Nov. 14, 1950 R. P. HEUER 2,529,607

SUSPENDED FURNACE ROOF

Filed July 3, 1944 4 Sheets-Sheet 1

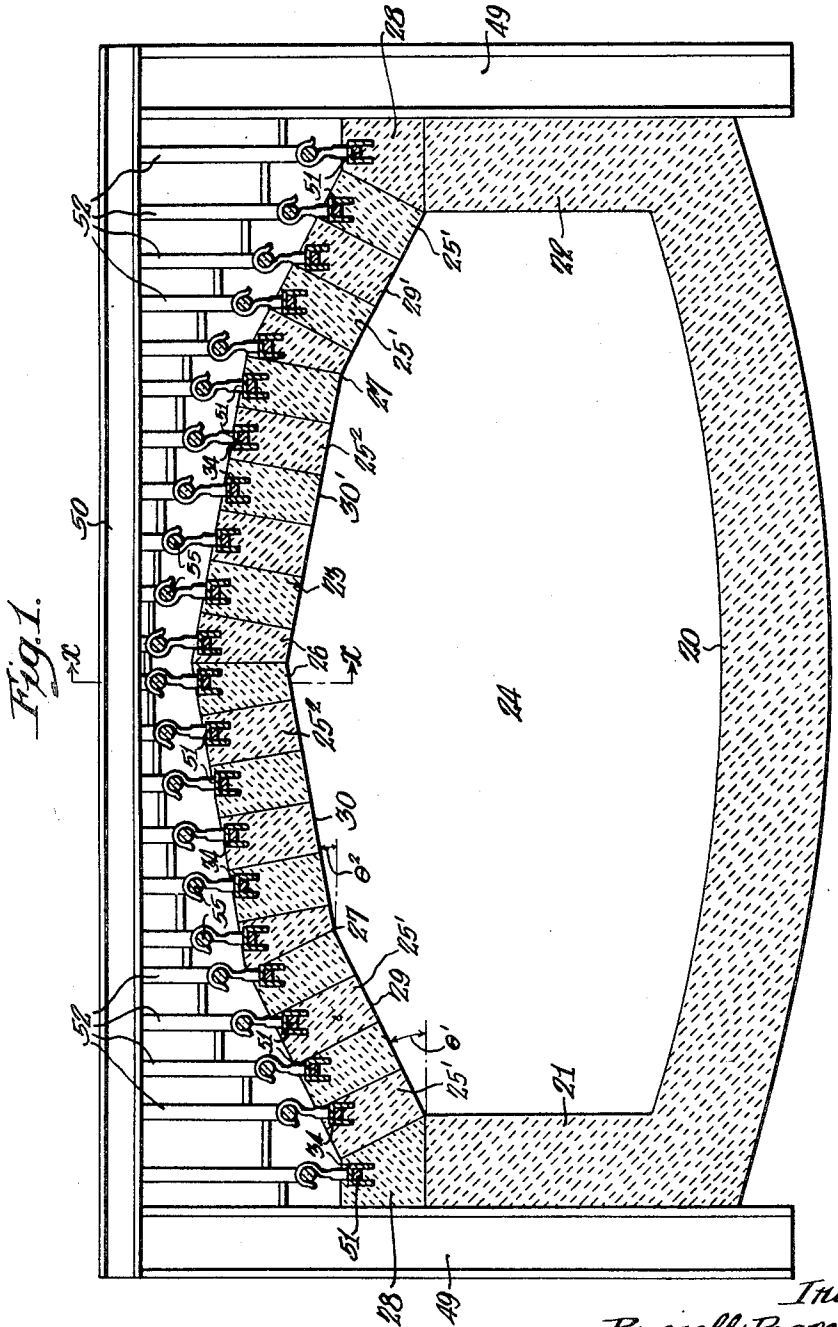


Fig. 1.

Inventor
Russell Pearce Heuer
by Cushman Darby & Cushman and Son
Attorneys

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Fig. 1a

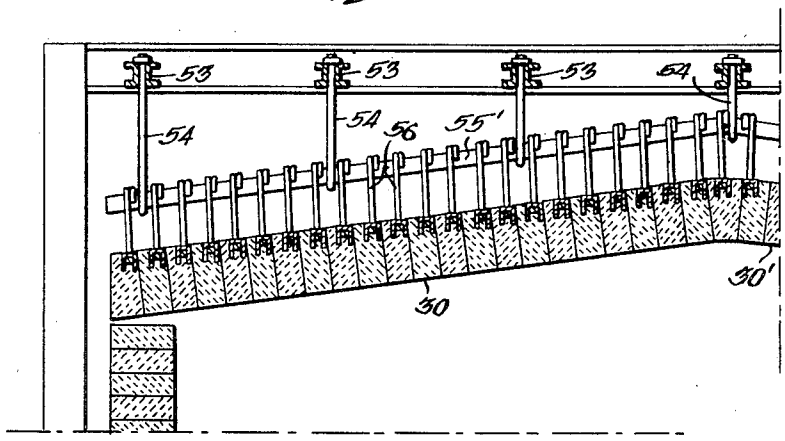


Fig. 2.

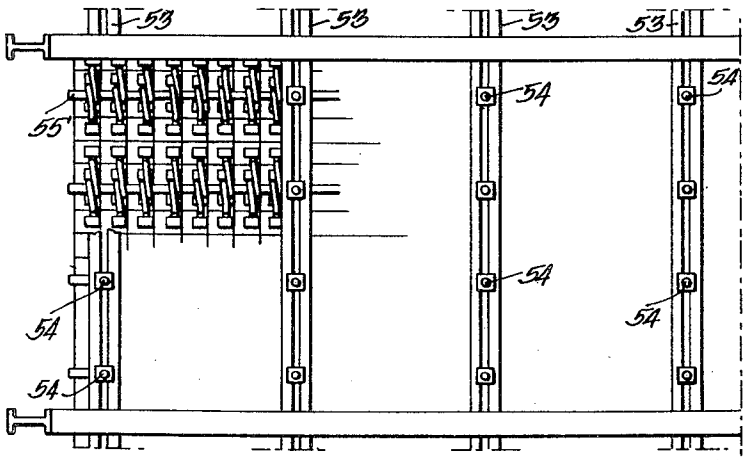
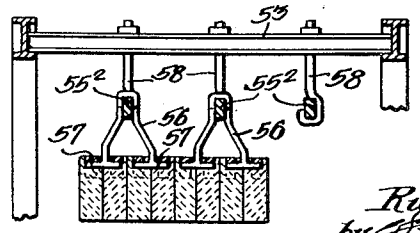


Fig. 1b



Inventor
Russell Pearce Heuer
by Hall Jackson and Sons
Attorneys

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Fig. 1c.

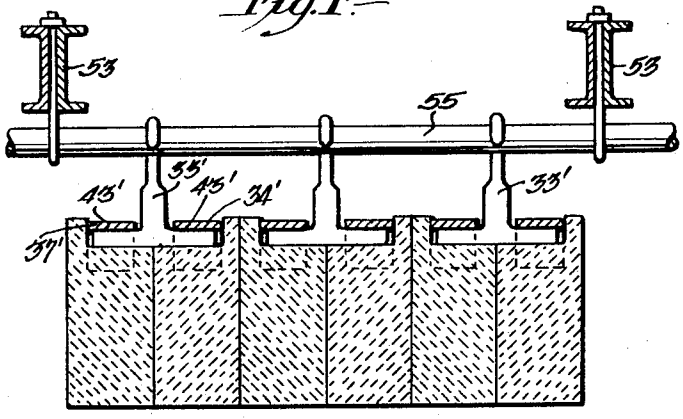


Fig. 4.

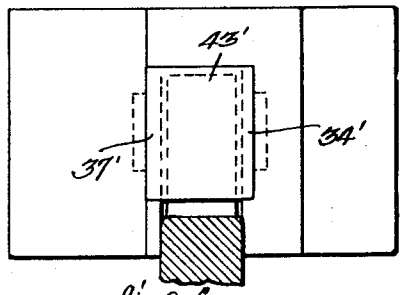
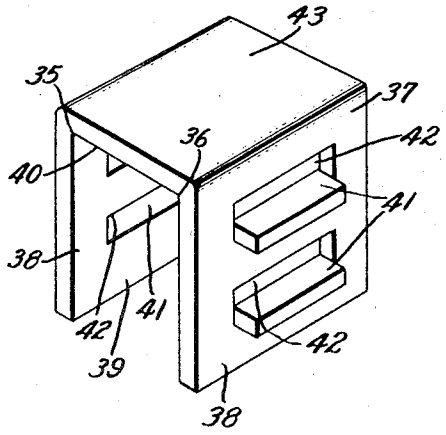


Fig. 3.



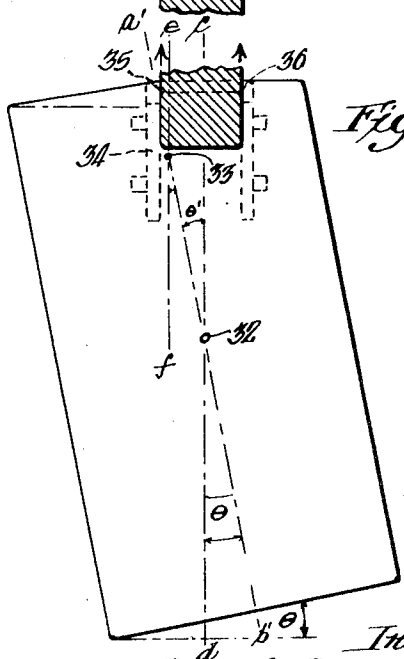


Fig. 5.

Inventor
Russell Pearce Heuer
by Kane Jackson and Son
Attorneys

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Fig. 6.

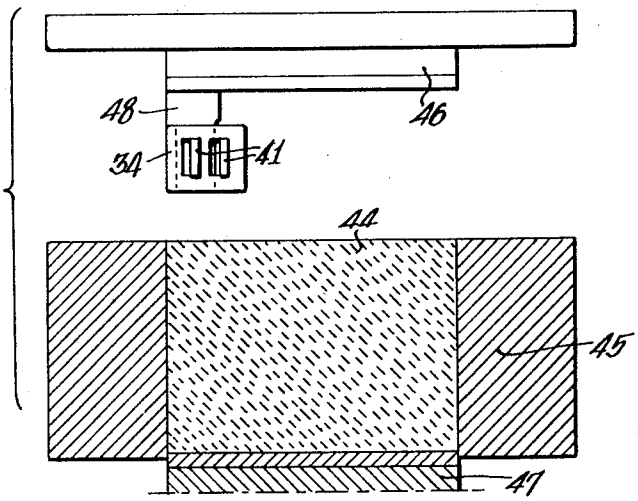


Fig. 7.

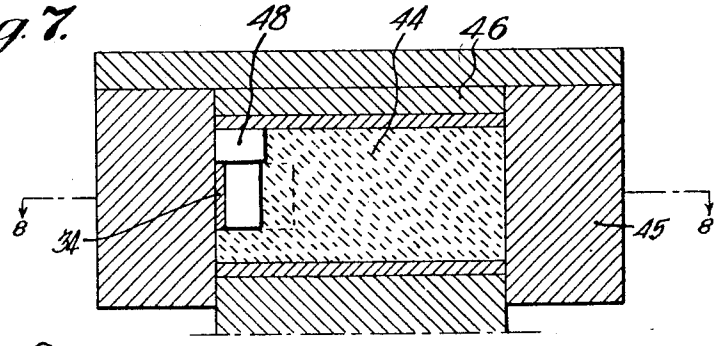
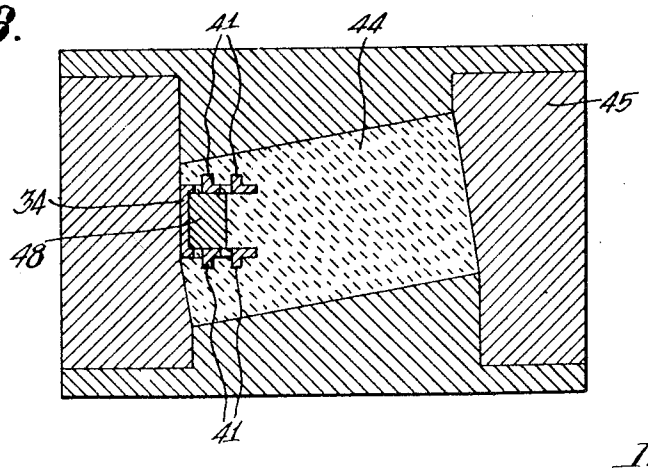


Fig. 8.



Inventor
Russell Pearce Heuer
by Stull Jackson and Son
Attorneys

Patented Nov. 14, 1950

2,529,607

UNITED STATES PATENT OFFICE

2,529,607

SUSPENDED FURNACE ROOF

Russell Pearce Heuer, Villa Nova, Pa., assignor to General Refractories Company, a corporation of Pennsylvania

Application July 3, 1944, Serial No. 543,240

7 Claims. (Cl. 110—99)

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My invention relates to suspended furnace roofs.

One purpose of the invention is to protect longitudinal lower edges of suspended roofing brick from undue edge exposure.

A further purpose is to construct a suspended roof which is shaped to provide a greater height at the center line of the roof than at the edge of the roof and to suspend the component brick freely in a way that brings their major axes perpendicular to the interior surface of the roof.

A further purpose is to suspend roof brick off-center with respect to their longitudinal axes so that the brick may hang freely with their longitudinal axes in a diagonal position.

A further purpose is to suspend furnace roof brick in pairs each of each pair being suspended off-center with respect to its major axis.

A further purpose is to provide a metal socket adapted to be molded off-center within the individual brick, to afford a seat for hangers for the individual brick and to cant or tilt the brick with respect to the major axis of the brick.

A further purpose is to insert sockets within the sides as distinguished from the middle portions of the upper ends of brick and to suspend the brick from hooks engaging these sockets and preferably entering adjacent brick from their adjacent facing sides.

A further purpose is to maintain the same slant or slope of the brick with respect to their major axes notwithstanding progressive rise of their centers of gravity with wear.

I have preferred to illustrate forms which are simple and inexpensive and which are well suited to illustrate the principles thereof.

The invention relates to the methods involved as well as to the brick and their support.

Figure 1 is a transverse section of the furnace arch in a suspended roof utilizing my invention.

Figures 1^a, 1^b, and 1^c are fragmentary sections of furnace arches.

Figure 2 is a top plan view of a portion of a structure similar to Figure 1.

Figure 3 is a perspective view of a socket for insertion within the brick suitable to receive a hanger for support of the brick.

Figure 4 is a fragmentary section through a hanger according to the present form, including a top plan view of the brick.

Figure 5 is a fragmentary section through a hanger according to the present invention with a side elevation of the brick.

Figures 6 and 7 are vertical sections of a press

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during formation of a brick, the parts being shown in separated position in Figure 6.

Figure 8 is a section of Figure 7, taken upon the line 8—8.

In the drawings similar numerals indicate like parts.

The construction of furnace roofs using the conventional sprung arch requires that the roof height be greater at the center line of the arch than at the side. This difference in height is known as the rise of the arch. In using a suspended roof in place of a sprung arch in a given furnace it is not necessary for structural reasons to provide a rise in the roof. The suspended roof can be built with no rise at all. However, in metallurgical melting furnaces such as the open hearth steel furnace and the copper reverberatory furnace it is desirable to build the suspended roof with a rise. The roof with a rise gives better furnace operation and simplifies the construction and repair of the furnace sidewalls.

The conventional refractory brick furnace of the prior art employs an arch which is highest at the center and the bricks form a serrated contour on the inner surface of the arch roof.

If the arch is built as the arc of a circle to conform to the shape of a sprung arch, the brick at the sides of the arch expose a large vertical surface. When the furnace is operated the brick tend to spall along planes perpendicular to this exposed vertical surface. Since the brick at the sides of the roof expose larger vertical surfaces than those at the center of the roof the sides of the roof tend to wear away more rapidly than the intermediate portion and the roof comes to premature failure by wearing thin along the sides.

The furnace of Figure 1 comprises hearth 20, side walls 21 and 22 and roof 23, all enclosing a space or volume 24.

The roof 23 is made up of individual refractory brick 25 which may be alike for the same slope of interior roof surface, except as special brick are, of course, required such as at 26, at the keystone, at 27 where a change of slope of the interior surface of the roof takes place, and at 26, at the ends of the arch. The brick are, of course different as at 25′ and 25^2 where a different slope of roof is used, since the points of attachment of the hangers with the brick will be off-center to different extents so as to cant the brick to the proper (different) angle.

In the existing furnaces where the brick are vertical, the major axes of the brick, are vertical since the center of gravity of the brick and

the points of support lie along a line corresponding to the major axis of the brick.

In Figure 1 instead of the serrated construction of the prior art, I use special brick in that special off-center support for the brick is provided and in that by means of this off-center support a line c—d, as shown in Figure 5, passing vertically through the center of gravity **32** of the brick does not correspond with nor run parallel to the major a'—b' of the brick.

I show the inner surface of the roof as made up of four planes, **29**, **29'**, **30** and **30'** in Figure 1 which planes form angles with a horizontal such as θ' and θ^2. In Figure 1^a one plane only shows at each side, at **30**, **30'**. Obviously the number of planes and the angles θ which these planes may make with the horizontal will vary according to the conditions met in the furnace roof to be constructed. By varying this number and the angle θ any desirable rise can be obtained.

In Figures 4 and 5 one form of the new brick is illustrated in which a socket **34** is molded into the brick and is seen to be off-center, i. e. to the right in Figures 4 and 5 of the line a'—b' through the center of gravity **32**. When the brick are new the line of support c—d differs from the axis of the brick by the angle θ. For construction of a given roof section, such as the section represented by plane **29** or **29'**, the angle θ will equal the angle θ', which the plane **29** or **29'** makes with the horizontal.

As the brick wear, the center of gravity will move up along the length of the brick.

When the brick is so far eroded that its center of gravity appears at point **33**, a vertical line through this point is represented by the line e—f. It is desirable that lines c—d and e—f shall intersect the socket **34** inside the points **35** and **36** of the outermost support from this socket. If this be so, the angle θ will remain constant during the life of the brick. Accordingly it is desirable that the hanger socket be wide enough and so located in the brick as to fulfill the above conditions.

The brick are made of refractory which is suited for use after drying at moderate temperature without kiln firing. This does not mean that burned brick are not suitable but merely that there is an advantage in allowing the furnace heat to burn the brick progressively while the advantages of the unburned brick are maintained in that part of the brick which has not yet been burned.

The composition of the refractory may vary widely and still yield a brick which is suitable for use without kiln drying.

A recommended mix is the following chrome magnesite composition:

Chrome Ore Coarse Grains (Thru 6 mesh and resting on 28 mesh)	60%
Magnesia (Periclase) fine Grains (Thru 65 mesh)	40%

To this mixture is added 2% by weight of air-floated kaolin and a solution of sulfuric acid sufficient to provide about 1% of sulfuric acid and 4% of moisture in the prepared mix. Refractory brick molded from this mix may be dried at about 300° F. whereupon they are suitable for use. It is desirable to avoid high temperature kiln firing since this might melt the socket imbedded in the brick or oxidize the metal so that it would suffer a loss in strength or utility.

I prefer to mold into the brick a socket **34** which sharply defines the shape and position of the surface to be engaged by an outside hanger, as well as the exact position within the brick at which the hanger engagement shall take place. Such a socket is seen in Figure 3. Though it is desirable, it is one only of many forms which would serve the purpose and is shown not only because it is desirable itself but also in order that my disclosure may include one definite form which is acceptable for the purpose.

The socket **34** shown comprises a U-shaped outer shell **37** having legs **38**, a suitable inner side surface **39** and under surface **40** at the bend of the U, to be engaged by the hanger. As seen in Figure 3, the socket recess formed is rectangular with a broad flat engaging surface at **40**. The socket has outwardly extending tabs **41** bent out from the metal of the socket. Both the extension of the tabs out into the body of the brick and the projection of the body of the brick within the recesses **42** left by bending them out, as well as the permissible submersion of the top **43** of the socket beneath the upper end of the brick, serve thoroughly to seat and hold the socket within the brick.

The socket should be wide enough so that the lines of support of the brick extending through the centers of gravity will always pass through the top of the socket, notwithstanding that through wear the center of gravity may move up progressively toward the top of the brick.

It is quite desirable that the finished brick with the inserted socket should not only be co-molded and thereby be embedded into refractory to form a bond with the refractory but that the brick should be formed under considerable pressure. I would recommend pressures not less than fifteen hundred pounds per square inch but consider that higher pressures up to or exceeding, for example, ten thousand pounds per square inch are desirable.

Considering now Figures 6, 7 and 8, a prepared mix **44** is placed in a mold box **45** between plungers **46** and **47**. The plunger **46** carries a plug **48** of proper shape to keep the recess for the socket free from mix and the socket is mounted upon the plug. The socket may be held in position by magnets located in the plunger **46** or the socket may be formed to fit the plug snugly and be formed to be held in place by light friction.

The top plunger **46** is moved down under pressure to the position seen in Figure 7 embodying the socket in the refractory.

After the plunger **46** has completed its pressing stroke the plunger and plug are withdrawn and the lower plunger **47** is then moved upwardly and the brick is discharged from the mold.

It is desirable that the plug used to form the recess for the socket be tapered or otherwise shaped or given clearance such as to facilitate its withdrawal from the formed brick without damage to the refractory.

My hangers are suitable for supporting brick from the framework above the furnace of which a conventional form is shown in Figure 1. The side standards **49** support beams **50** from which, in my several forms, hangers for the ultimate brick are variously supported. In Figure 1, units **51**, which comprise the hangers, sockets and brick, hang from the beams by non-rigid tension members **52** and longitudinally extending rods or bars **55**.

In Figure 1^a is shown a structure that varies from this form somewhat because the rods or

bars 55' are transverse instead of longitudinal and are hung from pairs of channels 53 by means of hook bolts 54 directly supporting the bars 55'. The form of Figure 1[a] appears in fragmentary top plan view in Figure 2.

In Figure 1[b] the individual rods and bars 55[2] extend longitudinally as in Figure 1 as distinguished from transversely as in Figure 1[a] and the pairs of channels are transverse instead of longitudinal.

In Figures 1[a] and 1[b] the brick are supported in pairs from hangers 56 provided with T-shaped projections 57 which engage the brick through the hanger sockets 34. The hangers are suspended by the transverse bars 55' or the longitudinal bars 55[2] which themselves are suspended by means of hooks 58. The hangers are grouped in pairs (right and left) at each point of support.

Figure 1[c] represents a section along the plane x—x in Figure 1. Transverse bars 55 are supported from longitudinal pairs of channels 53 and the T hangers are hung from these bars. The hangers are not grouped in pairs as in Figure 1[a].

The roofs of the different figures may be arched at any desired angle.

It will be evident that the metallic socket may be fabricated from rolled steel, malleable cast iron, heat resisting alloy or other material and that the form of the socket need not be that of a U provided it and the hanger interfit properly to offer suitable support to the brick.

In view of my invention and disclosure variations and modifications to meet individual whim 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 structure shown, and I, therefore, claim all such in so far 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. A refractory brick for suspended furnace roofs having a recess from one lateral face of the brick located wholly at one corner of the brick, at the intended upper end, the recess lying wholly on one side of the longitudinal axis of the brick when viewed from the lateral face having the recess, and the longitudinal axis of the recess being wholly on that side of the longitudinal axis of the brick when viewed from that lateral face, the recess being above the center of gravity of the brick at the intended angle of suspension of the brick, and a comolded metallic socket supported within the recess, the socket being nonsymmetrical with respect to the longitudinal axis of the brick.

2. A refractory brick hanging with its long dimension generally upright but at an angle to the vertical, having a recess from one lateral face of the brick located wholly at one upper corner of the brick, the recess lying wholly on one side of the longitudinal axis of the brick when viewed from that lateral face and the longitudinal axis of the recess being wholly on that side of the longitudinal axis of the brick when viewed from that lateral face, the recess being above the center of gravity of the brick at the angle of suspension, a comolded metallic socket supported within the recess, the socket being nonsymmetrical with respect to the longitudinal axis of the brick, and a hanger engaged in the socket recess extending upwardly and suspending the brick.

3. A pair of refractory furnace roof brick hanging with their long dimensions generally upright

but at an angle to the vertical, engaging end to end, each having a recess from one lateral face of the brick in line with the recess in the other brick and located wholly at one upper corner of the brick, the recess lying wholly on one side of the longitudinal axis of the brick when viewed from that lateral face and the longitudinal axis of the recess being wholly on that side of the longitudinal axis of the brick when viewed from that lateral face, the recess being above the center of gravity of the brick at the angle of suspension, a comolded metallic socket supported within the recess, the socket being nonsymmetrical with respect to the longitudinal axis of the brick and a T hanger having the bars of the T in the respective sockets, extending upwardly and suspending the brick.

4. A refractory suspended furnace roof brick having a recess from one lateral face of the brick located wholly at one corner of the brick, at the intended upper end, the recess lying wholly on one side of the longitudinal axis of the brick when viewed from that lateral face and the longitudinal axis of the recess being wholly on that side of the longitudinal axis of the brick when viewed from that lateral face, the recess being wholly above the center of gravity of the brick at the intended angle of suspension of the brick, and a comolded inverted U-shaped metallic socket supported within the recess, and having a base of the U which is adapted to form a flat engagement or seat for suspending the brick, and the socket being nonsymmetrical with respect to the longitudinal axis of the brick, whereby with change in center of gravity as the brick erodes, the vertical lines through the center of gravity remain between the points in the socket for supporting engagement to avoid a tendency of the brick to rock.

5. A refractory brick hanging with its longitudinal dimension generally upright, but at an angle to the vertical, having a recess from one lateral face of the brick located wholly at one upper conrer of the brick, the recess lying wholly on one side of the longitudinal axis of the brick when viewed from that lateral face and the longitudinal axis of the recess being wholly on that side of the longitudinal axis of the brick when viewed from that lateral face, the recess being above the center of gravity of the brick at the angle of suspension, a comolded metallic socket supported within the recess, the socket being nonsymmetrical with respect to the longitudinal axis of the brick, and a hanger engaged in the socket recess, extending upwardly, and suspending the brick, the lateral limits of supporting engagement of the hanger in the socket embracing the vertical lines through the center of gravity of the brick as the brick erodes away during service.

6. A suspending furnace roof comprising hangers for brick, which are arranged at different angles on different parts of the roof and refractory roof brick which at the time of installation are unfired, each roof brick having a hanger socket open from one lateral face of the brick, engaged by a hanger and imbedded in the body of the brick at an upper corner, the socket being wholly on one side of the longitudinal axis of the brick when viewed from that lateral face and the longitudinal axis of the recess in the socket being wholly on that side of the longitudinal axis of the brick when viewed from that lateral face, and the socket being positioned nonsymmetrically with respect to the longitudinal axis of the brick, the lateral limits of the supporting engagement of the hanger within the socket embracing the vertical lines

through the centers of gravity of the brick as the brick erodes, and the extent of off-center location of the recess in the different brick being different, whereby different brick remain stable at different angles.

7. A suspended furnace roof comprising hangers for brick which are arranged at different angles on different parts of the roof and refractory roof brick which at the time of installation are unfired, each roof brick having a hanger socket open from one lateral face of the brick, engaged by a hanger and imbedded in the body of the brick at an upper corner, the hanger socket being wholly on one side of the longitudinal axis of the brick when viewed from that lateral face and the recess in the hanger socket having a longitudinal axis which is wholly on one side of the longitudinal axis of the brick when viewed from that lateral face, the lateral limits of supporting engagement of the hanger within the socket embracing the vertical lines through the center of gravity of the brick as the brick erodes, whereby the tendency of the brick to rock is avoided, and the location of the socket recesses in the brick of respective groups being more pronouncedly off center toward the edge than toward the center of the roof, whereby the brick near the edge remain stable at a steeper angle of inclination.

RUSSELL PEARCE HEUER.

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