April 9, 1968 R. J. DEMAISON 3,376,681

FURNACE WALL OF BLOCKS WITH EMBEDDED FASTENING ELEMENTS

Filed March 8, 1965 5 Sheets-Sheet 1

Fig. 1.

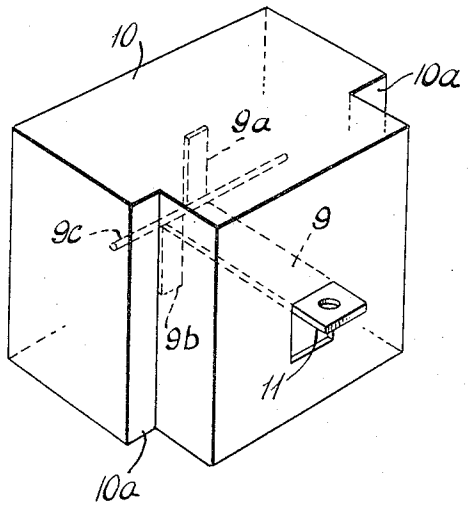


Fig. 2.

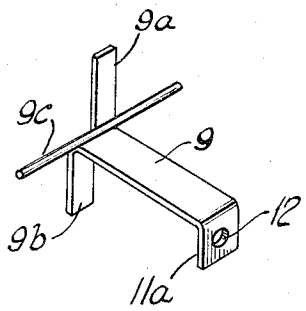
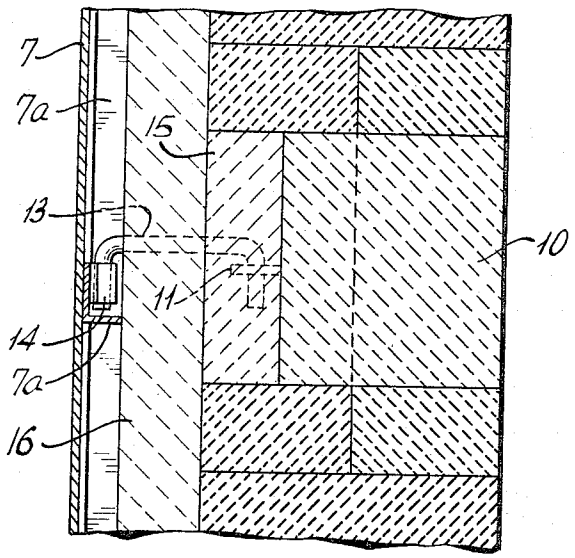


Fig. 5.



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FURNACE WALL OF BLOCKS WITH EMBEDDED FASTENING ELEMENTS

Filed March 8, 1965 5 Sheets-Sheet 2

Fig. 3.

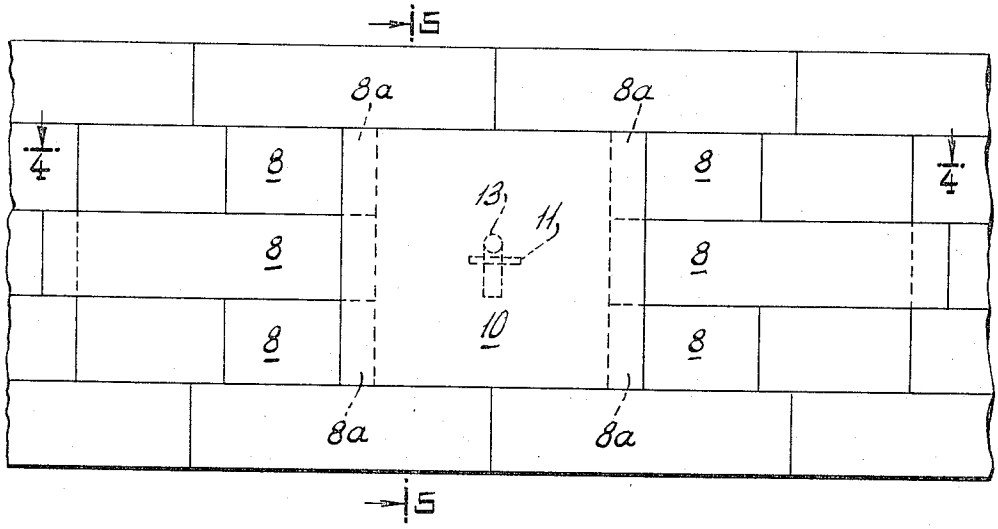
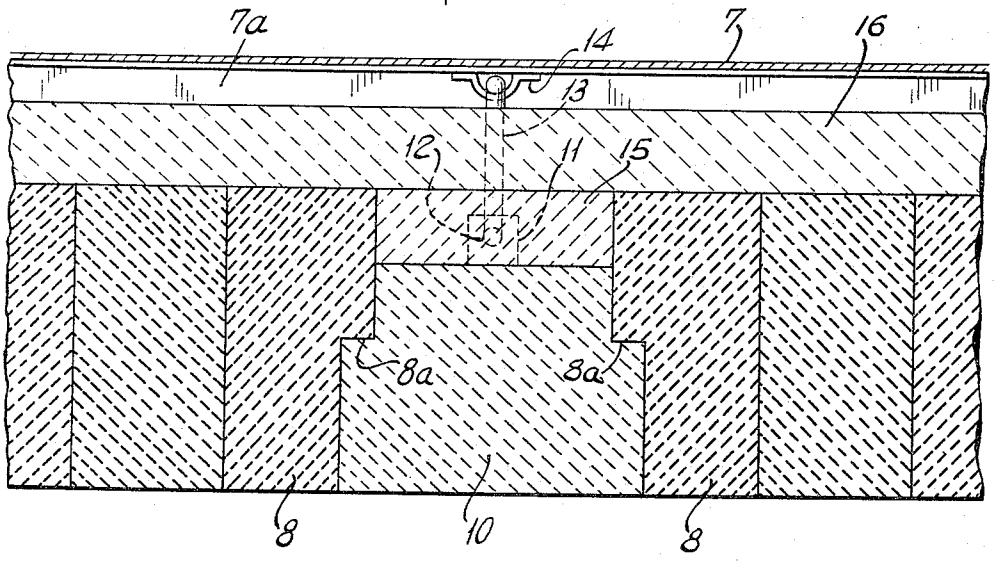


Fig. 4



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FURNACE WALL OF BLOCKS WITH EMBEDDED FASTENING ELEMENTS

Filed March 8, 1965 5 Sheets-Sheet 3

Fig. 6.

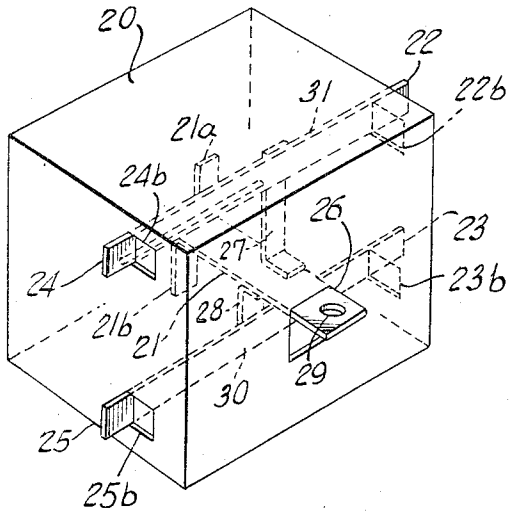


Fig. 7.

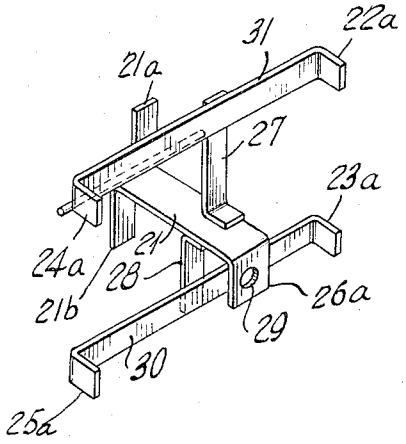
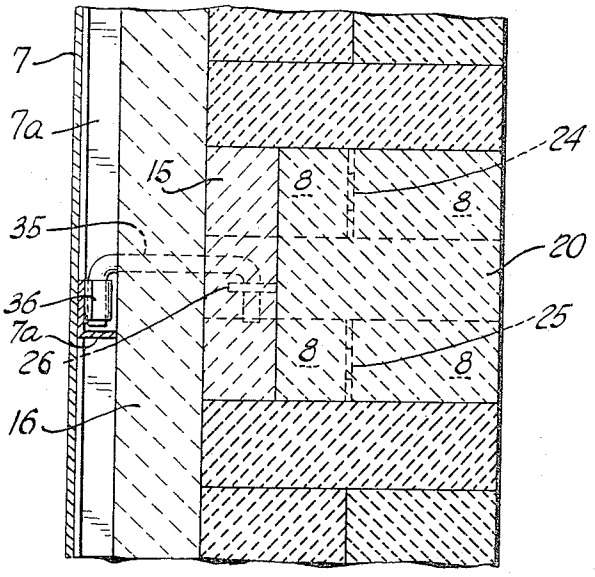


Fig. 10.



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April 9, 1968 R. J. DEMAISON 3,376,681

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Filed March 8, 1965 5 Sheets-Sheet 4

Fig. 8.

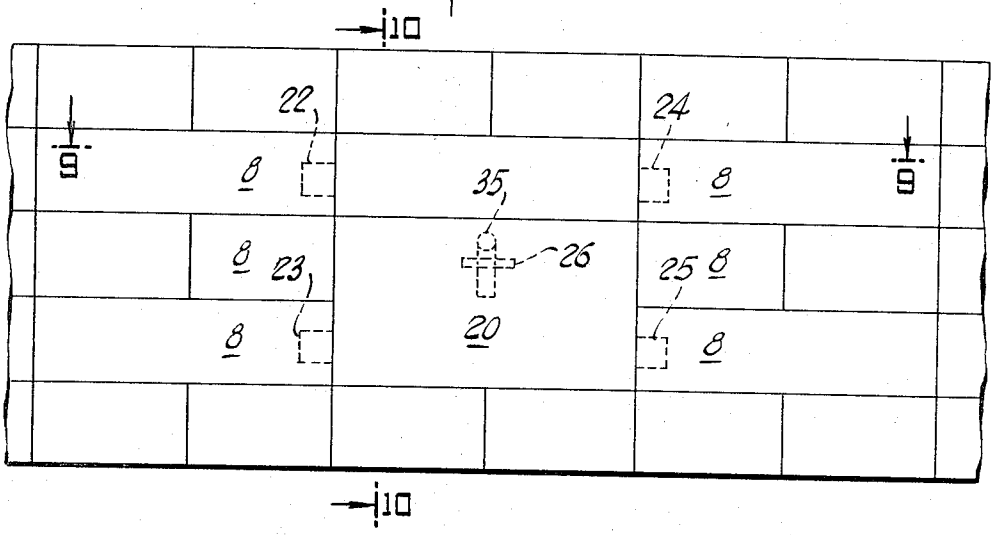
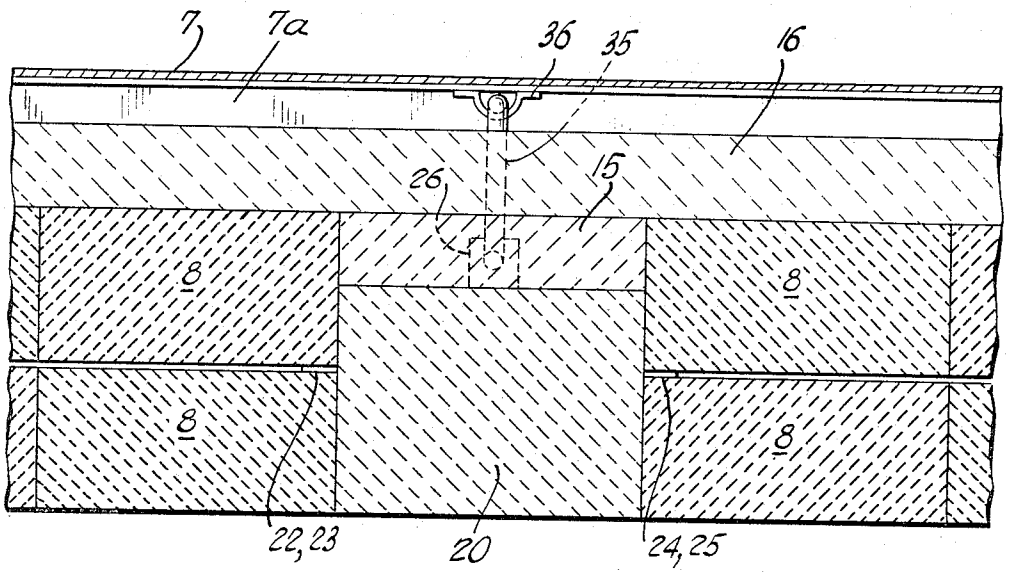


Fig. 9.



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Filed March 8, 1965 5 Sheets-Sheet 5

Fig. 11.

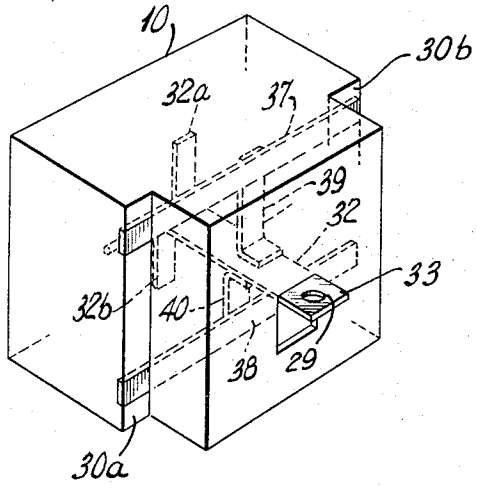
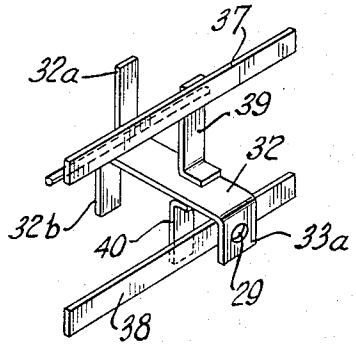


Fig. 12.



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FURNACE WALL OF BLOCKS WITH EMBEDDED FASTENING ELEMENTS

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Filed Mar. 8, 1965, Ser. No. 437,708
9 Claims. (Cl. 52—508)

ABSTRACT OF THE DISCLOSURE

A furnace wall construction having a lining spaced from and sustained independently of the outer furnace supporting structure, which lining comprises a series of laid up refractory fire bricks and a series of lining retaining blocks interspersed therewith, said retaining blocks being composed of light weight refractory insulating material and having embedded therein metallic reinforcing means formed with fastening elements tied to the outer furnace supporting structure.

This invention is directed to a new means for retaining the linings of a furnace formed of individual refactory fire brick in spaced relation to the normal outer furnace supporting structure. The words "furnace lining" will in this entire disclosure mean the normal furnace lining laid up of normal sized refractory fire bricks selected for the temperatures or other conditions to which they will be subjected and will include all types of furnaces in which said refractory fire bricks are normally used as linings.

A prime feature of the invention is the provision of a furnace lining retaining block cast of suitable light weight refractory insulating material and having a metallic reinforcing means permanently embedded therein, said means including a fastening element protruding from the back face of the block, whereby a series of such blocks may be placed in the furnace lining at suitable intervals and then by means of the tie clips inserted into the fastening elements connected to the outer furnace supporting structure. The retaining blocks are of such size and shape as to hold in place a plurality of courses of the refractory fire bricks and prevent buckling and distortion with subsequent lining failure.

The connecting clips are designed to permit the retaining blocks to move freely in all directions for expansion and contraction under the furnace heat. The expansion and contraction may be controlled by varying the spacing of the retaining blocks with reference to one another as well as by varying the density of the light weight refactory insulating material of which the blocks are cast.

The shape or form of the retaining blocks is such that they may be readily stacked and nested for shipment in normal containers or cartons, and accordingly the metallic fastening elements are cast in shallow recesses formed in the rear faces of said blocks to thus present no packing or shipping problem, said elements being capable of being bent outwardly into their protruding positions when the blocks are laid up in place in the lining.

The composition of the light weight refractory insulating materials for the retaining blocks may be varied to allow the blocks to be varied in density and temperature

resistance according to furnace conditions. The prime consideration in the choice of materials will be the temperature to which the blocks will be subjected and the abrasion, erosion and spalling patterns established by temperature variations and furnace atmospheres.

The metallic reinforcing means not only provide fastening elements which will allow the blocks to be held in spaced relation to the outer furnace supporting structure but in addition they greatly strengthen the blocks themselves to resist cracking or spalling under the effects of the furnace heat as well as the crushing forces due to expansion. Moreover, the reinforcing means with the tie clips fastened to the outer furnace structure function effectively as a heat dissipating means.

The invention will be more fully understood and further objects and advantages thereof will become more apparent when reference is made to the following detailed description of a preferred embodiment of the invention and the accompanying drawings in which:

FIG. 1 is an isometric drawing of one form of furnace lining retaining block and shows its metallic fastening element in protruding position ready to accept the tie clip;

FIG. 2 is a detail view of the metallic reinforcing means which is permanently embedded in the retaining block of FIG. 1 and shows the protruding portion of the metallic fastening element in retracted casting position for shipping;

FIG. 3 is a partial front view of a furnace lining with a retaining block in place therein and shows the surrounding courses of the individual refractory fire bricks;

FIG. 4 is a horizontal cross sectional view of the furnace lining of FIG. 3 taken along the line 4—4 and looking in the direction of the arrows and shows a retaining block of the set-back type laid up with the individual refractory fire bricks as a part of the lining. The fastening element for the block is shown protruding from the back face thereof and connected by the tie clip to another fastening element located on the inner face of the outer furnace supporting structure;

FIG. 5 is a vertical cross sectional view of the furnace lining of FIG. 3 taken along the line 5—5 and looking in the direction of the arrows. In this view, the tie clip is more clearly depicted;

FIG. 6 is an isometric drawing of another type of furnace lining retaining block and shows the metallic fastening means permanently cast therein, with the fastening element in protruding position ready to accept the tie member but with two additional fastening elements protruding from the side faces of the retaining block for interlock with adjacent refractory fire bricks;

FIG. 7 is a detail view of the metallic reinforcing means shown permanently embedded in the retaining block of FIG. 6 but with all three fastening elements in non-protruding or block casting position;

FIG. 8 is a partial front view of a furnace lining containing a retaining block of the type shown in FIGS. 6 and 7;

FIG. 9 is a horizontal cross sectional view of the furnace lining of FIG. 8 taken along the line 9—9 and looking in the direction of the arrows;

FIG. 10 is a vertical cross sectional view of the furnace lining of FIG. 8 taken along the lines 10—10 and looking in the direction of the arrows;

FIG. 11 is a view similar to FIG. 1 but showing a third type of furnace lining retaining block; and

FIG. 12 is a view similar to FIG. 2, but showing another form of metallic reinforcing means for the blocks shown in FIG. 11.

Before proceeding with a detailed description, an outline of one general aspect of the present invention will be set forth. It relates to a method of using the normal shaped and sized refractory fire bricks and a series of furnace lining retaining blocks suitably and strategically placed in laying up the refractory fire bricks to form a furnace lining which is not supported on the outer furnace supporting structure but is tied to the furnace supporting structure in suitable spaced relation thereto to thus eliminate the possibility of the outer furnace supporting structure becoming distorted as is normally the case when the refractory fire bricks are hung on and supported by the outer furnace supporting structure. Such an arrangement also insures that the furnace lining will not distort or pull away from the outer furnace structure and fail under the heat of the furnace. In addition, another cause of furnace lining failure is also removed by having the series of retaining blocks laid in place at suitable intervals in the lining and by employing retaining blocks composed of a suitable light weight refractory insulating material which will be of such density as to allow the blocks to absorb the expansion of the refractory fire bricks without causing any damage thereto, thus taking care of the two greatest and most destructive causes of furnace lining failure.

Referring now to the drawings, there is shown in FIG. 1 one type of furnace lining retaining block **10** having the metallic reinforcing means **9** permanently cast therein and including the fastening element **11** shown in protruding position ready to accept the tie clip or member **13**. It will be noted that this particular retaining block **10** is formed on its rear face with vertical set backs **10***a* to receive the refractory fire bricks therein and form an overlap with adjoining refractory fire bricks. The front portion of the retaining block is made of the same depth as the normal depth of the refractory fire bricks to be used in forming the furnace lining. The height of the block may be varied to cover the height of two or more courses, allowing a suitable thickness for the joints between the blocks as they are laid up to form normal header and stretcher courses. The fastening element **11** is cast in the block with the bent down portion **11***a* as shown in FIG. 2 and thus when bent outwardly into operative position leaves a shallow recess **11***b* formed in the rear face to thus allow the blocks to be cast and shipped with no metal protrusions.

The metallic reinforcing means **9** consists of a flat piece of stainless steel of suitable type for the temperatures and refractory materials being employed and is split at one end and the ends **9***a* and **9***b* then bent upwardly and downwardly as shown in FIGS. 1 and 2. At the opposite end, the flat steel piece is turned downwardly to form the protruding portion **11***a* of the fastening element **11**, first having punched therein the hole **12** which receives one of the downwardly extending end portions **13***a* of the inverted U-shaped tie clip **13**. The stainless steel rod **9***c* is then spot welded in place to form the completed metallic reinforcing assembly means. The metallic reinforcing means **9** help to distribute the loading on the retaining block when the latter is holding the courses of the refractory fire bricks in spaced relation to the outer furnace supporting structure. This feature is of prime importance when it is considered that the metallic retaining means and the metallic tie clip **13** associated therewith must hold the block **10** in place against the forces encountered during the expansion and contraction of the refractory fire bricks on firing the furnace. The reinforcing means and tie clip will also carry off some of the heat contained in the block. The strip thicknesses normally used in the reinforcing means is from 12 to 16 gauge while the rod diameters run from #10 gauge (wire size) to ½" depending upon the number of courses being held in place by the block and the operating temperatures of the furnace as well as the relative locations of the blocks in the furnace lining.

As shown in FIGS. 3 and 4, the furnace lining retaining block **10** is of a size to hold in place three courses of the refractory fire bricks **8** forming the furnace lining in place in spaced relation to the outer furnace supporting structure **7**. The retaining block in this instance will therefore be 9" wide (brick size 9" x 4½" x 2½") and 7$\frac{9}{16}$" high to thus encompass and hold three 2½" high bricks plus two $\frac{1}{32}$" thick joints therebetween. The vertical set backs **10***a* on the rear face of the block, which actually do the holding by overlapping the refractory fire bricks of the furnace lining, may be made at least 1½" wide or, if extremes in temperatures are to be encountered, may be widened to 2" to thus insure retention of the refractory fire bricks therebehind and in addition preclude opening of the joints. It will be noted that the furnace lining in this instance consists of parallel courses of bricks laid one upon another. The header courses are laid perpendicular to the furnace wall face and the stretcher courses are laid parallel to the furnace wall face. In this manner, the front and rear bricks of the stretcher courses are held by the header courses in the retaining block area while the stretcher courses above and below the block are held thereto only by the cement bond of the joints. This construction makes it very simple to lay up the furnace linings with the retaining blocks in proper place and suitably spaced from one another in vertical and horizontal directions in the lining to hold the completed furnace lining in spaced relation to the outer furnace supporting structure and in addition preclude any movement of the wall during construction.

In laying up the fire bricks in normal stretcher and header courses, when a position is reached to install a retaining block on a stretcher course, the block is set in place and the tie clip **13** is dropped in place to connect the protruding portion of the fastening element **11** with the corresponding fastening element **14** located on the inner face of the outer furnace structure **7**, as shown more clearly in FIG. 5. If the furnace supporting structure **7** is such that the distances to be spanned by the clip members **13** are not constant, the tie members may be made up in various standard lengths or may be made adjustable to insure the perfect vertical and horizontal alignment of the lining regardless of variations of the outer furnace supporting structure. With the retaining block in place in the furnace lining, it is possible to lay up the courses of the fire bricks on either side of the block and on up to the positioning of the next retaining block. It will be noted that the refractory fire bricks of the header course that are laid up to cover the stretcher courses and abut the retaining block **10** are notched or chopped on their rear sides, as at **8***a*, to fit into the vertical set backs **10***a* of the retaining block and thus overlap the block. The reason for this is to keep the spacing constant for maximum strength and joint offsetting or breaking.

It will be noted that the horizontal section of FIG. 4 is taken through the header course of fire bricks which is laid across the stretcher course below to thus tie the lining bricks together as well as to the retaining block. This section also shows that the retaining block is formed or cast of less than the full depth of the two courses of refractory fire bricks in order to leave at its rear face a space which is filled with light weight insulating refractory material **15** in order to anchor the tie clip member **13** in place but still allow it to move under the influence of expansion and contraction. In this instance, the outer furnace supporting structure **7** consists of structural angles and plates and the fastening element **14** is welded to the angle **7***a*. Also in this disclosure, the space between the outer furnace supporting structure and the rear face of the

furnace lining is filled up with suitable light weight insulating refractory material 16 to further control the heat losses of the furnace. Preferably, the fillings 15 and 16 will be composed of the same light weight insulating refractory material as that from which the retaining block is cast but they may be of a lesser density, if desired, for greater insulating value. The filling 15 also allows for access to the tie members 13 when repairs are necessary.

The vertical cross-sectional view of FIG. 5 shows the same details as FIG. 4 but in this view the form and arrangement of the tie member 13 are more clearly depicted.

FIG. 6 is an isometric drawing of a second form of furnace lining retaining block 20 without set backs. In this instance, the metallic reinforcing means 21 are also permanently embedded in said retaining block and include four retaining elements 22, 23, 24 and 25. The fastening element 26 is similar in all respects to the fastening element 11 of the first embodiment, presenting a protruding portion 26 for connection with the inverted U-shaped tie clip 13 and upwardly and downwardly bent anchor portions 21*a* and 21*b*. The embedded portion of the retaining element 30 is welded to the downwardly extending L-shaped bracket 28 and the embedded portion of the retaining element 31 is welded to the upwardly extending L-shaped bracket 27. Like the element 26, the retaining elements 30 and 31 present at their opposite ends protruding portions 22, 23, 24 and 25 respectively. These portions 22, 23, 24 and 25 protrude from the side faces of the block 20 and interlock into the joints formed between adjacent refractory fire bricks 8 (see FIGS. 8 and 10) but are cast in bent form 22*a*, 23*a*, 24*a* and 25*a* (see FIG. 7) in recesses 22*b*, 23*b*, 24*b* and 25*b* (see FIG. 6) respectively, of the block in order to permit packaging and shipping of the blocks with no outwardly extending metal elements. The block 20, like the block 10, is made to cover three vertical courses of the fire bricks 8 and to leave a space at the rear for the filling 15, as shown in FIGS. 8, 9 and 10. Since the block 20 has no set backs, the fire bricks may all be of uniform shape.

The third type of furnace lining retaining block 30 shown in FIG. 11 is similar in size and shape to the first type of retaining block 10 shown in FIG. 1, having vertical set backs 30*a*. The metallic reinforcing means 32 are quite similar to the metallic reinforcing means 21 shown in FIG. 7 for the second type of block 20 shown in FIG. 6. However, in the present instance the metallic reinforcing means 32 include but one fastening element having a protruding portion 33 for connection with the inverted U-shaped tie clip 13 and upwardly and downwardly bent anchor portions 32*a* and 32*b*. The reinforcing means 32 also include two flat transverse strips 37 and 38, the top strip 37 being welded to the upper end of an L-shaped bracket 39 rising from the upper side of the reinforcing means 32, and the lower strip 38 being welded to the lower end of a similar L-shaped braket 40 depending from the reinforcing means 32. The two transverse strips 37 and 38 extend entirely across the retaining block 30 with their outer faces flush with the rearwardly directed faces of the vertical set backs 30*a* and their ends flush with the side wall (see FIG. 11). The primary purpose here is to provide additional reinforcement for the retaining block in the set back areas and also to furnish additional means for dissipating heat.

From the foregoing disclosure, it can be seen that the instant invention fills a long felt need in the field of furnace lining construction, as it allows the linings to be laid up of standard sized refractory fire bricks with the exception that the furnace lining retaining blocks are added and laid up in the lining at suitable intervals and suitably spaced from the outer furnace supporting structure to thus insure retention of the lining on said structure. This automatically eliminates any movement of the lining during laying up and insures the lining staying in alignment during firing. In addition, the retaining blocks allow the fire bricks forming the furnace lining to take the vertical load of said lining with no transference of said load to the (vertical) outer furnace supporting structure. The retaining blocks (being composed of insulating refractory material of low density) also eliminate the necessity of installing expansion joints in the lining, except in large furnaces, as the blocks themselves act as individual expansion joints, absorbing the expansion of the brick area surrounding them. Where there is no furnace supporting structure per se but only an outer casing, the retaining blocks may be accurately spaced from said casing to thus hold the furnace lining in perfect alignment therewith.

Many different types of light weight insulating refractory materials that may be used for the manufacture of the retaining blocks are well known to the art. For example, some of said materials are now being sold by the Quigley Company, 415 Madison Ave., New York, N.Y. 10017, under the following trade names:

Insulag	Cast Refract
Panelag	Cast Refract
Plastic Insulcrete	Cast A1 Refract
Hyal Plastic Insulcrete	

The above identified materials are good for temperatures up to 3200° F. and their densities can be readily varied, the weight of cast Panelag, for example, being as low as 28 lbs. per cubic foot, and the weight of Insulag, for example, being 36 lbs. per cubic foot as contrasted with fire brick at 130 lbs. per cubic foot.

As set forth in the Demaison Patent No. 3,206,154, the well known composition which is made and sold under the above trademark Insulag to be mixed with water to provide a plastic porous insulating refractory material is as follows:

	Percent
(1) Mineral fibers	5 to 15
(2) Insulating porous dust	25 to 40
(3) Hydraulic setting cement	25 to 40
(4) Fireclay	20 to 35
(5) Aluminum powder	0.1 to 0.5

According to the instant invention, furnace linings can be made up of ordinary sized refractory fire bricks of suitable temperature ratings and refractory maintenance and replacement costs thus reduced. It is also possible to reuse the tie clips as well as the fastening elements located on the outer furnace supporting structure when a new lining is installed as they are little affected by the heat that filters back through the retaining blocks and the insulation fillings. The blocks in addition allow the easy repair of spots or areas in the furnace lining without disturbing the whole lining.

What is claimed is:

1. A vertical furnace wall construction, comprising, in combination, an outer furnace supporting structure, a series of individual refractory fire bricks laid one upon another in a plurality of courses in spaced relation to the outer furnace supporting structure to form a lining for said supporting structure, the weight of said lining being sustained independently of the outer furnace supporting structure, a series of furnace lining retaining blocks laid up with the individual refractory fire bricks as a part of the lining and of a size substantially larger than that of the refractory fire bricks and individual ones of which being adapted to contact at least three horizontal courses of said refractory fire bricks, said retaining blocks being composed of light weight refractory insulating material to permit and absorb expansion and contraction of the fire bricks under furnace heat, the density of the blocks being less than the density of the fire bricks, metallic reinforcing means permanently embedded in the furnace lining retaining blocks and having fastening elements protruding from the back faces of said retaining blocks, a series of fastening elements located on the inner

face of the outer furnace supporting structure in fore and aft alignment with the fastening elements protruding from the back faces of the retaining blocks, and a series of tie members connecting the fastening elements protruding from the back faces of the retaining blocks with the corresponding fastening elements located on the inner face of the outer furnace supporting structure.

2. A furnace wall construction according to claim 1 wherein the series of furnace lining retaining blocks are spaced from one another both vertically and horizontally throughout the area of the lining at distances selected according to the furnace temperature.

3. A furnace wall construction according to claim 1 wherein the tie members forming the connections between the fastening elements protruding from the back faces of the retaining blocks and on the inner face of the outer furnace supporting structure permit the retaining blocks to move freely in all directions for expansion and contraction under the furnace heat.

4. A furnace wall construction according to claim 1, wherein said fastening elements lie in shallow recesses formed in the rear faces of the retaining blocks as cast and are capable of being bent outwardly into their protruding positions when the blocks are laid up in place in the lining.

5. A vertical furnace wall construction comprising, in combination, an outer furnace supporting structure, a series of individual refractory fire bricks laid one upon another in a plurality of courses in spaced relation to the outer furnace supporting structure to form a lining for said supporting structure, the weight of said lining being sustained independently of the outer furnace supporting structure, a series of furnace lining retaining blocks of less density than the fire bricks laid up with the individual refractory fire bricks as a part of the lining and of a size substantially larger than the refractory fire bricks and adapted to hold in place a plurality of courses of said refractory fire bricks, metallic reinforcing means permanently embedded in the furnace lining retaining blocks and having fastening elements protruding from the back faces of said retaining blocks, a series of fastening elements located on the inner face of the outer furnace supporting structure in fore and aft alignment with the fastening elements protruding from the back faces of the retaining blocks, and a series of tie members connecting the fastening elements protruding from the back faces of the retaining blocks with the corresponding fastening elements located on the inner face of the outer furnace supporting structure, wherein said retaining blocks are of less depth from front to rear than the surrounding refractory fire bricks so as to leave a space at the rear faces of said retaining blocks to accommodate the fastening elements and the tie members, wherein said space is filled with light weght insulating refractory material, and wherein said retaining elements lie in shallow recesses formed in the back faces of the retaining blocks as cast and are capable of being bent outwardly into their protruding positions when the block is laid up in place in the lining.

6. A vertical furnace wall construction comprising, in combination, an outer furnace supporting structure, a series of individual refractory fire bricks laid one upon another in a plurality of courses in spaced relation to the outer furnace supporting structure to form a lining for said supporting structure, the weight of said lining being sustained independently of the outer furnace supporting structure, a series of furnace lining retaining blocks of less density than the fire bricks laid up with the individual refractory fire bricks as a part of the lining and of a size substantially larger than that of the refractory fire bricks and adapted to hold in place a plurality of courses of said refractory fire bricks, metallic reinforcing means permanently embedded in the furnace lining retaining blocks and having fastening elements protruding from the back faces of said retaining blocks, a series of fastening elements located on the inner face of the outer furnace supporting structure in fore and aft alignment with the fastening elements protruding from the back faces of the retaining blocks, and a series of tie members connecting the fastening elements protruding from the back faces of the retaining blocks with the corresponding fastening elements located on the inner face of the outer furnace supporting structure, wherein said retaining blocks are formed on their rear faces with vertical setbacks, wherein the refractory fire bricks are laid up to project into said setbacks so as to form an overlap between said retaining blocks and said refractory fire bricks to prevent inward displacement of the fire bricks, and wherein said metallic reinforcing means extend from the back faces of the blocks through the portions thereof containing the setbacks into the portions thereof forward of the setbacks and having laterally extending reinforcing elements forwardly of the setback-containing portions.

7. A furnace wall construction comprising an outer furnace supporting structure, a series of individual refractory fire bricks laid one upon another in a plurality of courses in spaced relation to the outer furnace supporting structure to form a lining for said supporting structure, the weight of said lining being sustained independently of the outer furnace supporting structure, a series of furnace lining retaining blocks laid up with the individual refractory fire bricks as a part of the lining and of a size substantially larger than that of the refractory fire bricks and adapted to hold in place a plurality of courses of said refractory fire bricks, metallic reinforcing means permanently embedded in the furnace lining retaining blocks and having fastening elements protruding from the back faces of said retaining blocks, a series of fastening elements located on the inner face of the outer furnace supporting structure in fore and aft alignment with the fastening elements protruding from the back faces of the retaining blocks, and a series of tie members connecting the fastening elements protruding from the back faces of the retaining blocks with the corresponding fastening elements located on the inner face of the outer furnace supporting structure, wherein the retaining blocks are formed on their rear faces with vertical setbacks and wherein the refractory fire bricks are laid up to project into said setbacks so as to form an overlap between said retaining blocks and said refractory fire bricks to prevent inward displacement of the fire bricks, and wherein the metallic reinforcing means for said retaining blocks include portions extending across and flush with the rearwardly directed faces of the vertical setbacks.

8. A furnace wall construction comprising, in combination, an outer furnace supporting structure, a series of individual refractory fire bricks laid one upon another in a plurality of courses in spaced relation to the outer furnace supporting structure to form a lining for said supporting structure, a series of furnace lining retaining blocks laid up with the individual refractory fire bricks as a part of the lining and of a size to hold in place a plurality of courses of said refractory fire bricks, metallic reinforcing means permanently embedded in the furnace lining retaining blocks and having fastening elements protruding from the back faces of said retaining blocks, a series of fastening elements located on the inner face of the outer furnace supporting structure in fore and aft alignment with the fastening elements protruding from the back faces of the retaining blocks, and a series of tie members connecting the fastening elements protruding from the back faces of the retaining blocks with the corresponding fastening elements located on the inner face of the outer furnace supporting structure, characterized in that the metallic reinforcing means permanently embedded in the retaining blocks also present retaining elements which protrude from the side faces of said blocks and interlock with adjacent refractory fire bricks.

9. A furnace wall construction according to claim 8 wherein said retaining elements lie in shallow recesses

formed in the side faces of the retaining block as cast and are capable of being bent outwardly into their protruding positions when the block is laid up in place in the lining.

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