

April 3, 1951

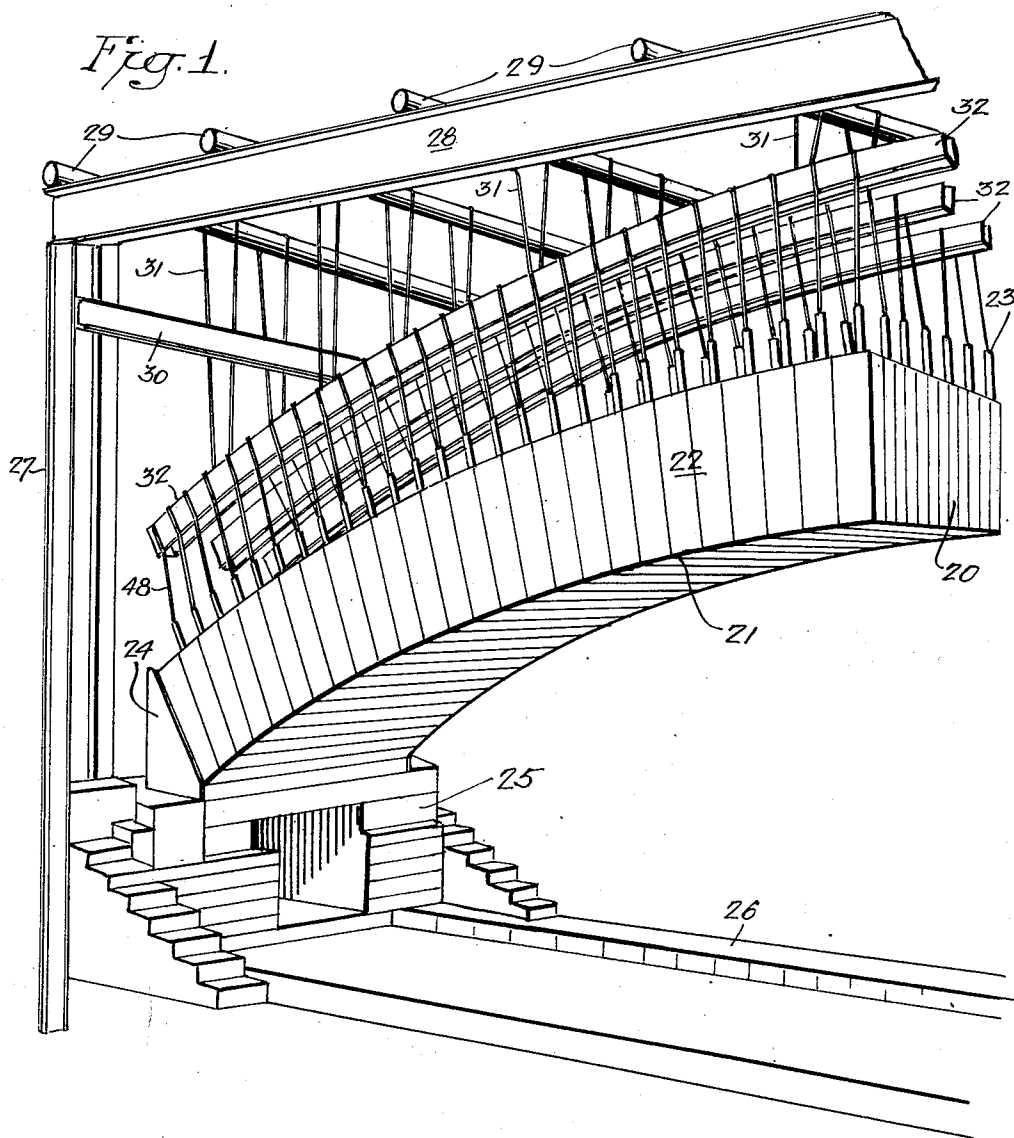
R. P. HEUER

2,547,322

SUSPENDED REFRACTORY BRICK AND INTERPOSED OXIDIZABLE
METALLIC PLATE FURNACE ROOF AND PROCESS
OF CONSTRUCTING THE SAME

Filed Jan. 23, 1946

3 Sheets-Sheet 1



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Fig. 2.

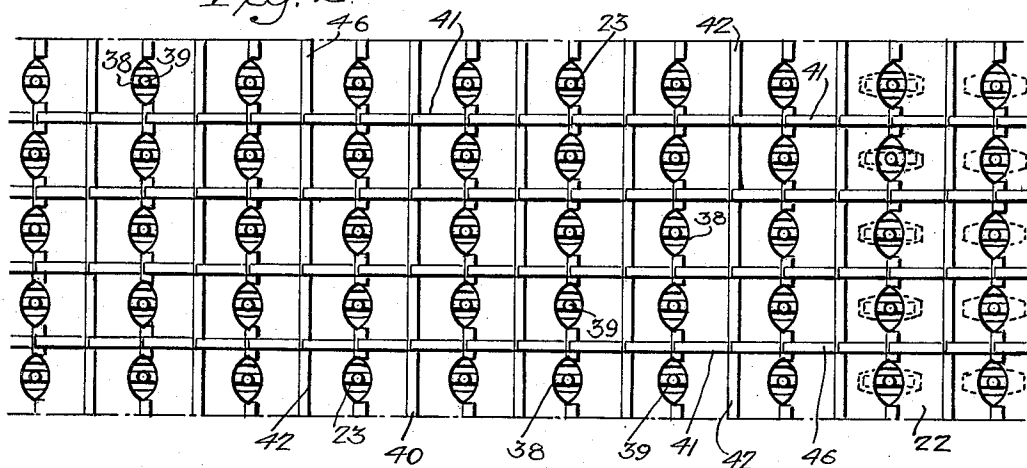
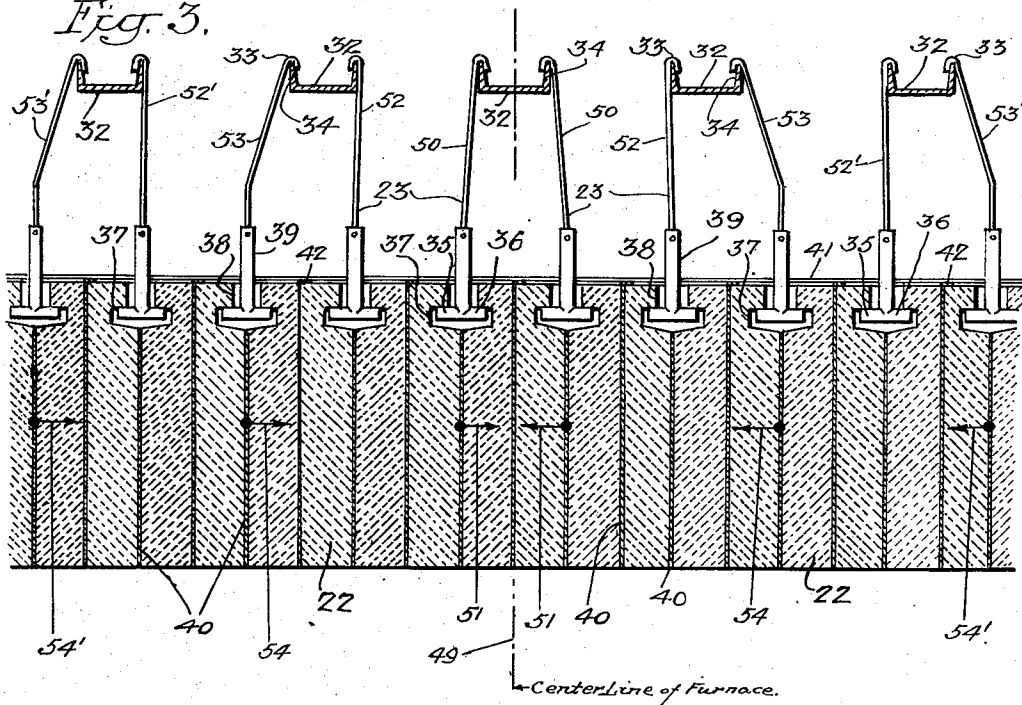


Fig. 3.



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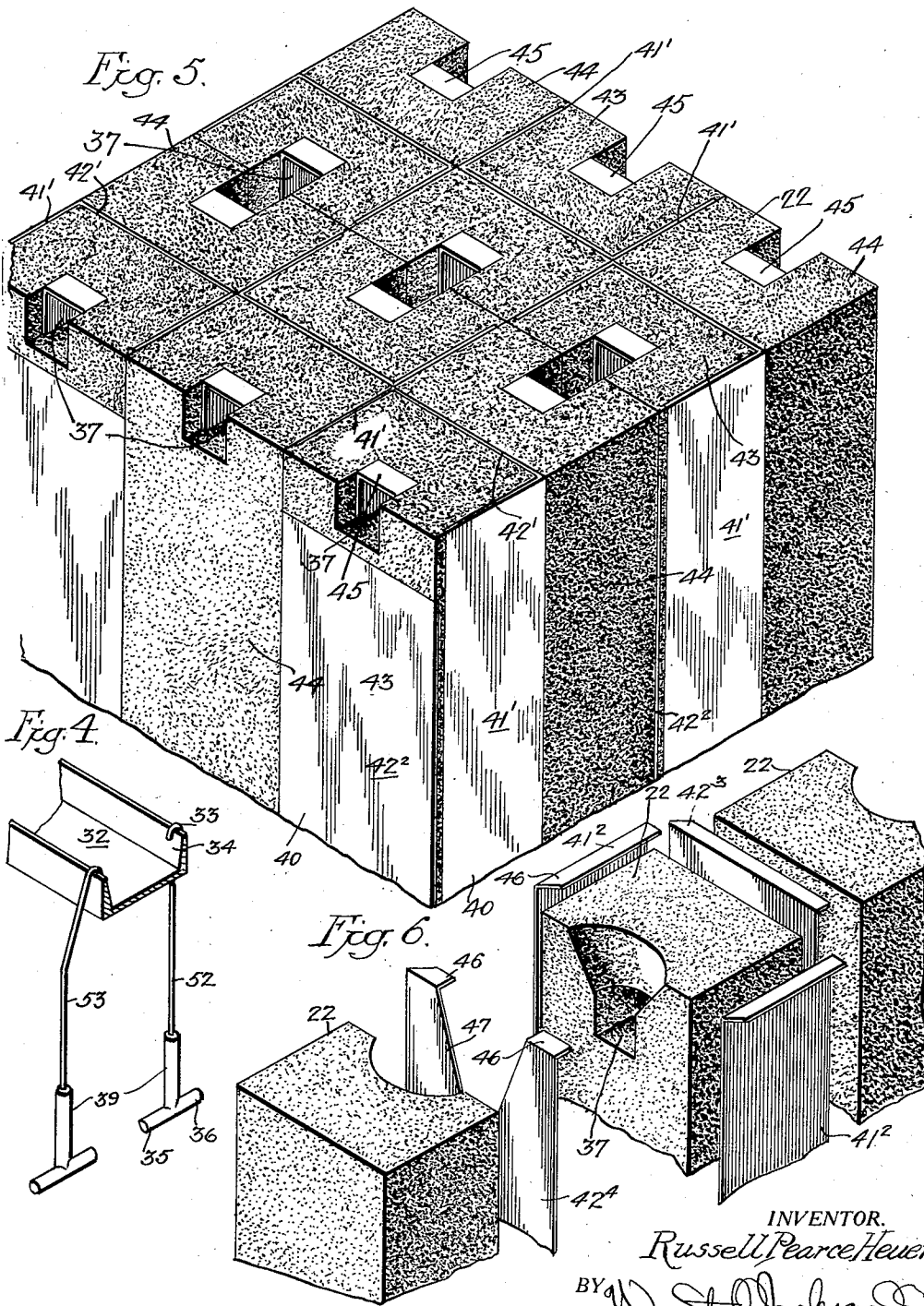
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,547,322

SUSPENDED REFRACTORY BRICK AND INTERPOSED OXIDIZABLE METALLIC PLATE
FURNACE ROOF AND PROCESS OF CONSTRUCTING THE SAMERussell Pearce Heuer, Villanova, Pa., assignor to
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of Pennsylvania

Application January 23, 1946, Serial No. 642,907

14 Claims. (Cl. 110—99)

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My invention relates to suspended furnace roofs and processes relating thereto.

A purpose of my invention is to obtain long life from suspended furnace roof brick having oxidizable metallic plates laterally interposed between adjoining brick.

A further purpose is to assure the application of controllable pressure laterally to oxidizable metallic plates in a suspended furnace roof at the time the roof is first heated to furnace temperature and before the plates have oxidized and the oxide of the plates has integrated with the refractory oxides of the brick.

A further purpose is to facilitate the integration of suspended basic refractory roof brick to laterally interposed oxidizable metallic plates by suspending the brick before heating the roof under yielding lateral pressure exerted at the time of first suspension at intervals along the length of the roof to maintain pressure contact during the first oxidization of the plates, and then heating the roof and oxidizing the plates while such pressure is exerted.

A further purpose is to obtain such yielding lateral pressure from a component of the gravitational force on the brick.

A further purpose is to integrate suspended basic refractory roof brick to laterally interposed oxidizable metallic plates by suspending the individual bricks prior to heating of the roof in a curved arch with lateral freedom to shift and to apply a lateral component of the gravitational force on the brick to the plates toward the sides of the arch while confining the sides of the arch, preferably simultaneously applying lateral pressure longitudinally of the arch from a lateral component of the gravitational force on the brick, and heating the roof and oxidizing the plates while such sidewise and lengthwise pressures are exerted.

A further purpose is to suspend the brick, desirably in pairs, by hangers supported at points removed from the vertical and swingable to exert a lateral component of the gravitational force on the brick to bring pressure against the plates.

A further purpose is to suspend the brick by hooks on hangers engaging desirably curved beams and to vertically misalign the hangers radially of the curve and desirably in the direc-

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tion away from the skewbacks at the sides of the roof and also to vertically misalign in a longitudinal direction so as to apply pressure to plates in both directions.

Further purposes appear in the specification and in the claims.

In the drawings I have chosen to illustrate one only of the many forms of the invention, with minor variations, the form and variations being chosen from the standpoints of convenience in illustration, satisfactory operation and clear demonstration of the principles involved.

Figure 1 is a partially diagrammatic fragmentary perspective view of a furnace roof to which the invention has been applied.

Figure 2 is a sectional top view of my improved furnace roof, the section being taken parallel to the roof and conforming with its curvature.

Figure 3 is a vertical section of the roof of Figure 2 in the direction longitudinal of the roof.

Figure 4 is a fragmentary isolated perspective showing a beam and hangers.

Figure 5 is a fragmentary perspective showing brick with plates.

Figure 6 is a detached, fragmentary perspective of a modified construction of brick and plates.

In the drawings like numerals refer to like parts throughout.

The invention is applied to suspended furnace roofs for furnaces and similar structures which are subject to high temperatures, and particularly to suspended furnace roofs of metallurgical furnaces such as copper reverberatory furnaces, open hearth steel furnaces and the like. The roofs of the present invention will normally comprise basic refractory brick such as magnesia, chrome, magnesia-chrome and chrome-magnesia, although it will be evident that other basic refractory material may be employed. For the purposes of the present invention, materials such as chrome, which are sometimes described as neutral, are considered to be basic refractories. The brick will also be fired or unfired as desired.

In the prior art, it has been found that a very desirable integration will occur between oxidizable metallic spacer plates laterally interposed among the suspended furnace roof brick and the brick themselves, actually forming a monolithic structure after the roof is in full operation. It is ordinarily considered that oxidization of the

spacer plate, which normally consists of iron or steel, under the action of the furnace atmosphere, produces iron oxide, which under elevated temperature and high pressure combines with the refractory oxides of the brick to form an extremely firm bond both to the unoxidized portion of the plates and to the brick. In a relatively short time of furnace operation, the lower ends of the plates are completely converted to oxide and welded to the brick.

The necessary pressure can be, and in the prior art normally has been, readily obtained by confining the roof. Since the space occupied by the oxide of the spacer plates is greatly in excess of (approximately double) the space occupied by the metallic plates, the roof may be assembled loosely and the growth of the plates as they oxidize will result in application of lateral pressure.

In my U. S. Patent No. 2,154,813, granted April 18, 1939, for Suspended Furnace Roof, incorporated herein by reference and made a part hereof, a suspended furnace roof has been described which includes the lateral spacers above referred to. This specification discloses the use of brick hanging vertically from their means of support. The brick were assembled rather loosely so that there was some room between the lateral spacer and the adjoining brick. No effort was made to apply lateral pressure to bring the brick and spacer together in tight contact at the time the roof was first constructed.

The growth of the spacer under oxidization was sufficient to develop firm contact between the oxidized spacer and the adjoining brick, applying lateral pressure upon the brick against the spacer to integrate the entire mass. The patent above referred to mentions the use of a frame structure surrounding the roof which might be used to exert lateral pressure, and might be eliminated if desired. The suspension of the roof brick themselves in the aforesaid patent disclosure did not apply lateral thrust at the time the roof was first constructed. The reliance was upon the creation of lateral thrust after the roof was put in operation.

Pollen U. S. Patent No. 2,163,435, granted June 20, 1939, for Furnace Roof Construction, shows a modification of the Heuer roof in which tapered bricks are used and direct contact between the lateral spacers and the brick is avoided. It has now been found that this type of construction is not an improvement over the construction shown in the Heuer patent but is actually inferior. When such a furnace is started, the high temperature gases penetrate between the bricks, oxidize the metallic plates and the oxide formed, not being in intimate pressure contact with the brick, does not produce high melting point compounds with the refractory oxides of the brick, but instead liquefies and runs out of the joints. It is necessary that the oxidization of the plate take place in firm contact with the refractory in order for the refractory to react with the oxide, raising its melting point and avoiding or retarding the melting out of the oxide of the plate as previously described.

The present invention is designed to overcome the difficulties encountered in these prior art constructions. In the present invention the thin oxidizable metallic lateral spacers between the brick are subjected, at the time the roof is constructed, to lateral pressure from the gravitational force on the brick themselves. The oxides formed from the lateral spacers are in pressure contact with the brick at the time they form so

that excessive fluxing of the spacers from the joints between the brick will not take place.

Figure 1 illustrates a suspended refractory roof 20 of curved arch formation as shown at 21, comprising refractory brick 22 suspended by hangers 23 and engaging skewbacks 24 at the side of the roof (only one skewback is shown since only half the roof is illustrated). The furnace wall is diagrammatically indicated at 25 and the furnace bottom is similarly suggested at 23.

The suspension structure for the roof desirably consists of columns 27 supporting girders 28 which carry stringers 29. The columns are spaced by stiffeners 30.

From the stringers, desirably hung by tension loops 31, a series of parallel hanger beams 32 is provided, desirably of channel formation as shown in Figure 3. The hanger beams preferably extend from side to side of the roof, from a position above one skewback to a position above the other skewback, and, where the roof arch is curved as shown in Figure 1, the hanger beams as there shown are each curved parallel with or in conformity to the curve of the arch.

The hangers 23, as shown in Figures 3 and 4, have hook ends 33 hooking over the upwardly directed flanges 34 of the hanger beams. It will be noted that while the hooks are firmly supported in tension, they permit angular swinging in a plane parallel with the flanges, so as to permit exerting a lateral pressure component toward one of the skewbacks as later described.

The attachment of the hangers to the brick may be of any conventional type, here shown consisting of double hanger projections 35 and 36 engaging in hanger recesses 37 of the bricks, which have space at 38 to receive the shanks 39 of the hangers.

Oxidizable metallic spacer plates 40, suitably of iron or steel, stainless steel or other iron-chromium alloy (which is oxidizable at the temperature of the furnace roof), but permissibly of copper, aluminum or an alloy of aluminum and copper where the temperature is low enough to permit the use of such other metals, are interposed between brick desirably both on the faces toward the sides of the furnace and also on the faces toward the longitudinal ends of the furnace as shown in Figure 2, where the spacer plates on the brick faces toward the sides of the furnace are indicated at 41 and those on the faces of the brick toward the longitudinal ends of the furnaces are indicated at 42.

As stated in my patent above referred to, the thickness of the spacer plates is desirably not more than $\frac{1}{4}$ inch, satisfactory spacer plate thicknesses being $\frac{1}{32}$, $\frac{3}{64}$ and $\frac{1}{8}$ inch.

The detail of spacer plate construction and application to the brick is not important from the standpoint of the present invention. In Figure 5, one conventional construction is indicated in which basic refractory bricks 22, preferably of unfired character are provided with plates 40 on four sides of each alternate brick 43, the other alternate brick 44 in each direction being free from plates. The plates are preferably applied to the brick 43 by comolding, the plates being secured ordinarily by embedding projections from the plates in the brick. In this construction two plates 41' on the faces of the brick toward the sides of the furnace are made integral in U-formation with one plate 42' on a face toward one longitudinal end. The other plate 42' on the opposite face toward one longi-

tudinal end, is separately applied, and terminates below the hanger recess 37.

The hanger recess 37 is bridged by a metallic socket bar 45 embedded in the brick, and receiving a hanger 35 or 36.

In Figure 6 I show a construction provided with separate plates, primarily intended for fired brick. Here plates 41² are on the faces of the brick toward the sides of the furnace and plates 42³ and 42⁴ are on the faces of the brick toward the longitudinal ends. Flanges 46 at the tops of the plates engage over the brick to prevent the plates from dropping out during assembly. The plates 42⁴ adjoining the hangers are recessed at 47 to avoid interference.

Various other arrangements of plates, adhering to some or all faces of one brick and omitted from contacting faces of adjoining brick, are well known and will not be illustrated.

In order to provide lateral pressure between bricks toward the skewbacks (sides), it will be seen in Figure 1 that each hanger is not hanging vertically, but is hanging radially of the arch curvature, that is, misaligned or canted as shown at 48 with its lower end displaced away from the nearest skewback, and free to exert lateral pressure by slight swinging about its hook as a pivot. Therefore, on the plates applied to the lateral faces of the brick directed toward the sides of the furnace, there is always a lateral pressure component of the gravitational force on the bricks to apply lateral pressure.

Thus it will be seen that by the combination of the skewbacks, and the radially extending misaligned and swingable hangers, it is possible to apply pressure readily to the oxidizable metallic plates on the lateral faces of the brick toward the sides of the furnace.

In order to provide lateral pressure on the oxidizable metallic plates on the faces of the brick facing toward the longitudinal ends of the furnace, certain hangers are also vertically misaligned in this direction as best shown in Figures 3 and 4. Assuming that the center line of the roof in the longitudinal direction is at 49, the adjoining hangers on either side of the center line at the center line beam are vertically misaligned with their lower ends offset away from the center line and toward the longitudinal ends of the furnace as shown at 50, so that a lateral component of pressure indicated by an arrow 51 is exerted by brick on such hangers against a plate. On the next beam on either side of the center line, one hanger 52 may be approximately vertical as shown, if it is not desired to have too much lateral pressure. The use of vertical hangers interposed among the misaligned hangers where desired provides a means of reducing and controlling the lateral pressure. The other hangers of these beams are vertically misaligned as shown at 53 away from the center line and toward the longitudinal ends of the furnace to apply lateral pressure as indicated by the arrows 54 upon the spacer plates between the brick supported by such hangers and the center line.

Similarly on the next beam, one hanger at 52' may be approximately vertical as shown and apply no lateral pressure while the next hanger 53' may be vertically misaligned as shown toward the longitudinal ends and apply lateral pressure on spacer plates toward the center line as indicated by the arrows 54'.

Thus it will be evident that lateral pressure is interposed between plates facing toward the longitudinal ends of the furnace and that such

lateral pressure is controlled by the choice between approximately vertical hangers and misaligned hangers which is offered. In the assembly the spacing of the beams may be freely adjusted by sliding the tension loops along the stringers. It is also important to note that the hooks in their engagement on the flanges of the beams permit the misaligned hangers considerable rocking toward or away from the vertical line through the hooks to adjust during the assembly. It is thus evident that the hangers about their hook support are freely rockable in both directions with respect to the vertical.

In the assembly of the arch, after the supporting structure and beams have been erected and the skewbacks on each side have been put in place, the arch is built by placing successive courses of brick beginning at the skewbacks and extending toward the middle of the furnace roof until the two sides meet, making appropriate allowance for normal expansion during the heating of the roof either at the point of meeting, at intervals throughout the roof, or by adjustment of the skewbacks.

When the roof is heated to its maximum temperature, its over-all dimensions increase approximately one percent. If the expansion intervals are used the total amount of such expansion facilities should approximate one percent, but in cases of different refractories different allowances may be necessary. If the over-all growth of the roof is to be compensated at the skewbacks, these skewbacks should be mounted so that they can move outwardly from the furnace in the desired amount, suitably employing yieldable skewbacks so that the compressive forces on the brick as shown in the construction are not lost. It will be evident however that the allowance for expansion will be so adjusted that when the roof attains a temperature at which appreciable oxidation of the plates will take place, all plates will be firmly in contact with the adjoining brick.

As the roof is assembled, the hangers are disposed in the manner already described to provide substantial angular thrust both toward the skewbacks and longitudinally of the roof, thus assuring good contact of the spacers with the adjoining refractory during the initial oxidation. In experimental application of the present invention to a furnace, it has been noticed that the iron oxide joining material is very satisfactorily held in position, so that the integration secured in suspended roofs applying the present invention is as satisfactory as that obtained where spacer plates are employed in side wall construction.

It will be evident that by the present invention the lateral pressure between the spacer plates is applied during the first heating of the roof, and is readily controllable under the guidance of the roof constructor by adjusting the misalignment of the hangers or using vertical hangers where desired. In this way, difficulty through excessive lateral pressure can be avoided, which might result in actual failure of brick under crushing, while at the same time adequate lateral pressure can be assured.

It will be evident that the principles of the invention can be applied to exert lateral pressure at any point in the roof toward one skewback or toward the opposite one, and toward one end or toward the opposite one as preferred.

In view of my invention and disclosure variations and modifications to meet individual whim

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or particular need will doubtless become evident to others skilled in the art, to obtain all or part of the benefits of my invention without copying the process and structure shown, and I, therefore, claim all such insofar as they fall within the reasonable spirit and scope of my claims.

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

1. The process of integrating suspended basic refractory roof brick to laterally interposed unyielding oxidizable metallic plates, which comprises pivotally suspending the brick before heating the roof while offsetting the point of pivotal suspension of at least some of the brick with respect to the center of gravity of the brick suspended, all of the brick whose point of pivotal suspension is offset in a given group of brick having the point of pivotal suspension offset in the same direction with respect to the center of gravity of the brick suspended, pressing unyielding oxidizable metallic spacer plates between the lateral faces of the brick in face-to-face contact therewith and heating the roof and thereby oxidizing the unyielding plates while they are thus in contact with the brick.

2. The process of integrating suspended basic refractory roof brick to laterally interposed unyielding oxidizable metallic plates, which comprises pivotally suspending the brick before heating the roof, suspending some of the brick with the point of suspension vertically above the center of gravity of the brick suspended while offsetting the point of pivotal suspension of other brick interposed among those first mentioned with respect to the center of gravity of the brick suspended, all of the brick whose point of pivotal suspension is offset in a given group of brick having the point of pivotal suspension offset in the same direction with respect to the center of gravity of the brick suspended, interposing unyielding oxidizable metallic spacer plates between the lateral faces of the brick in face-to-face contact therewith and heating the roof and thereby oxidizing the unyielding plates.

3. The process of integrating suspended basic refractory roof brick to laterally interposed unyielding oxidizable metallic plates, which comprises suspending the individual brick prior to heating up the roof in a curved arch with lateral freedom to shift, while offsetting the point of pivotal suspension of at least some of the brick with respect to the center of gravity of the brick suspended, all of the brick whose point of pivotal suspension is offset in a given group of brick having the point of pivotal suspension offset toward the adjoining side of the arch with respect to the center of gravity of the brick suspended, interposing unyielding oxidizable metallic spacer plates between the lateral faces of the brick in face-to-face contact therewith and heating the roof and thereby oxidizing the unyielding plates.

4. The process of integrating basic refractory roof brick to laterally interposed unyielding oxidizable metallic plates, which comprises suspending the individual brick prior to heating of the roof in a curved arch with lateral freedom to shift, while offsetting the point of pivotal suspension of at least some of the brick with respect to the center of gravity of the brick suspended, all of the brick whose point of pivotal suspension is offset in a given group of brick having the point of pivotal suspension offset in the same direction with respect to the center of gravity of the brick suspended, at the same time offsetting the point

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of pivotal suspension of at least some of the brick with respect to the center of gravity of the brick suspended in a direction transverse to the offsetting first mentioned and all in the same direction in the same group of brick, interposing unyielding oxidizable metallic spacer plates between the lateral and longitudinal faces of the brick in face-to-face contact therewith and heating the roof and thereby oxidizing the unyielding plates.

5. In a suspended furnace roof, a group of adjoining basic refractory roof brick arranged side by side, unyielding oxidizable metallic plates interposed laterally between brick, hangers engaging the brick, certain of which are pivotally supported at points above and to one side of a vertical line through the center of gravity of brick supported by the particular hanger and swingable to provide a lateral component of the gravitational force on the brick to bring pressure against the plates, all of the hangers for the group being supported at points which are directly above the center of gravity of brick supported by the particular hanger or offset toward those brick whose hangers are supported directly above the center of gravity with respect to the vertical line through the center of gravity, and a lateral support for the group of brick in the direction of the lateral component.

6. In a suspended furnace roof, a group of basic refractory roof brick arranged side by side, unyielding oxidizable metallic plates interposed laterally between brick, and hangers each supporting a pair of brick, and at least some of the hangers in the group being pivotally supported above and to one side of a vertical line through the center of gravity of the pair of brick and swingable to provide a lateral component of the gravitational force on the brick to bring pressure against the plates, the hangers which are supported above and to one side in the same group of brick all having pivotal support offset to the same side of the vertical line through the center of gravity of the suspended brick, and a lateral support in the direction of lateral pressure.

7. In a suspended furnace roof, a group of basic refractory roof brick arranged side by side, unyielding oxidizable metallic plates interposed laterally between brick, beams extending above and generally parallel to the roof, hangers having hooks pivotally engaging on the beams, supporting the brick and at least some of the hangers being supported above and to one side of a vertical line through the center of gravity of the brick supported by the particular hanger and swingable so as to cause the brick to exert lateral pressure on the plates, the hangers which are supported above and to one side in the same group of brick all having pivotal support offset to the same side of the vertical line through the center of gravity of the suspended brick, and a lateral support in the direction of the lateral pressure.

8. In a suspended furnace roof, skewbacks on either side of the roof, a plurality of basic refractory roof brick arranged side by side in a curved arch extending between the skewbacks, unyielding oxidizable metallic plates interposed laterally between the brick, hangers for the brick, certain of which hangers are pivotally supported above and to the side toward the nearest skewback with respect to a vertical line through the center of gravity of the brick supported by the particular hanger, and swingable to permit cer-

tain brick to exert lateral pressure and the lateral pressure on opposite sides of an intermediate point between the skewbacks being exerted substantially entirely toward one skewback.

9. In a suspended furnace roof, skewbacks on either side of the roof, a plurality of basic refractory roof brick arranged side by side, a curved arch extending between the skewbacks, unyielding oxidizable metallic plates interposed laterally between brick, hangers for the brick, certain of which hangers are pivotally supported above and to the side toward the nearest skewback with respect to a vertical line through the center of gravity of the brick pivotally supported by the particular hanger and swingable to permit certain brick to exert lateral pressure on plates in the direction of the skewbacks, the lateral pressure on opposite sides of an intermediate point being substantially entirely in the direction of the adjoining skewback, and also certain of the hangers being supported above and to one side with respect to the vertical line through the center of gravity of the brick at right angles to the line between the skewbacks to exert lateral pressure on plates longitudinally of the roof, all of the brick in an adjoining group whose hangers are pivotally supported above and to one side of a vertical line through the brick supported having the pivotal support offset in the same direction from said vertical line, and a support in the direction of the longitudinal pressure.

10. In a suspended furnace roof, skewbacks on either side of the roof, a plurality of basic refractory roof brick arranged side by side in a curved arch extending between the skewbacks, unyielding oxidizable metallic plates interposed laterally between brick and hangers each supporting a pair of brick, certain of which hangers are pivotally supported above and to the side toward the nearest skewback with respect to a vertical line through the center of gravity of the brick supported by the particular hanger and swingable to permit certain brick to exert lateral pressure on plates in the direction of the skewbacks, all of the brick on one side of an intermediate point between the skewbacks which are pivotally supported above and to one side with respect to the vertical line through the center of gravity of the brick supported having the point of support offset with respect to said vertical line toward the nearest skewback, and certain of which hangers are also pivotally supported above and to one side of a vertical line through the center of gravity of the brick supported by the particular hanger at right angles to the line between the skewbacks to exert lateral pressure on plates longitudinally of the roof, all of the brick on one side of an intermediate point in the dimension of the roof transverse to that between the skewbacks, which are pivotally supported above and to one side with respect to the vertical line through the center of gravity of the brick supported having the point of support offset in the same direction with respect to said vertical line, and a support in the direction of the longitudinal pressure.

11. In a suspended furnace roof, skewbacks on either side of the roof, a plurality of basic refractory roof brick arranged side by side in a curved arch extending between the skewbacks, unyielding oxidizable metallic plates interposed laterally between brick, beams curved to conform with the curve of the arch extending across in the general direction between the skewbacks

above the roof and hangers for the brick having hooks pivotally engaged on the beams, supporting the brick and certain of the hangers being supported above and to the side toward the nearest skewback with respect to the vertical line through the center of gravity of the brick supported by the particular hanger and swingable to permit certain brick to exert lateral pressure on the plates in the direction of the skewbacks, the lateral pressure being exerted continuously in the same direction throughout a group of adjoining brick.

12. In a suspended furnace roof, skewbacks on either side of the roof, a plurality of basic refractory roof brick arranged side by side in a curved arch extending between the skewbacks, unyielding oxidizable metallic plates interposed laterally between brick, beams curved to conform with the curve of the arch extending across in the general direction between the skewbacks above the roof and hangers for the brick having hooks pivotally engaging on the beams, supporting the brick and certain of the hangers being supported above and to the side toward the nearest skewback with respect to the vertical line through the center of gravity of the brick supported by the particular hangers and swingable to permit certain brick to exert lateral pressure on the plates in the direction of the skewbacks, the point of hanger support of all brick adjoining the skewbacks which are supported above and to the side being offset toward the nearest skewback with respect to the said vertical line, and also supported above and to one side of a vertical line through the center of gravity of the brick supported by the particular hanger at right angles to the line between the skewbacks to exert lateral pressure on plates longitudinally of the roof, the point of hanger support of all brick in a given group which are supported above and to the side being offset in one direction with respect to the said vertical line, and means to restrain longitudinal motion of the brick under the lateral pressure.

13. In a suspended furnace roof, a plurality of basic refractory brick side by side, unyielding oxidizable metallic spacer plates laterally interposed between the brick and hangers pivotally suspending the brick, certain of the hangers being vertical and certain of the hangers being supported above and to one side of a vertical line through the center of gravity through the brick supported by the particular hanger, the hangers which are supported above and to one side in any one group having the point of support offset in the same direction with respect to the center of gravity of the brick supported, and a lateral support in the direction of the lateral pressure.

14. In a suspended furnace roof, a plurality of basic refractory brick side by side, unyielding oxidizable metallic spacer plates between brick on faces toward the side and also toward the longitudinal end of the roof, hangers suspending the brick, certain of said hangers being supported above and to the side toward one side of the roof with respect to the vertical line through the center of gravity of the brick supported by the particular hanger and swingable to exert lateral pressure, the hangers supported above and to one side in any group of brick having the point of support offset in the same direction with respect to vertical lines through the center of gravity of the brick supported, certain of the hangers being vertical in the plane extending ver-

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tically from end to end of the roof and others of the hangers being supported above and to the side toward one end of the roof with respect to a vertical line through the center of gravity of the brick supported by the particular hanger and swingable to exert lateral pressure endwise of the roof, the hangers supported above and to the side toward one end of the roof in a group of adjoining brick having the point of support offset all in the same direction with respect to the vertical lines through the center of gravity of the brick supported.

RUSSELL PEARCE HEUER.

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