

[54] FURNACE WALL CONSTRUCTION

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[58] Field of Search 110/1 A; 52/568, 52/564, 248, 9; 263/46

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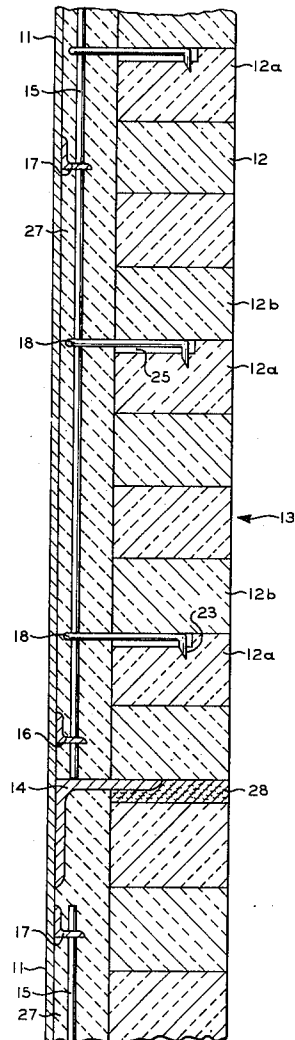
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[57] ABSTRACT

The upper surfaces of at least selected fire bricks in the inner lining wall of a furnace are grooved to receive the horizontal elements of a hook member, the grooves being of sufficiently greater depth than the thickness of the hook element to permit thermal expansion of the fire brick in the vertical direction without causing significant bending forces on the hook element.

8 Claims, 6 Drawing Figures



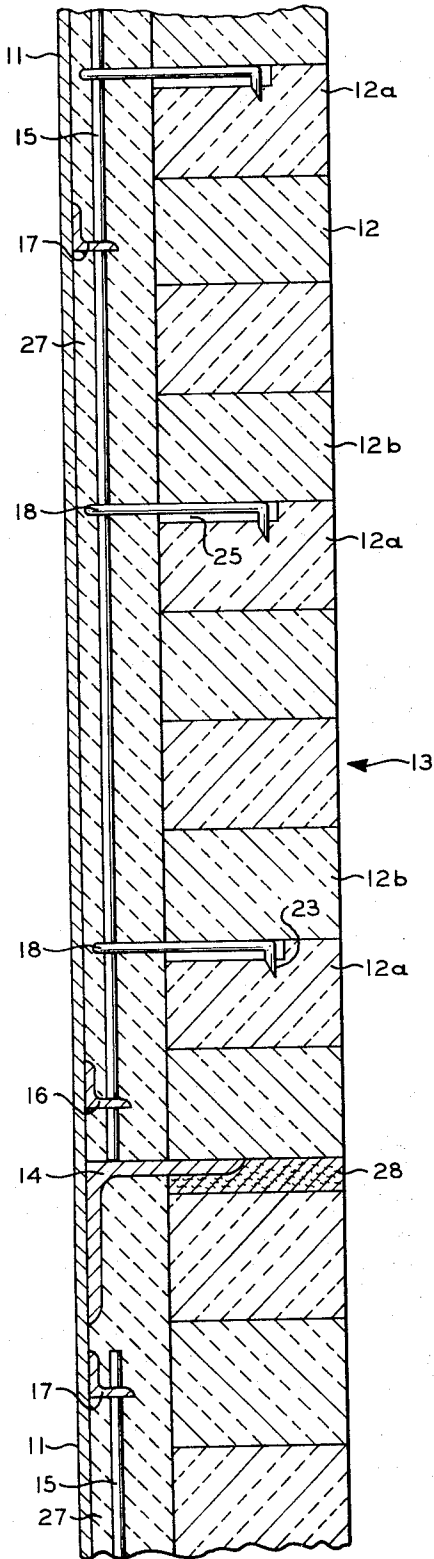


FIG. 1

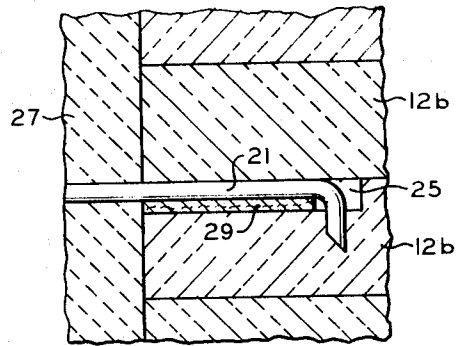


FIG. 3

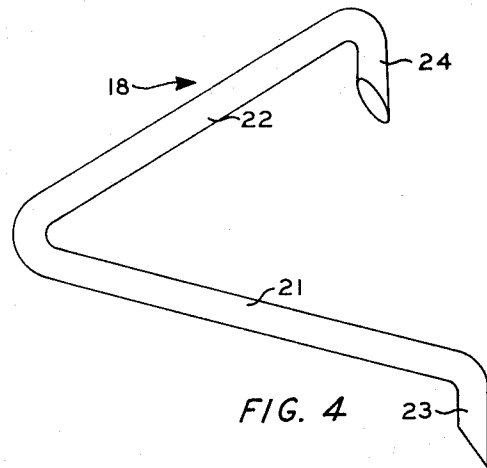
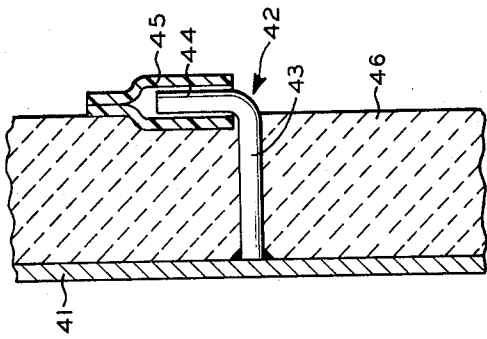
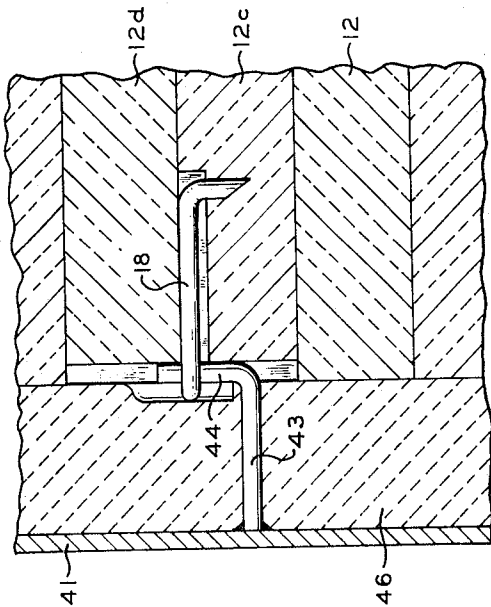
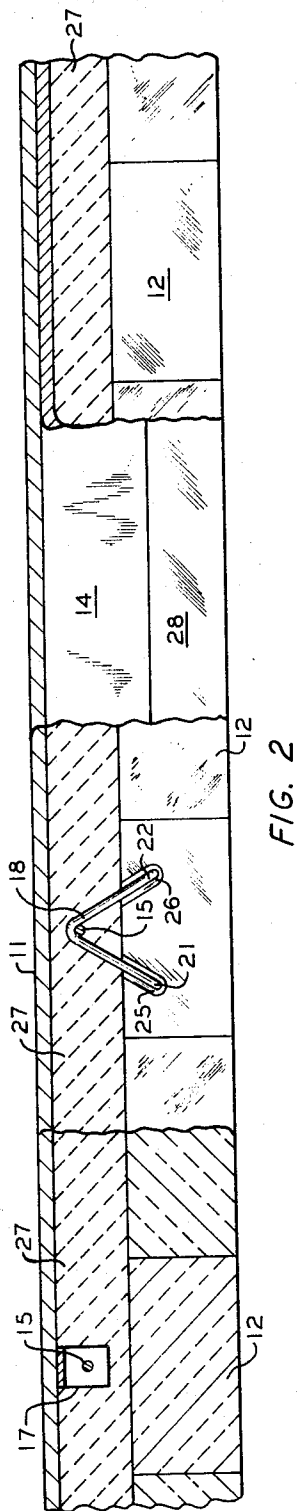


FIG. 4



FURNACE WALL CONSTRUCTION

This invention relates to improved furnace wall construction and methods of fabrication thereof.

In many furnace constructions, it has become desirable to have an intermediate layer of refractory material, such as preformed sheets of lightweight porous refractory material, between the outer steel shell and the inner lining of insulating fire bricks. The employment of the intermediate layer has posed problems concerning the lateral attachment of the fire brick wall and the shell. One proposal has been to utilize hook members which are secured to the shell and/or rigidly imbedded in the refractory concrete and which extend into horizontal joints of superimposed insulating fire bricks. The different degree of thermal expansion in the vertical direction encountered for the insulating fire bricks and for the refractory concrete has resulted in bending stresses being applied to the hook members, resulting in the cracking of the relatively fragile insulating fire bricks. This cracking of the insulating fire bricks can significantly shorten the useful life of the furnace wall. The utilization of preformed sheets of refractory material has also permitted the migration of combustion gases through the gaps to surround the sheets and to contact the inner face of the steel shell, thereby contributing to chemical deterioration of the refractory material and the shell.

Accordingly, it is an object of the invention to provide new and improved furnace wall constructions and methods of fabrication thereof. Another object of the invention is to minimize, if not eliminate, the formation of cracks in a furnace wall lining of insulating fire bricks. Another object of the invention is to substantially reduce, if not eliminate, chemical deterioration of the furnace wall. Other objects, aspects and advantages of the invention will be apparent from a study of the specification, the drawings and the appended claims to the invention.

In the drawings,

FIG. 1 is a vertical cross-sectional view of a furnace wall in accordance with one embodiment of the present invention;

FIG. 2 is a cross-sectional view along a series of horizontal planes of the wall of FIG. 1;

FIG. 3 is a fragmentary vertical cross-sectional view of a portion of the wall of FIG. 1 during construction;

FIG. 4 is a perspective view of the hook member utilized in the wall construction of FIG. 1;

FIG. 5 is a vertical cross-sectional view of a furnace wall in an intermediate stage of construction in accordance with a second embodiment of the invention; and

FIG. 6 is a vertical cross-sectional view of a portion of the completed wall in accordance with the second embodiment.

Referring now to the drawings in detail, and to FIGS. 1 and 2 in particular, there is illustrated a furnace wall comprising an outer wall or shell 11, generally of steel, and a series of individual insulating fire bricks 12 laid upon one another in a plurality of horizontal courses to form an inner lining wall 13. Although any known insulating fire brick can be employed in the wall construction of the invention, those containing less than 2 weight percent calcium oxide are presently preferred for furnaces to be operated with sulfur containing fuels. For furnaces having substantial height, the lining wall 13 can be divided into vertical sections of suitable height, for example about 8 feet. The lowermost sec-

tion can be laid directly upon the floor of the furnace, while each of the other sections can be laid upon a respective one of a corresponding series of horizontal flanges 14 which are secured to outer wall 11 by suitable means, for example welding or bolts.

A plurality of vertical support rods 15 can be horizontally spaced along the length of the furnace wall for each horizontal section. Each rod 15 can be positioned by at least one lower bracket 16 and at least one upper bracket 17. Brackets 16 and 17 are secured to the outer wall 11 by suitable means, for example by welding. Hook members 18 are spaced apart vertically along each support rod 15 to provide lateral support for lining wall 13. Although a single hook member can be employed with each support rod 15, it is presently preferable to employ a set of at least two vertically aligned hook members 18 with each support rod 15. While the hook member can have any suitable configuration which includes at least one horizontal leg adapted to extend into a joint between bricks 12, the V-shaped configuration illustrated in the drawings is presently preferred. Each hook member 18 is formed of heavy wire, and has two horizontal legs 21 and 22 which are joined at the outer ends thereof and which extend from a point adjacent the outer wall 11 inwardly on either side of the respective rod 15 into a horizontal joint between the respective set of lower brick 12a and upper brick 12b superimposed thereon. Hook legs 23 and 24 extend downwardly from the inner end of horizontal legs 21 and 22, respectively. The lower ends of legs 23 and 24 are preferably pointed to facilitate the forced insertion of legs 23 and 24 into the upper surface of lower brick 12a, without cracking the brick 12a, thereby forming vertically oriented cylindrical holes in brick 12a. The upper surface of brick 12a has grooves 25 and 26 formed therein to receive horizontal legs 21 and 22, respectively, of hook members 18. Grooves 25 and 26 have a greater horizontal width than horizontal legs 21 and 22 to prevent lateral binding of legs 21 and 22 in the grooves 25 and 26. Grooves 25 and 26 can be cut in the individual bricks 12a as the bricks 12a and hook members 18 are installed, or the bricks 12a can be preformed with grooves 25 and 26. In the latter case, it will generally be desirable for the width of grooves 25 and 26 to be sufficient to permit relative lateral adjustment of the brick 12a and the respective support rod 15. Grooves 25 and 26 have a greater depth than the vertical thickness of horizontal legs 21 and 22.

The space between shell 11 and the lining wall 13 is filled with a lightweight insulating refractory material 27 to provide additional insulation and to immobilize hook members 18. Material 27 can be any suitable known material, for example a hydraulic-setting castable refractory, a plaster refractory, or a gunning mix refractory. Material 27 has a significantly higher degree of impermeability to combustion gases formed in the operation of the furnace than the inner lining wall 13. Insulating fire bricks 12, although relatively porous to combustion gases, provide a substantial temperature differential, so that even though some combustion gases may migrate to the inner face of material 27, the temperature prevailing at the inner face of material 27 is sufficiently low so that the chemical deterioration of material 27 by reaction of combustion gas components, such as sulfur oxides, with components of material 27, such as calcium oxide, is substantially reduced, thereby prolonging the useful life of the furnace wall construc-

tion. The relatively high impermeability of material 27 also protects the outer portion of material 27 as well as shell 11 against chemical deterioration. Material 27 can be applied to the inner surface of shell 11 prior to the installation of bricks 12 by any suitable technique, for example by spraying or by application as a putty with a trowel or gun. However, in the embodiment of FIG. 1, it is presently preferred that material 27 be poured into place as a series of horizontal layers, each layer being cast after several courses of bricks have been laid. The gap between the top layer of bricks 12 in one section and the first layer of bricks on the next higher flange 14 can be filled with refractory fiber 28 after the installation of material 27 has been completed. It is presently preferred to place a layer 29 of combustible filler in grooves 25 and 26 during the pouring of refractory material 27, thereby positioning the hook member 18 in the upper portion of grooves 25 and 26 in finished wall construction when the furnace is cold. The material 29 is selected to be thermally disintegratable at a temperature achieved by that portion of the lining wall 13 during operation of the furnace. The disintegration of material 29 leaves a void space below each of the horizontal legs 21 and 22. As the furnace heats up to its operating temperature, the inner lining wall 13 expands vertically. The points on the lower ends of hook legs 23 and 24 readily permit the legs 23 and 24 to penetrate deeper into brick 12a as brick 12a is raised by the vertical expansion, while the void spaces below horizontal legs 21 and 22 permit the brick 12a to be raised without causing any significant bending force on the horizontal legs 21 and 22 despite the outer end of hook member 18 being held rigid by the layer of refractory material 27. The bricks 12 can be joined together by a thin layer of refractory mortar, in which case the filler material 29 prevents the accidental filling of grooves 25 and 26 with the mortar.

Referring now to the embodiment illustrated in FIGS. 5 and 6, a plurality of L-shaped rods 42 can be employed in lieu of support rods 15 and brackets 16 and 17. The outer end of the horizontal leg 43 of rod 42 can be secured to the outer wall or shell 41 by suitable means, for example by welding. The vertical leg 44 of rod 42 serves as the vertical guide rod for the respective hook member 18. A sleeve 45 of a suitable material, for example a thermoplastic material, and preferably closed at the upper end thereof, can be placed over the vertical leg 44 to protect leg 44 during the application of refractory material 46 to the inner surface of shell 41. The sleeve 45 has an annular thickness which is at least slightly greater than the horizontal thickness of the apex of the horizontal legs of hook members 18, so that after the application of refractory material 46, sleeve 45 can be removed to leave a notch or groove of sufficient depth to permit the apex of hook member 18 to be positioned around vertical leg 44 and for hook member 18 to have freedom of vertical movement along leg 44. The horizontal legs 21 and 22 of hook member 18 extend into the horizontal joint between lower insulating fire brick 12c and upper insulating fire brick 12d superimposed thereon. Bricks 12c and 12d are preferably provided with a vertically aligned groove of sufficient length and depth to accommodate vertical leg 44. Brick 12c is also preferably provided with grooves in the upper surface thereof of sufficient width and depth to receive horizontal legs 21 and 22. This arrangement provides for lateral stability of the inner lin-

ing wall of fire bricks while permitting relative vertical motion between hook member 18 and support bar 42 caused by differences in thermal expansion of the fire bricks 12 and the refractory material 46. The refractory material 46 serves the same functions as material 27 of FIG. 1, and can be any of the materials recited as examples for material 27 and similarly can be applied by any suitable technique. However, the construction of FIGS. 5 and 6 is particularly suited for the application of refractory material 27 by spraying.

Reasonable variations and modifications are possible within the scope of the foregoing disclosure, the drawings and the appended claims to the invention.

I claim:

1. A furnace wall construction comprising an outer wall, a series of individual insulating fire bricks laid upon one another in a plurality of courses adjacent to said outer wall to form an inner lining wall, a plurality of hook members rigidly secured relative to said outer wall, each hook member having at least one horizontal leg extending inwardly from said outer wall into a horizontal joint between a respective first one of said insulating fire bricks and another one of said insulating fire bricks superimposed on said respective first one of said insulating fire bricks, a hook leg extending downwardly from the inner end of said horizontal leg into a hole in said respective first one of said insulating fire bricks to at least substantially prevent lateral motion of said respective first one of said insulating fire bricks toward or away from said outer wall, said respective one of the insulating fire bricks being provided with a groove in the upper surface thereof parallel to an immediately under said horizontal leg, said groove being wider than said horizontal leg and of sufficient depth to provide an air space below said horizontal leg, said air space being of sufficient height to permit vertical expansion of said lining wall relative to said outer wall without effecting any significant bending force upon the horizontal legs of said plurality of hook members, the lower end of each of the hook legs being sufficiently pointed to permit the hook leg to be forced into the respective first one of said insulating fire bricks during fabrication of said furnace wall construction to form said hole without cracking the respective first one of said insulating fire bricks and to permit the hook leg to penetrate deeper into the respective first one of said insulating fire bricks without cracking the respective first one of said insulating fire bricks as said respective first one of said insulating fire bricks is raised by vertical expansion as the furnace is heated up to its operating temperature.

2. A furnace wall construction in accordance with claim 1 wherein said insulating fire brick contains less than 2 weight percent calcium oxide.

3. A furnace wall construction in accordance with claim 1 wherein said insulating fire bricks are joined to one another by a layer of refractory mortar, and wherein said air space is filled with a combustible filler which holds the horizontal leg in the desired position and prevents the entry of mortar into said air space during construction of said liner, said filler being disintegratable at a temperature achieved by the lining during operation of the furnace.

4. A furnace wall construction in accordance with claim 1 wherein said outer wall comprises a steel shell and a cast layer of a refractory material between said steel shell and said lining wall, said cast layer having a

significantly higher degree of impermeability to combustion gas than said inner lining wall to thereby minimize chemical deterioration of the furnace wall construction.

5. A furnace wall construction in accordance with claim 4 wherein said refractory material is selected from the group consisting of hydraulic-setting castable refractories, plastic refractories, and gunning mixes.

6. A furnace wall construction in accordance with claim 5 wherein each of said hook members has two horizontal leg members connected at their outer ends in a generally V-shape, wherein the hook members are positioned in a plurality of sets, each set comprising at least two vertically aligned hook members, a corresponding plurality of vertical support rods, each vertical support rod being positioned between the horizontal legs of the hook members in a respective set and spaced from said lining, and means for securing the support rods to said steel shell.

7. A furnace wall construction comprising an outer wall, a series of individual insulating fire bricks laid upon one another in a plurality of courses adjacent to said outer wall to form an inner lining wall, a plurality of L-shaped rods located between said outer wall and said inner lining wall, each of said rods having a horizontal leg and a vertical leg, the end of the horizontal leg opposite the vertical leg being attached to said outer wall, a plurality of hook members, each hook member having at least two horizontal legs which are joined at the outer ends thereof in a generally V-shape configuration and which extend from a point adjacent said outer wall inwardly on either side of the vertical leg of a respective one of said rods into a horizontal joint between a respective first one of said insulating fire bricks and another one of said insulating fire bricks superimposed on said respective first one of said insulating fire bricks, at least one horizontal leg of each said hook member having a hook leg extending downwardly from the inner end thereof into a hole in said respective first one of said insulating fire bricks, the space between said outer wall and said inner lining wall being at least substantially filled with an insulating refractory material except about the vertical leg of each of said rods and that portion of each hook member which extends outwardly from said inner lining wall toward said outer wall so that relative vertical movement of each hook member along the vertical leg of the respective

rod is not hindered, whereby lateral motion of said respective first one of said insulating fire bricks toward or away from said outer wall is at least substantially prevented.

8. A method of fabricating a furnace wall construction comprising an outer wall, a series of individual insulating fire bricks laid upon one another in a plurality of courses adjacent to said outer wall to form an inner lining wall, a plurality of L-shaped rods located between said outer wall and said inner lining wall, each of said rods having a horizontal leg and a vertical leg, the end of the horizontal leg opposite the vertical leg being attached to said outer wall, a plurality of hook members, each hook member having at least two horizontal legs which are joined at the outer ends thereof in a generally V-shape configuration and which extend from a point adjacent said outer wall inwardly on either side of the vertical leg of a respective one of said rods into a horizontal joint between a respective first one of said insulating fire bricks and another one of said insulating fire bricks superimposed on said respective first one of said insulating fire bricks, at least one horizontal leg of each said hook member having a hook leg extending downwardly from the inner end thereof into a hole in said respective first one of said insulating fire bricks, the space between said outer wall and said inner lining wall being at least substantially filled with an insulating refractory material except about the vertical leg of each of said rods and that portion of each hook member which extends outwardly from said inner lining wall toward said outer wall so that relative vertical movement of each hook member along the vertical leg of the respective rod is not hindered, whereby lateral motion of said respective first one of said insulating fire bricks toward or away from said outer wall is at least substantially prevented; which comprises, in sequence, attaching said L-shaped rods to said outer wall, covering the vertical leg of each of said rods with a respective one of a corresponding plurality of removable sleeves having an annular thickness at least slightly greater than the horizontal thickness of said hook members at the outer end thereof, applying said insulating refractory material to said outer wall, removing the sleeves from the vertical legs, and installing said bricks and said hook members.

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