

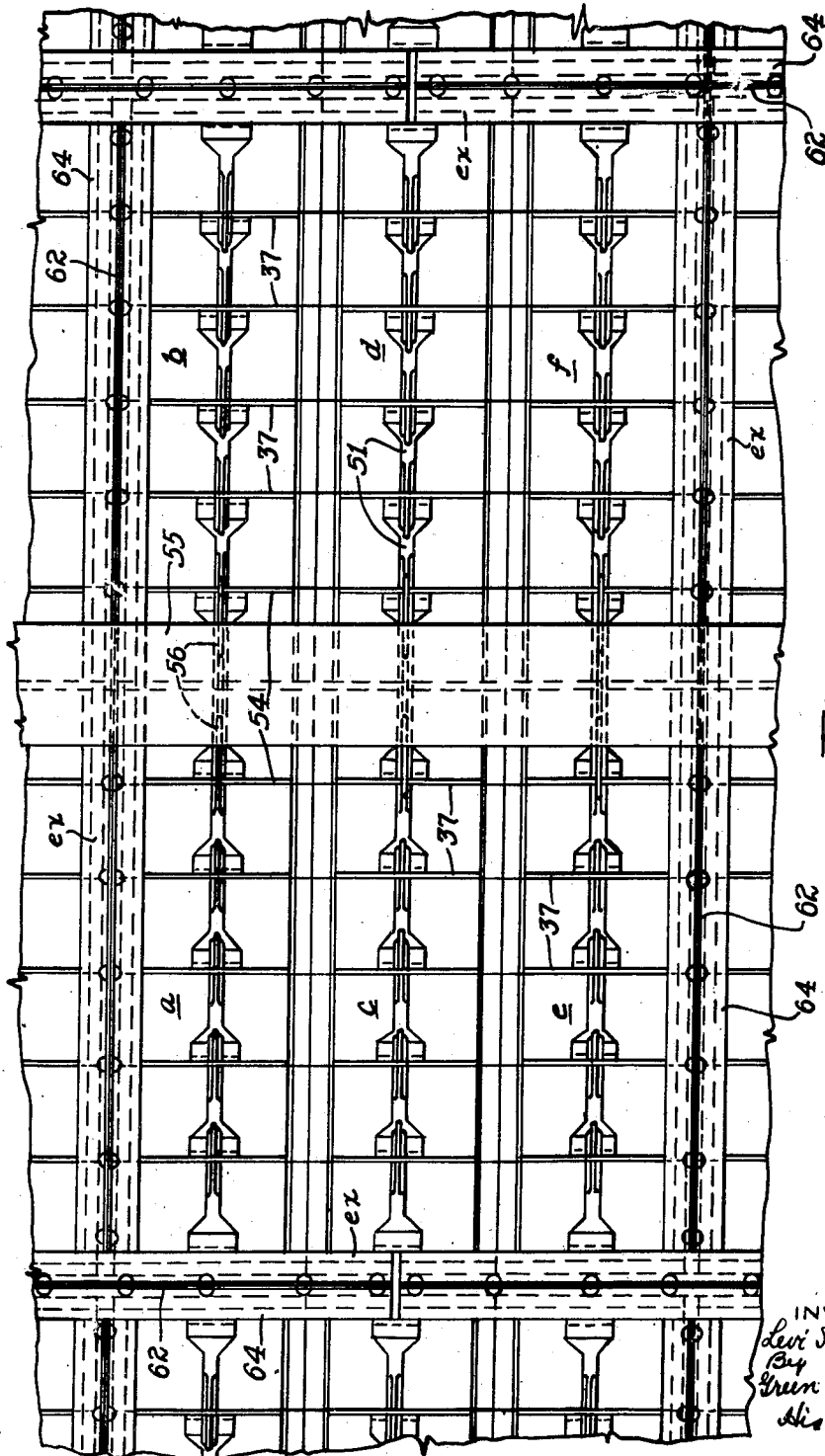
July 19, 1949.

L. S. LONGENECKER
REFRACTORY BLOCK FURNACE ENCLOSURE STRUCTURE
WITH OXIDIZABLE METAL REINFORCING MEANS

2,476,423

Filed Feb. 14, 1944

7 Sheets-Sheet 1



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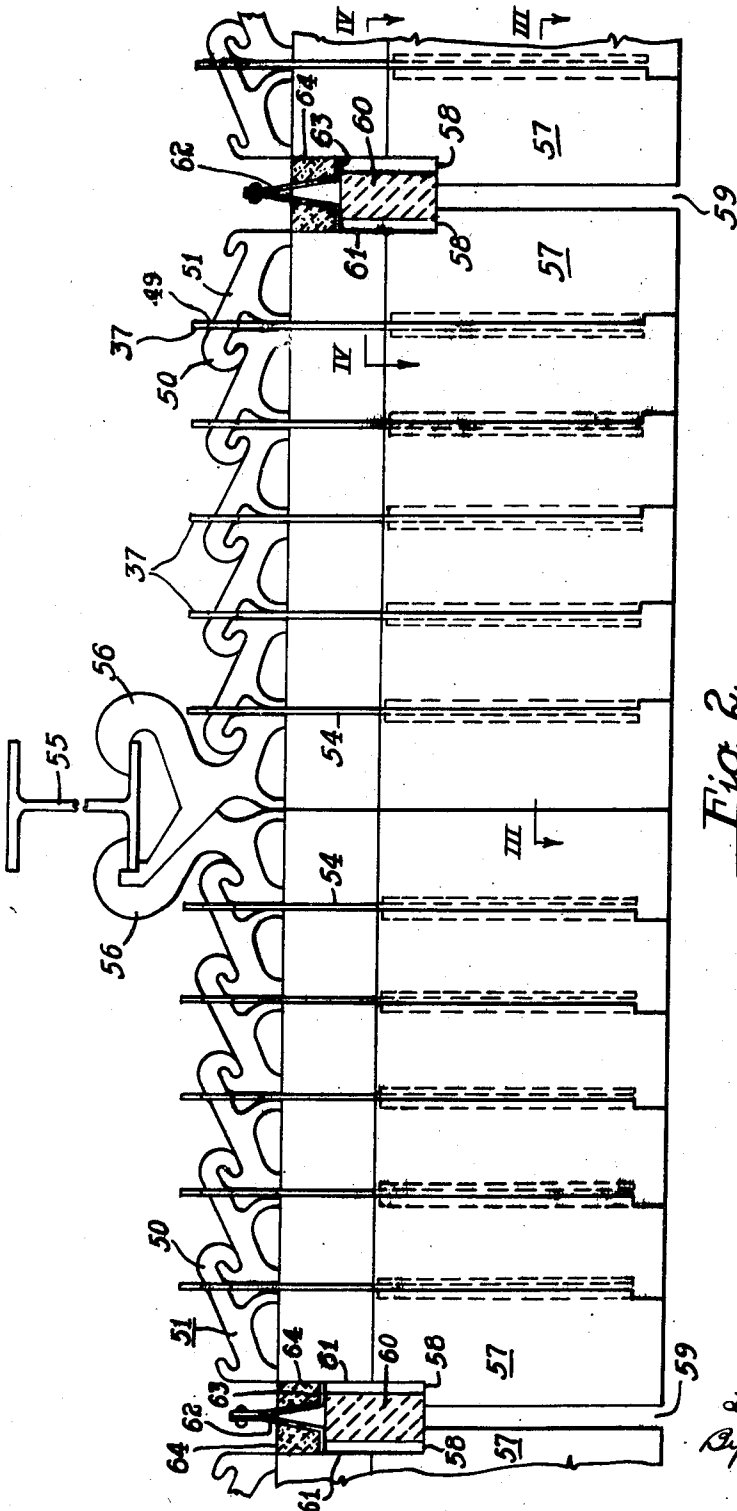


Fig. 2.

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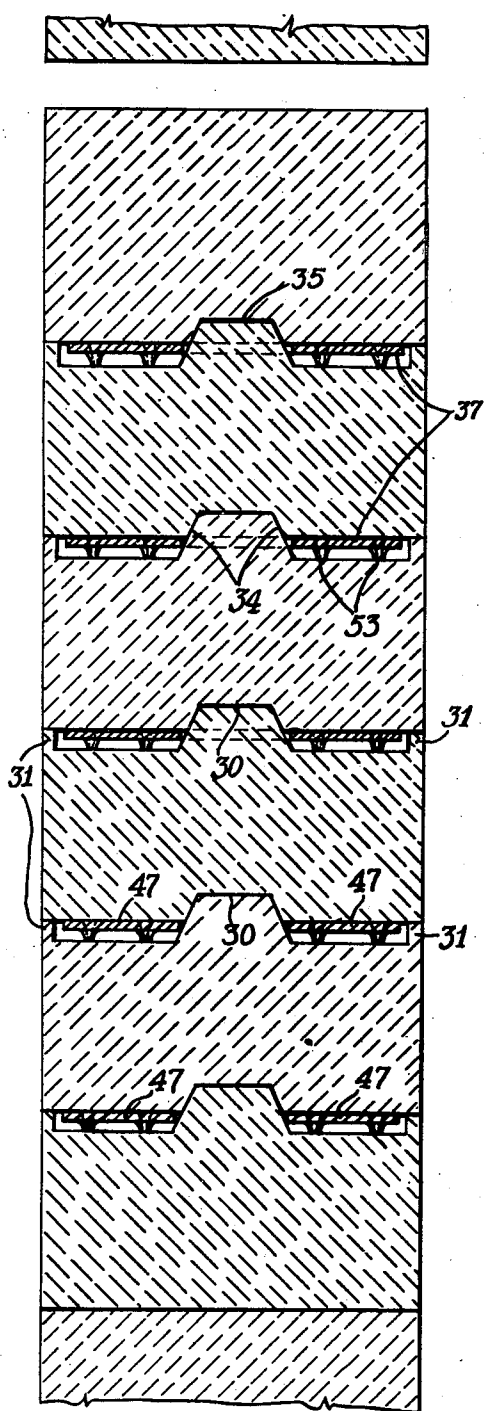


Fig. 3.

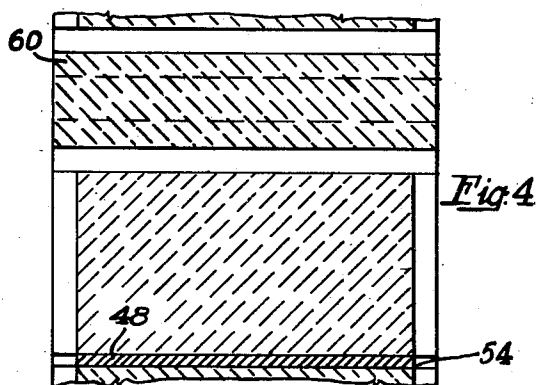


Fig. 4.

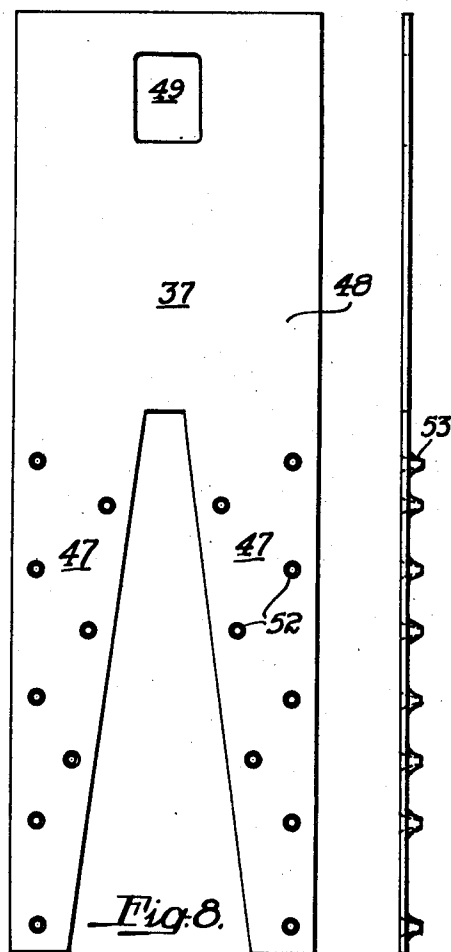


Fig. 8.

Fig. 9.

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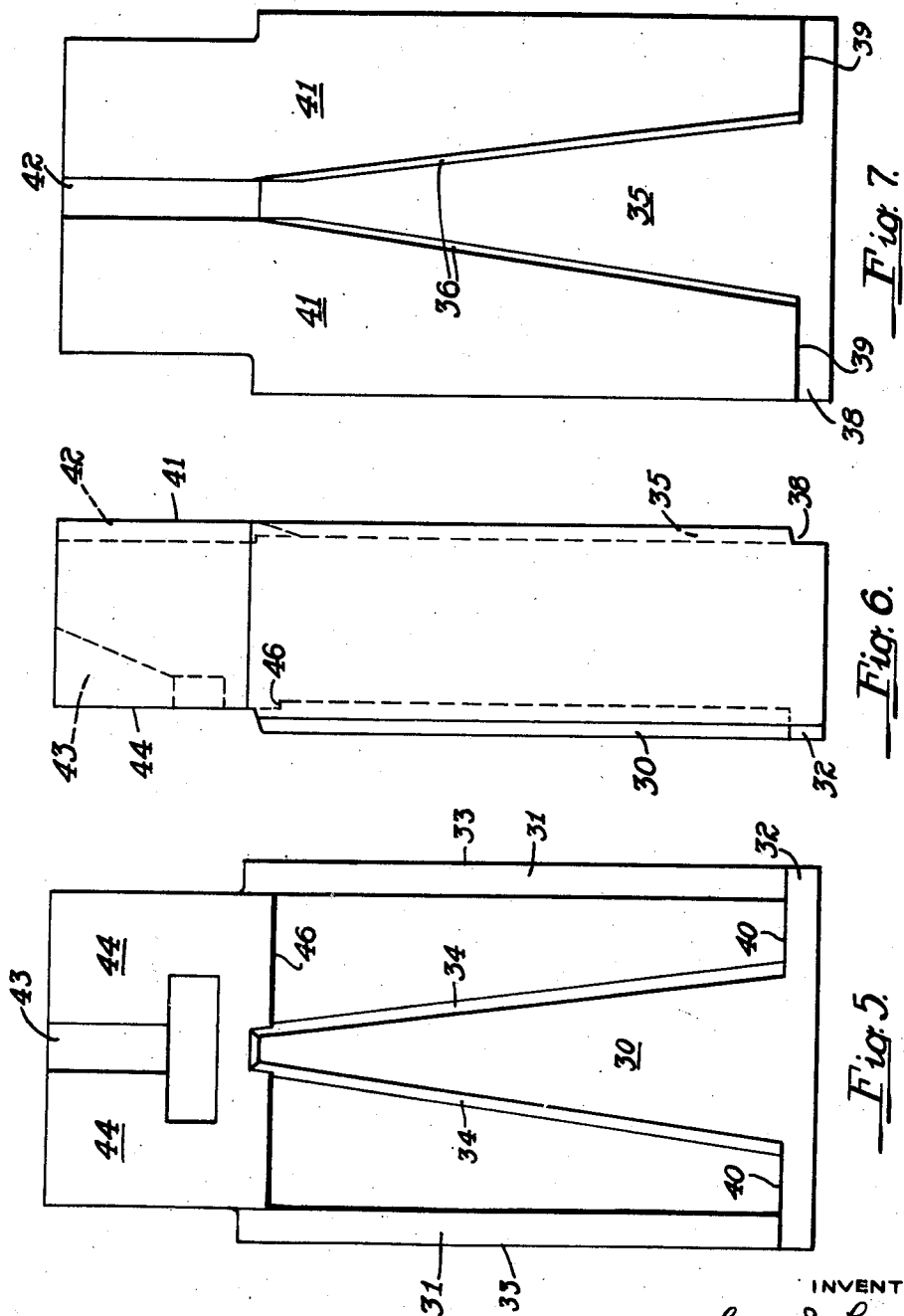
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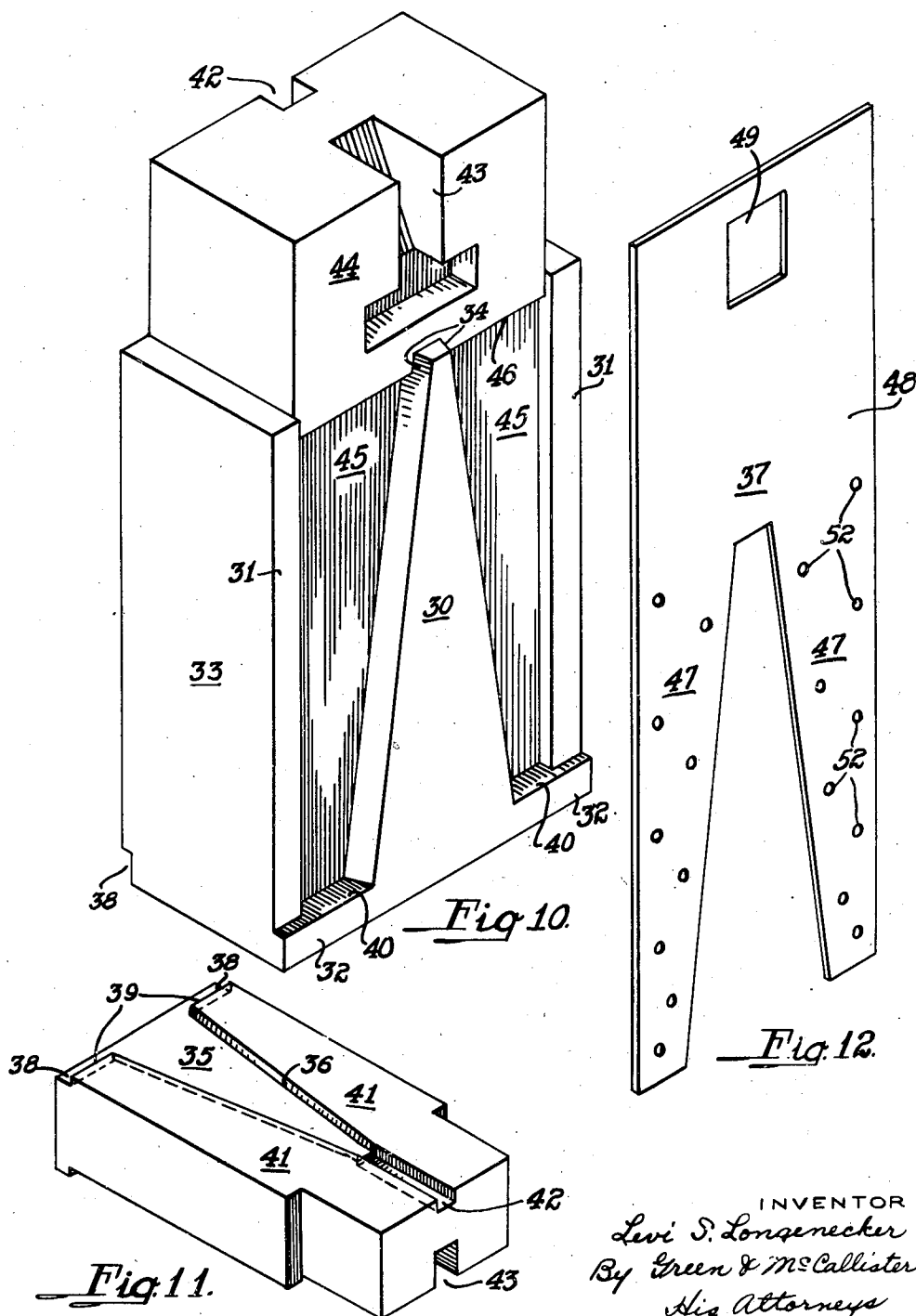
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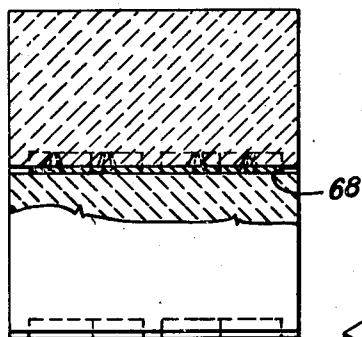


Fig. 13.

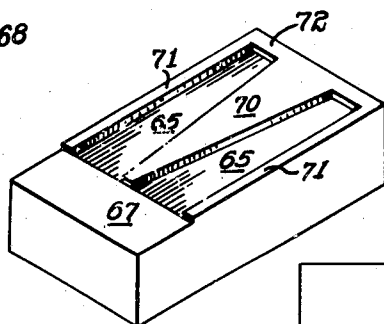


Fig. 14.

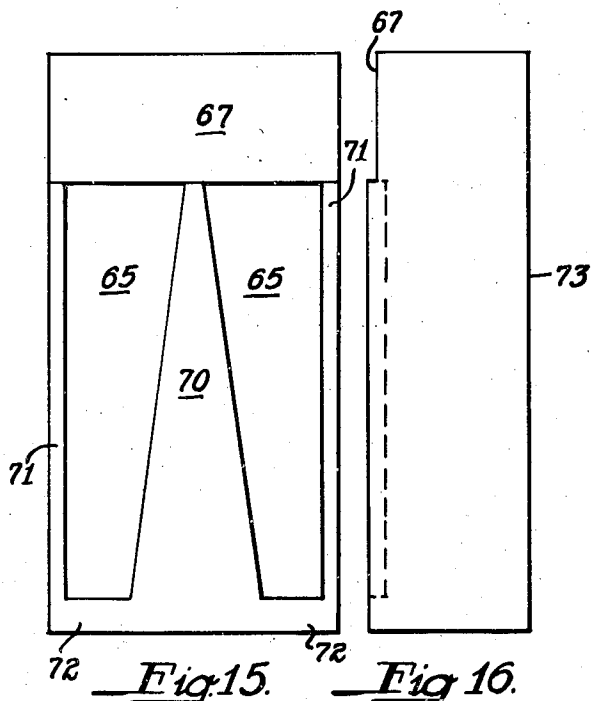


Fig. 15.

Fig. 16.

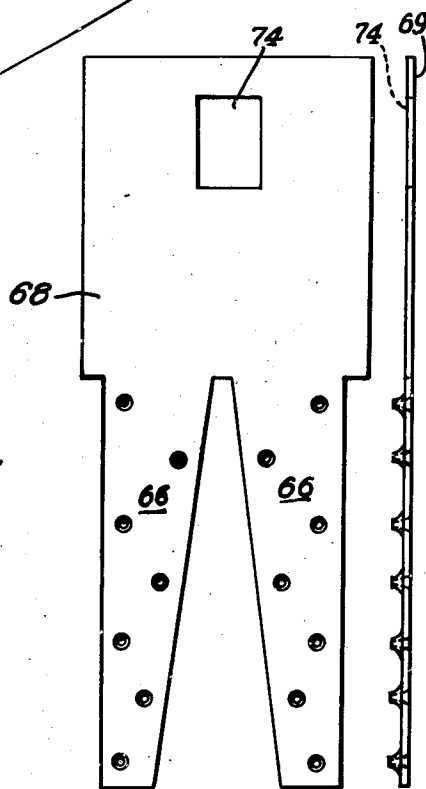


Fig. 17. Fig. 18.

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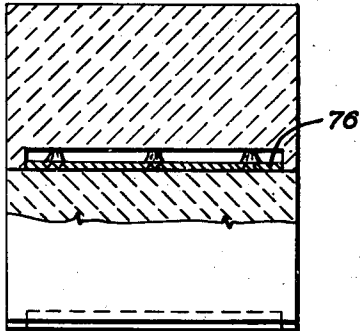


Fig. 19.

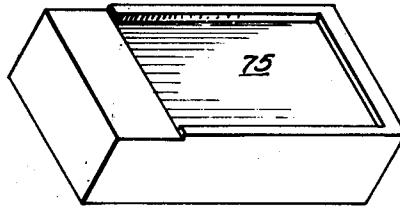


Fig. 20.

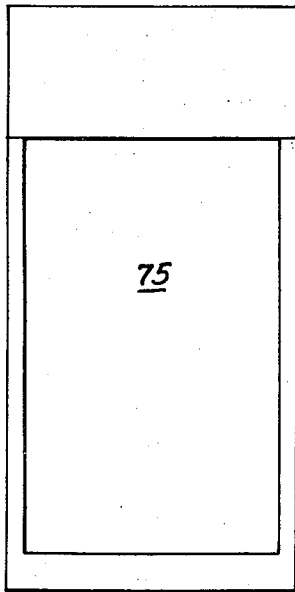


Fig. 21.

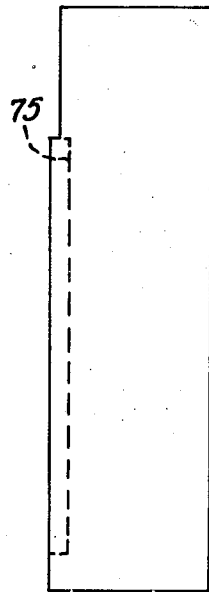


Fig. 22.

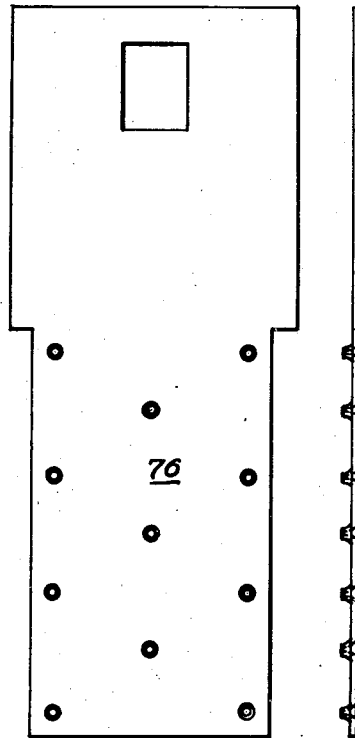


Fig. 23. Fig. 24.

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UNITED STATES PATENT OFFICE

2,476,423

REFRACTORY BLOCK FURNACE ENCLOSURE
STRUCTURE WITH OXIDIZABLE METAL
REINFORCING MEANS

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Application February 14, 1944, Serial No. 522,259

22 Claims. (Cl. 110—99)

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This invention relates to furnace chamber enclosure structures such as furnace walls and roofs.

Numerous attempts have been made to produce refractory shapes such as bricks, blocks or tile for furnace roof and side wall structures, from basic material such as magnesite, chrome ore or other refractories or mixtures which are generally known as basic materials. These materials, when formed into shapes such as bricks, blocks or tile, are structurally weak and are usually reinforced by plate-like oxidizable metal members which either lie between the bricks or blocks or encase the sides of the same, leaving their inner and outer ends uncovered.

Examples of such structures are disclosed in Maccallum Patent 1,106,725 of August 11, 1914, Griffith Patent 1,500,204 of July 8, 1924, Groninger Patent 1,672,524 of June 5, 1928, Heuer Patents 2,154,813 and 2,155,165 of April 18, 1939, 2,229,911 of July 14, 1942 and 2,304,170 of December 8, 1942.

Structures made up of these refractory shapes (bricks, blocks or tiles) and metal reinforcing members have met with some success when used in furnaces such as copper smelting furnaces in which the temperatures encountered seldom exceed 2800° F. and with practically no success, so far as I am aware, when used in open hearth or high temperature furnaces—furnaces in which the temperatures well exceed 2800° F.

These prior metal reinforcing members extend the full length of the blocks or bricks and the inner ends of these members therefore are subjected to the direct heat within the furnace chamber.

In furnace roofs and side walls there is a drop in temperature from the inner, or furnace chamber face thereof to the outer face. The temperature of the inner face, in the case of open hearth furnaces, may exceed 3000° F. while the temperature of the outer face may be but 1000° F.

It has heretofore been assumed that these prior metal reinforcing members oxidize throughout about the inner two thirds of their length, and thus become sufficiently refractory to serve as efficient reinforcing members for the blocks or bricks. I have found, however, that when the same are used in open hearth furnaces, the inner end portions which are exposed to the direct heat of the furnace chamber, melt and soak into the pores of the bricks or blocks, leaving voids or spaces therebetween. The width of each of these spaces or voids is about equal to the original thickness of the metal reinforcing member, provided the bricks or blocks were assembled in abut-

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ting relation with the plate-like reinforcing members. These voids extend a considerable distance into the structure, in some cases for as much as one-third of the length of the bricks or blocks, thus leaving these portions without adequate reinforcement.

Beyond these voids or open spaces, part of the remaining portion of each of these metal reinforcing members does oxidize. The extreme outer end portion, or that portion which is farthest removed from the furnace chamber, does not oxidize to any appreciable extent. This portion usually is the outer third of the reinforcing member.

The intermediate portion, or that portion between the outer portion just referred to and the inner end of the void or space, during oxidation, becomes somewhat wedge-shaped, having its thinnest portion adjacent the outer portion, and its heaviest section at the adjacent end of the void or space.

These reinforcing members are usually made from sheet steel or iron and are about $\frac{1}{8}$ of an inch thick, and, due to oxidation may swell in thickness to as much as $\frac{1}{4}$ of an inch at the end adjacent the inner end of the voids or space.

This behavior of these reinforcing members is due to the different temperatures encountered lengthwise of the bricks or blocks, that is, between the inner or furnace chamber side and the outer side of the roof or wall structure. This distance can be divided into three zones; zone 1 or the inner zone is the zone within which the voids or spaces occur. Zone 2 or the intermediate zone is the zone in which oxidation and wedge-like swelling of the reinforcing members occurs, and zone 3, the outer zone, is that adjacent the outside of the roof or wall structure, in which little, if any, oxidation of the reinforcing members occurs.

The wedge-shape acquired by the reinforcing members within zone 2 subjects the bricks or blocks to extreme localized stresses adjacent the junction of zones 1 and 2, that is, adjacent the inner ends of the spaces or voids.

I have observed that when those portions of the reinforcing members within zone 1 melt and soak into the bricks or blocks, they oxidize and swell. This causes the brick or block edges adjacent the inner or furnace chamber face of the structure to take on the appearance of blistering or bloating. This disrupts the structure and accordingly reduces its resistance to furnace temperatures and the action of the hot gases within the furnace chamber.

The stresses set up by the growth of the reinforcing members in zone 2, and the blistering or

bloating occasioned by oxidation of the metal that soaks into the bricks or blocks in zone 1 are, I am convinced, important factors in causing failure of these prior structures when used in high temperature furnaces such as open hearth furnaces.

One object of this invention is to produce an improved furnace chamber enclosing structure of the type in which the refractory shapes entering into its make-up are reinforced by oxidizable metal members.

Another object is to produce an improved suspended furnace roof structure in which basic refractory shapes are effectively reinforced by oxidizable metal members.

A further object is to produce improved basic refractory blocks and oxidizable metal reinforcing members for furnace chamber enclosing structures, of such form that said reinforcing members are shielded from the direct heat within the furnace chamber, prior to oxidizing.

A still further object is to produce for use in the make-up of the enclosing structure of a high temperature furnace chamber, basic refractory blocks and metal reinforcing members for such blocks such that said metal reinforcing members are so embedded within the refractory structure that they are shielded from the direct heat within the furnace chamber, prior to oxidizing.

Another object is to produce an improved metal member for reinforcing basic refractory shapes used in the construction of furnace roofs and side walls.

Another object is to produce an improved suspended roof structure of relatively long life from blocks formed of basic material and oxidizable metal reinforcing members.

These and other objects, I attain by means of the structures described in the specification and illustrated in the drawings accompanying and forming part of this application.

In the drawings:

Figure 1 is a top plan view of a portion of a suspended roof structure embodying this invention;

Fig. 2 is a side elevational view of that portion of the roof structure illustrated in Fig. 1;

Fig. 3 is a sectional view taken on line III—III of Fig. 2;

Fig. 4 is a sectional view taken on line IV—IV of Fig. 2;

Figs. 5, 6 and 7 are elevational views looking at the front, side and back respectively of a refractory block such as employed in the suspended roof structure of Figs. 1, 2, 3 and 4;

Fig. 8 is an elevational view looking toward the back of the metal reinforcing member used in connection with the refractory block of Figs. 5, 6 and 7;

Fig. 9 is a side view of the metal reinforcing member of Fig. 8;

Fig. 10 is an isometric view of the refractory block of Figs. 5, 6 and 7, looking toward one side and the front of such block;

Fig. 11 is an isometric view of the block of Fig. 10 tilted down so as to disclose the back of the same;

Fig. 12 is an isometric view of the metal reinforcing member of Figs. 8 and 9 looking toward one edge and the front thereof. This view is associated with Fig. 10 and shows the reinforcing member in position to be moved into place in the recess formed for its reception in the front face of the block;

Fig. 13 is a view partially in section and partially in elevation of a portion of a side wall or

floor structure embodying this invention. This view is looking toward the furnace chamber side of the structure;

Fig. 14 is an isometric view looking toward the outer end, one side and the front of a refractory block such as disclosed in Fig. 13;

Fig. 15 is a front elevational view of the block of Fig. 14;

Fig. 16 is a side elevational view of such block;

Fig. 17 is a view looking toward the back of a metal reinforcing member such as used in the structure of Fig. 13;

Fig. 18 is a side view of the reinforcing member of Fig. 17;

Figs. 19 to 24 inclusive are views similar to Figs. 13 to 18 inclusive illustrating a modified form of block for use in the make-up of a furnace side wall and/or floor embodying this invention.

A furnace chamber enclosing structure embodying this invention comprises rows of blocks formed of basic refractory material and oxidizable metal reinforcing members for such blocks. Certain of the blocks in each row are arranged in abutting relation and one wide face of each such block is provided with a recess which extends from its outer end toward its inner end and terminates short of its inner end. Such recess also terminates short of the side edges of the face within which it is formed.

An oxidizable sheet or plate-like ferrous metal member is positioned within each such recess and extends from the inner end thereof outwardly into the atmosphere beyond the outer end of the block. This outwardly extending portion serves as a cooling fin for the reinforcing member. Since the refractory blocks on opposite sides of each reinforcing member are arranged in abutting relation, the reinforcing members are completely shielded from the furnace temperatures by refractory block material.

In the case of furnace side walls, the outwardly projecting cooling fin can be tied to the buckstays or other fixed members and thus assist in holding the walls in position. In the case of suspended roof structures, the projecting cooling fins are engaged by the hangers by which the refractory blocks are suspended.

In suspended roof structures embodying this invention, each row of refractory blocks comprises a number of groups of bundles of blocks with expansion joints between certain of such groups or bundles.

In constructing a suspended furnace roof embodying this invention, the blocks are preformed from suitable basic refractory material and are given the general shape of the blocks disclosed in my United States Patent 1,913,168 of June 6, 1933. The shape, however, is modified so that the blocks receive and protect the metal reinforcing members.

In my said patent, the blocks are interlocked by means of interengaging tongues and grooves which are formed in the opposing wide faces thereof. Each tongue and groove is of generally triangular shape with the base of the triangle at the inner end of the block and with its apex adjacent the outer end of the block. For the purposes of this application, the inner end of the block is the end which is directly subjected to the furnace temperatures, while the outer end is the end opposite that subjected to the furnace temperatures.

The particular block of this application which I prefer to use in suspended furnace roof struc-

tures embodying this invention is that illustrated in Figs. 1, 2, 3, 4, 5, 6, 7, 10, and 11. As there shown, the wide side of the block having triangular tongue 30, has flanges 31 extending along its side edges and flanges 32 which merge with the base of tongue 30 and extend in opposite directions from said tongue to the sides 33 of the block. Flanges 32 are of the same depth as tongue 30, while flanges 31 are of less depth than said tongue. The sides 34 of the tongue, as shown in Figs. 3, 4 and 10, converge as in my said patent.

The side of the block opposite tongue 30 is provided with a groove 35 which is formed to cooperate with tongue 30 of the next adjacent block, as disclosed in Fig. 3. Groove 35 has diverging side walls 36, and, as disclosed in Fig. 3, is of less depth than tongue 30, so that when two blocks are placed in abutting relation, with the tongue of one block engaging the groove of the other, a walled recess or pocket is provided between such blocks for receiving the metal reinforcing member 37.

The inner end of the side of the block having groove 35 therein, is formed with offsets as at 38 so that when two blocks are assembled in abutting relation, with the tongue of one block located within the groove of the other, and with the inner ends of the two blocks in alignment, the lower end portions 39 of the grooved side of the block will contact with faces 40 of flanges 32 and flat face 41 of the block will contact with flanges 31.

The outer end of the block, that portion having formed therein the slots 42 and 43 for the hanger by which the block is suspended, is narrower than the main part of the block by an amount equal to the combined width of the two flanges 31. The distance from face 41 to face 44 of this outer end portion is greater than the distance from face 41 to face 45, thus forming a shoulder 46 at the junction of faces 44 and 45.

Tongue 30 divides face 45 of the block into two identical portions and thus divides the recess or pocket for the metal reinforcing member into two parts.

The reinforcing member 37 for the suspended roof blocks, as shown in Figs. 3, 8 and 12, is bifurcated throughout a substantial part of its length and the furcate parts 47 are shaped so as to conform more or less to the shape of the recesses or pockets on opposite sides of tongue 30. The outer end portion 48 has an opening 49 formed at its center and adjacent its outer end. Opening 49 as shown in Fig. 2 permits the reinforcing member 37 to be slipped over hook-like arm 50 of hanger element 51 and moved into assembled position with relation to the block.

Each leg 47 of the reinforcing member 37 has holes 52 punched therein from one side. This punching operation is preferably performed by a device which will form the hole and force the metal around the hole outwardly to form protuberances 53 (Figs. 3 and 9). These protuberances project outwardly $\frac{1}{8}$ " more or less. When the reinforcing member is in assembled position with the block, portion 48 of the member rests against face 44 and the outer ends of the protuberances 53 contact with two-part face 45 of the block. If some of the protuberances are too long or the reinforcing member is slightly bent or warped, causing it to stand too far away from face 45, the reinforcing member can be easily caused to assume its proper position within the recess or pocket of the block by lightly tapping the reinforcing member opposite the offending

protuberances, and thus sink the ends of the protuberances into face 45.

It is desirable to have the depth of shoulder 46 equal to the length of protuberances 53, so that portion 48 of the reinforcing member can lie in contact with face 44 of the block as shown at 54 in Figs. 2 and 5.

Each row of roof blocks is arranged in groups or bundles and each bundle or group is suspended from an overhead beam such as beam 55 forming part of the furnace superstructure, by a cantilever beam composed of hanger members 51 and a hanger hook member 56 which hooks on to beam 55 as in my said patent. The blocks in the bundles or groups on opposite sides of beam 55 tend to move to an inclined position, as in my said patent and because of this, the blocks in the groups or bundles on opposite sides of beam 55 are held positively in engagement with one another, thus forming pockets or recesses for the reinforcing members that are sealed from the hot gases within the furnace chamber. The group or bundle of blocks on one side of beam 55 counterbalances the group or bundle on the opposite side of said beam so that the blocks of both groups or bundles are held in horizontal alignment.

I preferably arrange a number of rows of bundles or groups of blocks in abutting relation, such as groups *a, b, c, d, e, and f*, and surrounding this collection of bundles or groups which in effect constitutes an island, I provide expansion joints which entirely surround each such island and separate it from the adjacent islands or collections of bundles or groups. In Fig. 1, these expansion joints are shown in top plan and are designated by the letters *ex*.

For the purpose of forming these expansion joints, the blocks forming the perimeter of each island or collection of bundles or groups are made special such as blocks 57 and are formed with a main portion which is of greater thickness than the thickness of the regular blocks to provide a shoulder 58.

The blocks at the perimeter of each island are spaced from the blocks forming the perimeters of the adjacent islands as at 59, and supported by the shoulders 58 of the perimetral blocks of the adjacent islands are refractory sealing blocks 60, which overlie and close the spaces between perimetral blocks 57. Blocks 60 are spaced from adjacent sides 61 of the upper portions of the perimetral blocks to allow for horizontal expansion of the islands. Resting on the top of each block 60 is an inverted V-shaped metal member 62 formed with feet 63 which contact with faces 60 of the perimetral blocks, and the spaces on opposite sides of this inverted V member are filled with plastic refractory material 64. These inverted V members are preferably formed from metal that will maintain its springiness at the temperatures encountered.

By bifurcating the major part of each reinforcing member, I not only permit metal reinforcing members to be used with interlocking blocks of the type disclosed in my said patent but I save an appreciable amount of metal.

From the foregoing, it will be apparent that the reinforcing members, or the bifurcated portions thereof located within the recesses or pockets, are, to all intents and purposes, embedded within the refractory roof structure and are effectively shielded from the furnace temperatures and from contact with the hot gasses within the furnace chamber prior to oxidizing.

If it is desired to embody this invention in

furnace side walls in which the refractory blocks are interlocked, as in the structure above described, and in which the individual blocks are secured in position by hangers, a block supporting structure of the type disclosed in the apron wall of my United States Patent 1,977,799 of October 23, 1934, or 2,294,788 of September 1, 1902, may be utilized.

In Figs. 13 to 18 inclusive, I have disclosed part of a furnace side wall structure embodying a modification of the refractory block and the reinforcing member of this invention. In this modification, the refractory blocks are not interlocked but each, in one face thereof, is provided with the divided recess 65 for receiving legs 66 of a bifurcated sheet metal reinforcing member of the type disclosed in Figs. 3, 8, and 12. In this modification, the face 67 of the block is adapted to support portion 68 of the reinforcing member so that its face 69 will lie flush with faces 70, 71, and 72 of the tongue, side and end flanges, respectively; the outer ends of the protuberances of legs 66—66 contacting the bottom of grooves 65 of the block.

In this modification, face 73 of the block, the face opposite the recessed face, is flat and is adapted to rest in contact with face 69 of the reinforcing member and faces 70, 71 and 72 of the tongue side and end flanges respectively.

The outer end portion of the reinforcing member is provided with a hole or opening 74 for use in tying the reinforcing members to the buckstays for the purpose of holding the side wall in place.

In Figs. 19 to 24 inclusive, a still further modification of this invention is disclosed. This modification is similar to the modification of Figs. 13 to 18 inclusive except that the pocket or recess for receiving the reinforcing member is not divided into two compartments by a tongue nor is the reinforcing member bifurcated.

The recess or pocket in this modification is numbered 75 and the single leg of the metal reinforcing member which is adapted to be positioned within such pocket is numbered 76.

In all of the structures above described, the metal reinforcing members are effective throughout the entire length thereof within the block. No portion of the reinforcing members located within the recesses or pockets of the blocks melts and flows out as in the prior structures, and, while such portions oxidize in whole or in part, there is ample room within the recesses or pockets for accommodating their growth or swelling due to oxidation. The blocks are not subjected to concentrated stresses due to swelling, and are not forced apart by swelling of the reinforcing members due to oxidation.

By means of this invention, I am able to produce, for high temperature furnaces such as open hearth furnaces, suspended roof and side wall structures made up of basic refractory blocks and metal reinforcing members which have a much longer life than prior art structures.

In some instances, it may be desirable to so treat the reinforcing members or parts thereof before installation as to hasten oxidation of such members or parts during initial heating up of the furnace. This may be accomplished in different ways, but one simple way is to dip such members or parts before installation in nitric acid.

In some high temperature installations, more particularly in suspended roof structures for high temperature furnaces, it may be desirable to provide my metal reinforcing members for all four sides of the blocks, except the perimetral blocks

comprised in an island or group of blocks. This may be accomplished by providing one narrow side of each block of the group or island, including the perimetral blocks, with a reinforcing member receiving recess or pocket such as disclosed in either of the modifications of Figs. 13 to 24 inclusive.

If desired, the rows of interlocked blocks comprised in an island or group such as above described can be interlocked in the manner disclosed in my United States Patent 1,874,321 of August 30, 1932.

If it is desired to utilize this invention in sprung arches or roofs, blocks of the general form of the blocks disclosed in my Patent 1,590,303 of June 29, 1926, made of basic refractory material, and modified to receive my metal reinforcing members may be utilized.

The structures embodying this invention are not limited to any particular type of basic refractory blocks, bricks or tile, since both burned basic refractory blocks, bricks or tile on unburned chemically bonded basic refractory blocks, bricks or tile may be used. Neither is the invention limited to ferrous metal reinforcing members for such blocks, bricks or tile, although at the present time I prefer to use ferrous metal reinforcing members.

At the present time, when an open hearth furnace is to be put in operation, the usual practice is to rapidly bring the same up to its operating temperature of about 3000° F. in about twenty hours.

In order to make certain that no part of my metal reinforcing members melt, prior to oxidation, I prefer to adopt an initial heating up cycle—particularly in connection with open hearth furnaces—that will insure sufficient time for oxidation of the inner ends of the metal reinforcing members prior to melting.

The first step in this cycle is to raise the furnace temperature as fast as the furnace system will permit, to about 2850 or 2900° F. The second step is to hold this temperature for a period of at least five hours to permit the inner ends of the reinforcing members to oxidize. The third step in the cycle is to increase the temperature to the desired operating temperature.

This procedure produces a heating up curve with a nearly flat horizontal section from around 2850 to 2900° F. instead of the typical curve which rises continuously to operating temperature. This procedure has been disastrous to the old type metal reinforcing members when used in open hearth furnaces, since a substantial portion of each such reinforcing member melts prior to oxidation causing the voids or open spaces between the blocks, as above pointed out.

In the structure of my invention, I prevent the ends of the metal reinforcing members from melting and soaking into the blocks prior to oxidation. In other words, I insure oxidation of the metal reinforcing members prior to melting and while the reinforcing members after oxidizing do melt and soak into the blocks, there is no further swelling to cause blistering or bloating of the blocks. The side wall and roof structures of this invention of course become thinner during service. Oxidation of the inner portions of the reinforcing members provides refractory metal plugs which, as the blocks shorten, assume the function of the shields of refractory block material as these disappear. These plugs serve to screen the other portions of the reinforcing members from the heat and hot gases of the furnace chamber. As the

blocks shorten, more and more of each metal reinforcing member oxidizes so that there is always a refractory metal plug in the furnace chamber end of each recess or pocket.

The size or volumetric capacity of each reinforcing member pocket or recess, with relation to the amount of metal in that portion of the metal reinforcing member located therein, is such that swelling of the reinforcing members due to oxidation can not force apart the refractory blocks.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a furnace roof structure, refractory blocks arranged in side by side abutting relation with certain of such blocks so formed that pockets are provided therebetween which are open at their tops, extend downwardly from the upper face of the roof structure toward the lower face thereof and terminate short of such lower or furnace chamber face leaving refractory block material between each such pocket and the furnace chamber, an oxidizable sheet-like metal reinforcing member located within and extending above each such pocket and contacting the refractory blocks on opposite sides of such pocket, support means above the roof structure, hangers carried by such support means, anchored to said blocks and extending through openings in said reinforcing members; the volume of metal in that part of each reinforcing member confined within such pocket with relation to the size of such pocket being such that the reinforcing member can swell or grow to its maximum thickness occasioned by oxidation without forcing out of abutting relation the blocks with which it contacts.

2. In a furnace chamber enclosing structure, refractory blocks arranged in abutting relation with each such block formed with a recess in a side thereof abutting another block, and which, extending from its outer end terminates short of its opposite or furnace chamber end; such recess being narrower than the recessed side of the block, leaving refractory block material extending along the opposite edges and the furnace chamber end of the recessed side; and an oxidizable sheet-like metal reinforcing member located within each such recess and being so deformed that it engages the blocks on opposite sides thereof; the volume of metal in that part of each reinforcing member confined within its recess with relation to the size of such recess being such that the reinforcing member can swell or grow to its maximum thickness occasioned by oxidation, without forcing out of abutting relation the blocks with which it contacts.

3. In a furnace chamber roof structure, a group of refractory blocks arranged in abutting relation in a row and formed with interengaging tongues and grooves; such blocks being so formed as to provide recesses between the blocks on opposite sides of each such tongue; such recesses terminating short of the lower face of the roof, leaving a wall of refractory material between each such recess and the furnace chamber; an oxidizable metal reinforcing member for each block of such group, such reinforcing member having legs located within such recesses, support means above the roof and means for supporting such blocks and such reinforcing members from such support means; the volume of metal in each such leg with relation to the size of its recess being such that such leg can swell or grow to its maximum thickness occasioned by oxidation without forcing out

of abutting relation the blocks with which it contacts.

4. In a furnace roof structure, a group of refractory blocks arranged in abutting relation and having interengaging tongues and grooves in abutting sides thereof; such tongues and grooves being of such size and shape that recesses are provided on opposite sides of each such tongue that terminate short of the furnace chamber end of such blocks, a plate-like metal member located within each such recess and being so deformed as to engage the blocks on opposite sides thereof, support means above the roof, and means secured to such support means for supporting such blocks; the volume of metal in each plate-like member with relation to the size of its recess being such that such member can swell or grow to its maximum thickness occasioned by oxidation without forcing out of abutting relation the blocks with which it contacts.

5. In a furnace roof structure, a group of refractory blocks arranged in abutting relation and having interengaging tongues and grooves in abutting sides thereof; such tongues and grooves being of such size and shape that recesses are provided on opposite sides of each such tongue, such recesses terminating short of the lower face of the roof, leaving a wall of refractory material between each such recess and the furnace chamber, an oxidizable sheet-like metal member having legs located within such recesses and being so deformed as to engage the blocks located on opposite sides thereof, support means above the roof and means secured to such support means for supporting such blocks; the volume of metal in that part of each sheet-like member located within such recess with relation to the size of such recess being such that such member can swell or grow to its maximum thickness due to oxidation without forcing out of abutting relation the blocks on opposite sides thereof.

6. In a furnace chamber enclosure structure, a row of refractory blocks arranged side by side and in contact at their inner or furnace chamber ends, certain of such blocks being so formed that pockets are provided between blocks of such row which extend from the outer face of the structure toward its inner or furnace chamber face and terminate short of such inner face leaving a shield of refractory block material between each such pocket and the furnace chamber, an oxidizable sheet-like metal reinforcing member located within each such pocket and having portions thereof contacting the refractory blocks on opposite sides thereof; the volumetric capacity of each such pocket with relation to the volume of metal of that part of the reinforcing member within such pocket being such that such reinforcing members can grow or swell the maximum amount due to oxidation without forcing apart such blocks.

7. In a furnace chamber enclosure structure, rows of refractory blocks having the adjacent edges of their inner or furnace chamber ends in contact, some of such blocks being so formed that pockets are provided between certain adjacent blocks, such pockets extending from the outer ends of such blocks toward their inner ends, terminating short of such inner ends leaving refractory block material as shields between such pockets and the furnace chamber, an oxidizable sheet-like metal reinforcing member located within each such pocket, such reinforcing member having a length at least equal to the distance between the upper end of such pocket and such

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shield and a width not substantially less than the width of such pocket and being so deformed that before oxidation, it contacts and reinforces the blocks on opposite sides thereof; the volume of metal in that part of each reinforcing member confined within such pocket, with relation to the size of such pocket being such that the reinforcing member can swell or grow to its maximum thickness, occasioned by oxidation without forcing out of abutting relation the blocks with which it contacts.

8. In a furnace chamber enclosure structure, groups of refractory blocks arranged in abutting relation; some of the blocks in each such group being formed with a recess in a wide side thereof which abuts a wide side of another block of such group; each such recess extending inwardly from its outer toward its inner or furnace chamber end and terminating short of its inner end, leaving refractory material between each such recess and the furnace chamber, each such recess throughout at least the inner half of its length being branched, with such branches separated by a substantially V-shaped block portion having its apex adjacent the end of the block remote from the furnace chamber, and a branched metal reinforcing member located within each such recess and engaging the blocks on opposite sides thereof; each such reinforcing member being of such size and shape with relation to the size and shape of the recess within which it is located that sufficient space within the recess is provided to accommodate the increase in thickness of the reinforcing member due to its oxidation.

9. In a furnace chamber enclosing structure, refractory blocks arranged in rows with their inner or furnace chamber ends in abutting relation, some of the blocks in each row being so formed as to provide a recess in a side thereof that abuts another block of such row; each such recess extending inwardly from the face of the structure remote from the furnace chamber and terminating short of the inner or furnace chamber face, leaving a shield of refractory block material between each such recess and the furnace chamber, and a sheet-like oxidizable metal reinforcing member located within and extending substantially throughout the length and breadth of each such recess; the volume of metal in that part of each reinforcing member located within such recess, with relation to the size of such recess, being such that the reinforcing member can swell or grow to its maximum thickness occasioned by oxidation without forcing out of abutting relation the blocks with which it contacts.

10. A structure as defined in claim 9, in which each recess is provided with a generally triangular partition; in which each reinforcing member is bifurcated and straddles such partition; each branch of such reinforcing member being tapered in width and having its narrowest part adjacent the furnace chamber and its widest part remote from the furnace chamber.

11. In a furnace roof structure, refractory blocks arranged in rows in abutting relation throughout the major part of their lengths, some of such blocks being so formed as to provide a recess in a side thereof abutting another block of such row; such recess extending downwardly from the upper face of the roof structure toward its lower face and terminating short of such lower face leaving a shield of refractory block material between each such recess and the furnace chamber, a sheet-like oxidizable metal reinforcing member located within each such recess and

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which before oxidation thereof is so deformed as to contact the blocks on opposite sides thereof, support means above the furnace roof, and hangers supporting such blocks from such support means; the volumetric capacity of each such recess with relation to the volume of metal in that part of the reinforcing member confined within such recess being such that the reinforcing members can grow or swell the maximum amount due to oxidation without forcing such blocks out of contact.

12. In a furnace chamber roof or wall structure, rows of refractory blocks, with the blocks in each row arranged side by side and in contact at their inner or furnace chamber ends, some of such blocks being so formed that recesses are provided between adjacent blocks which extend from the outer face of the structure toward the inner or furnace chamber face and terminate short of such inner face leaving a shield of refractory block material between each such recess and the furnace chamber, each such recess being divided into two portions by a partition of refractory block material; an oxidizable sheet-like metal reinforcing member located within each such recess and having legs that straddle such partition; each such leg having portions thereof contacting the refractory blocks on opposite sides thereof; the volumetric capacity of each such recess with relation to the volume of metal in that part of the reinforcing member confined within such recess, being such that the reinforcing members can grow or swell the maximum amount due to oxidation without forcing out of contact the blocks with which they contact.

13. In a furnace roof structure, refractory blocks arranged side by side in abutting relation and having the adjacent edges of their lower ends in contact, some of such blocks being so formed as to provide recesses between abutting blocks which extend downwardly from the upper face of the roof structure toward its lower face and terminate short of such lower face leaving refractory block material to serve as a refractory shield between each such recess and the furnace chamber, a sheet-like oxidizable metal reinforcing member located within and extending substantially throughout the length and breadth of each such recess, such sheet-like metal member being so deformed that before oxidation thereof it engages the refractory blocks on opposite sides thereof, support means above the furnace roof, and hangers supporting such blocks from such support means and engaging such reinforcing members; the volumetric capacity of each such recess with relation to the volume of metal in that part of the reinforcing member confined within such recess, being such that the reinforcing members can grow or swell the maximum amount due to oxidation without forcing out of contact the blocks with which they contact.

14. A furnace roof structure as defined in claim 13, in which the reinforcing members project outwardly into the atmosphere above the roof blocks.

15. A furnace roof chamber structure as defined in claim 13, in which the reinforcing members are provided with block engaging portions which project outwardly beyond at least one wide face thereof.

16. A furnace roof structure as defined in claim 13, in which the reinforcing members project outwardly from the recesses at the ends of the blocks remote from the furnace chamber, in which each such projecting end is provided with an opening

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and in which each block is supported by a metal hanger which is anchored thereto and passes through the opening in the reinforcing member for such block.

17. A furnace roof structure as defined in claim 13, in which the refractory blocks are provided with interengaging tongues and grooves, with such tongues of greater height than the depth of such grooves, thus providing recesses on opposite sides of such tongues, and in which the reinforcing members are provided with bifurcated ends located within such recesses.

18. A furnace roof structure as defined in claim 13, in which each recess is provided with two branches, and in which each reinforcing member has two branches.

19. A furnace roof structure as defined in claim 13, in which each block is supported from a support by a metal hanger which is anchored to the block and passes through the reinforcing member.

20. In a furnace chamber enclosure structure, rows of refractory blocks arranged in abutting relation, some of such blocks being so formed that two tapered recesses are provided between adjacent blocks which extend lengthwise thereof and terminate short of their furnace chamber faces leaving a shield of refractory block material between each such recess and the furnace chamber, such recesses being separated by a triangular portion of refractory block material having its base adjacent the furnace chamber; and an oxidizable sheet-like metal member having a body portion and legs that extend from such body portion, straddle such triangular portion and lie within such recesses; the volumetric capacity of such recesses with relation to the volume of metal in such legs being such that such legs can grow or swell the maximum amount due to oxidation without forcing the adjacent blocks apart.

21. In a furnace chamber roof or wall structure, rows of refractory blocks, with the blocks in each row arranged side by side and in contact throughout the major part of their length, some of such blocks being so formed that two recesses are provided between adjacent blocks, such recesses extending inwardly of the structure and toward the furnace chamber face, terminating

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short of such face leaving a shield of refractory material between each such recess and the furnace chamber, such recesses being separated by a triangular portion of block material, and an oxidizable sheet-like metal member having legs that straddle such triangular portion and lie within such recesses; the volumetric capacity of such recesses with relation to the volume of metal in such legs being such that such legs can grow or swell the maximum amount due to oxidation without forcing apart the blocks with which they contact.

22. In a furnace chamber enclosure structure, a group of refractory blocks arranged in abutting relation in a row and being so formed that two pockets are provided between each two adjacent blocks which terminate short of their furnace chamber faces leaving a wall of refractory material between each such recess and the furnace chamber; such recesses being separated by a triangular portion of block material having its base adjacent the furnace chamber, and an oxidizable sheet-like metal member located between such blocks, extending outwardly beyond the outer ends thereof and having legs that straddle such triangular portion and lie within such recesses; the volume of metal in such legs with relation to the volumetric capacity of such recesses being such that such legs can swell or grow to their maximum thickness occasioned by oxidation without forcing out of abutting relation the blocks with which they contact.

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