walls thereof may be spaced from the ways 19 and 20 in which panels 22 and 23 are mounted, as well as spaced from the top and bottom surfaces 15 and 16 of the furnace by any suitable means, not shown.

The housing 27 may be attached to feet 28 for supporting the former. Housing 27 may be provided with a door 29 for facilitating the loading of chamber 10, said housing 27 also including a vent 30 from which the ambient air therein is adapted to exhaust. An electric motor 31 may be attached to one side wall of housing 27, and its output shaft may have connected to it a fan blade 32 that is located within the space between the side wall of housing 27 and one of the panels, such as 22, that slides within ways 19 and 20. Energization of motor 31 causes the fan blade 32 to positively force ambient air through the transverse passages 21, which air increases the heat losses of the chamber 10 and which air is finally exhausted through vent 30. In order to control the degree of heat loss within chamber 10, a thermocouple 33 may extend from the outside of the housing 27 to a point within the refractory of chamber 10, the thermocouple 33 being connected to suitable recording and/or control means 34.

Referring to FIGS. 2 and 3, each of the panel members 22 and 23 may include handles 35 and 36 that are located within housing 27. Rods 37 and 38 may extend through the front wall of housing 27 and be provided with knobs 39 and 40. The rod 37 may be connected to the handle 35, and the rod 38 may be connected to the handle 36. In this way, movement of panels 22 and 23 may be independently effected manually from the outside of the housing 27.

Referring to FIG. 3, a bracket 41 may be located within housing 27 on the front wall thereof. Bracket 41 is adapted to support means for automatically moving the panel 22 between its closed and open positions relative to the transverse passages 21, and a similar automatic means may be provided for panel 23. The automatic means 42 may take various forms such as solenoid means or the equivalent.

In order to energize the motor 31 when through passages 26 are in alignment with the through passages 21, and to de-energize the motor 31 when such passages are not aligned with each other, a normally closed limit switch 43 may be mounted within housing 27 (FIG. 3) in position to be actuated by the reciprocation of panels 22 and 23. There may be a switch 43 for each of the panels 22 and 23, and they may be wired in series with respect to motor 31 so that the through passages 26 in both passages 22 and 23 are required to be in align-

ment with through passages 21 before motor 31 is energized. With the apparatus in the condition shown in FIG. 3 where the passages 21 and 26 are misaligned, the switch 43 is open so that fan motor 31 is de-energized. Under these conditions, applying current to plug 12 causes heating of elements 11, raising the temperature within chamber 10. When a desired temperature has been reached within chamber 10, the thermocouple 33 may indicate such condition in the device 34, which may be arranged to control the energization of the automatic means 42 to move the panels 22 and 23 to a position where the passages 21 and 26 become aligned. When this occurs, the switch 43 is closed, energizing motor 31 so that the fan forces ambient air through the passages 21 and 26, which air increases the heat losses of the chamber 10 and exhausts through vent 30.

Although the various features of the improved furnace have been shown and described in detail to fully disclose embodiment of the invention, it will become apparent 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; an insulating mass surrounding said chamber; air passage means extending through said insulating mass 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 are slidably moved; a housing surrounding said furnace and including side walls spaced from the walls of said furnace; a motor mounted on one of the side walls of said housing adjacent one of said slidable panel means; a fan connected to the output shaft of said motor and located within the space between said side wall and said slidable panel means; temperature responsive means embedded within said insulating mass and connected to control means; and means responsive to said control means for automatically sliding said panel means between a position where the passage means therein is not in alignment with the air passage means extending through the insulating mass, to a position where alignment is provided between said air passage means.

2. In a furnace, a chamber; an insulating mass surrounding said chamber; air passage means extending through said insulating mass 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 are slidably moved; a housing surrounding said furnace and including side walls spaced from the walls of said furnace; a motor mounted on one of the side walls of said housing adjacent one of said slidable panel means; a fan connected to the output shaft of said motor and located within the space between said side wall and said slidable panel means; vent means for exhausting heated air from said housing; temperature responsive means embedded within said insulating mass and connected to control means; and means responsive to said control means for sliding said panel means between positions of nonalignment and alignment of the passage means within said panel means relative to the transverse passage means within said mass.

3. In a furnace, a chamber; an insulating mass surrounding said chamber; air passage means extending through said insulating mass 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 are slidably moved; a housing surrounding said furnace and including side walls

spaced from the walls of said furnace; a motor mounted on one of the side walls of said housing adjacent one of said slidable panel means; a fan connected to the output shaft of said motor and located within the space between said side wall and said slidable panel means; vent means for exhausting heated air from said housing; temperature responsive means embedded within said insulating mass and connected to control means; means responsive to said control means for sliding said panel means between positions of nonalignment and alignment of the passage means within said panel means relative to the transverse passage means within said mass; and manually operable means connected to each of said slidable panel means and extending to the exterior of said housing means.

4. In a furnace, a chamber; an insulating mass surrounding said chamber; air passage means extending through said insulating mass 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 are slidably moved; a housing surrounding said furnace and including side walls spaced from the walls of said furnace; a motor mounted on one of the side walls of said housing adjacent one of said slidable panel means; a fan connected to the output shaft of said motor and located within the space between said side wall and said slidable panel means; vent means for exhausting heated air from said housing; and means for energizing said motor when both said panel means are in position where the passage means therein are in alignment with the transverse passage means in said insulating mass, and for de-energizing said motor when said passage means are not in alignment.

5. In a furnace, a chamber; an insulating mass surrounding said chamber; air passage means extending through said insulating mass 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 air passage means that align with the air passage means in said insulating mass when said panel means are slidably moved; a housing surrounding said furnace and including side walls spaced from the walls of said furnace; a motor mounted on one of the side walls of said housing adjacent one of said slidable panel means; a fan connected to the output shaft of said motor and located within the space between said side wall and said slidable panel means; vent means for exhausting heated air from said housing; tempera-

ture responsive means embedded within said insulating mass and connected to control means; means responsive to said control means for sliding said panel means between positions of nonalignment and alignment of the passage means in said panel means relative to the transverse passage means within said mass; and means for energizing said motor when both said panel means are in position where the passage means therein are in alignment with the transverse passage means in said insulating mass, and for de-energizing said motor when said passage means are not in alignment.

6. In a furnace, a chamber, an insulating mass surrounding said chamber; air passage means extending through said insulating mass 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 air passage means that align with the air passage means in said insulating mass and when said panel means are slidably moved; a housing surrounding said furnace and including side walls spaced from the walls of said furnace; a motor mounted on one of the side walls of said housing adjacent one of said slidable panel means; a fan connected to the output shaft of said motor and located within the space between said side wall and said slidable panel means; vent means for exhausting heated air from said housing; temperature responsive means embedded within said insulating mass and connected to control means; means responsive to said control means for sliding said panel means between positions of nonalignment and alignment of the passage means in said panel means relative to the transverse passage means within said mass; manually operable means connected to each of said slidable panel means and extending to the exterior of said housing means; and means for energizing said motor when both said panel means are in position where the passage means in said panel means is in alignment with the transverse passage means in said insulating mass, and for de-energizing said motor when said passage means are not in alignment.

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