Feb. 12, 1957 R. P. HEUER 2,781,006

REFRACTORY WALL AND ROOF MAKING

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Fig. 1.

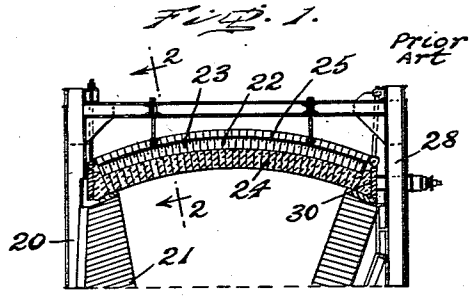


Fig. 2.

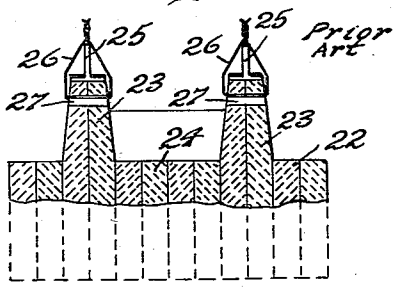


Fig. 3.

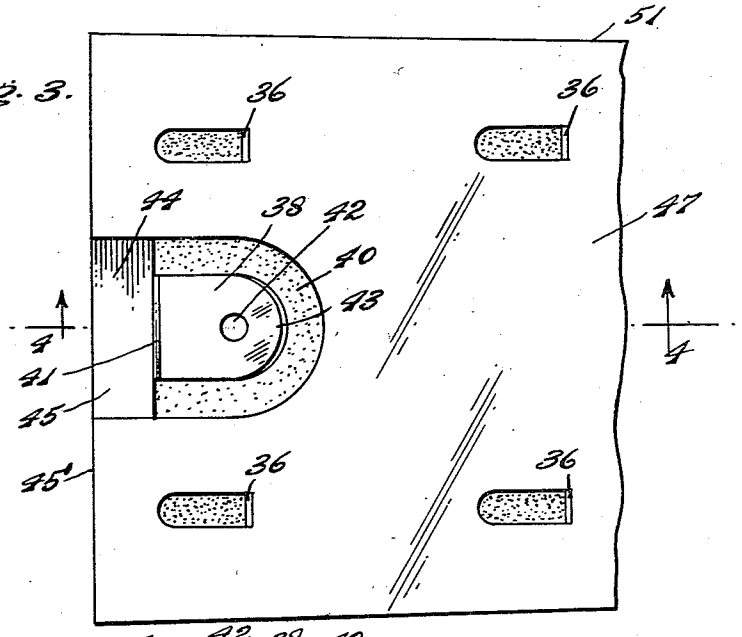
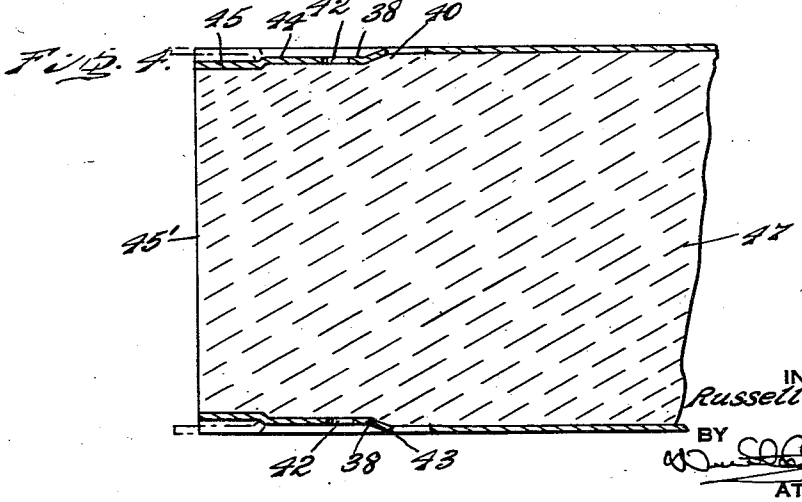


Fig. 4.



INVENTOR
Russell Pearce Heuer
BY
ATTORNEYS.

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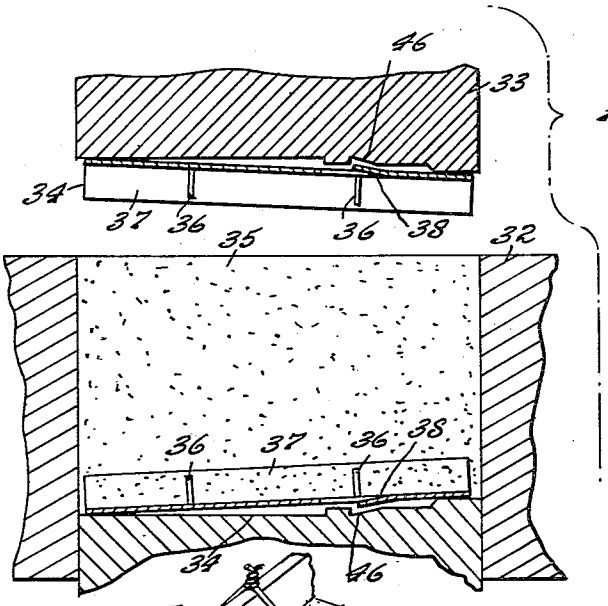


FIG. 5.

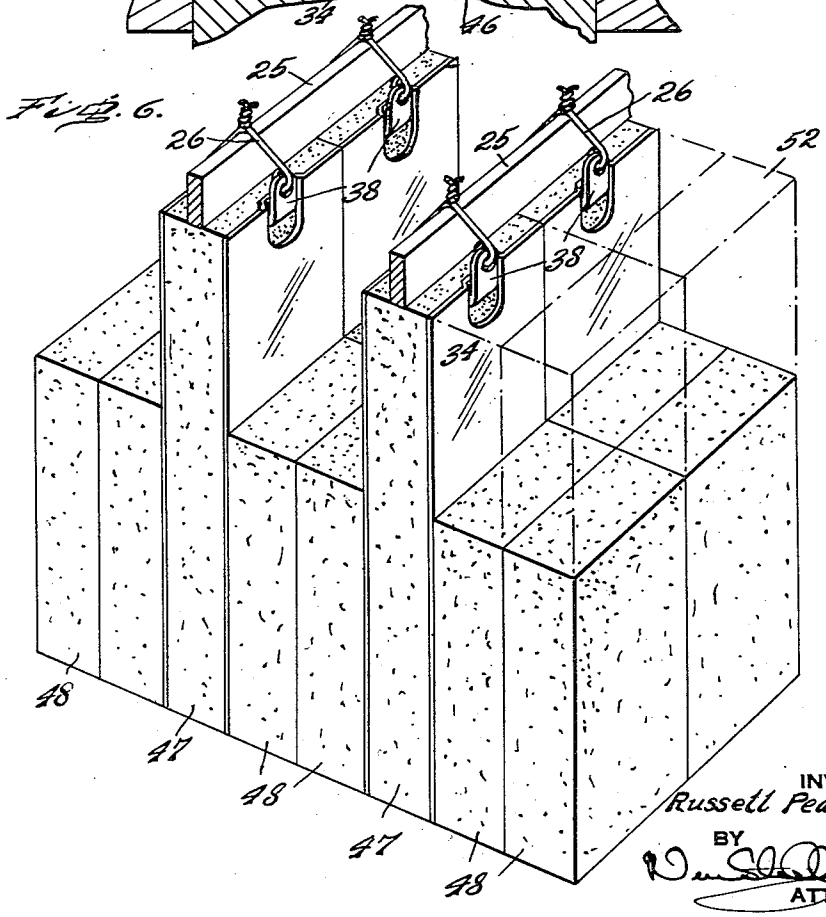


FIG. 6.

INVENTOR
Russell Pearce Heuer
BY
ATTORNEYS.

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Fig. 7.

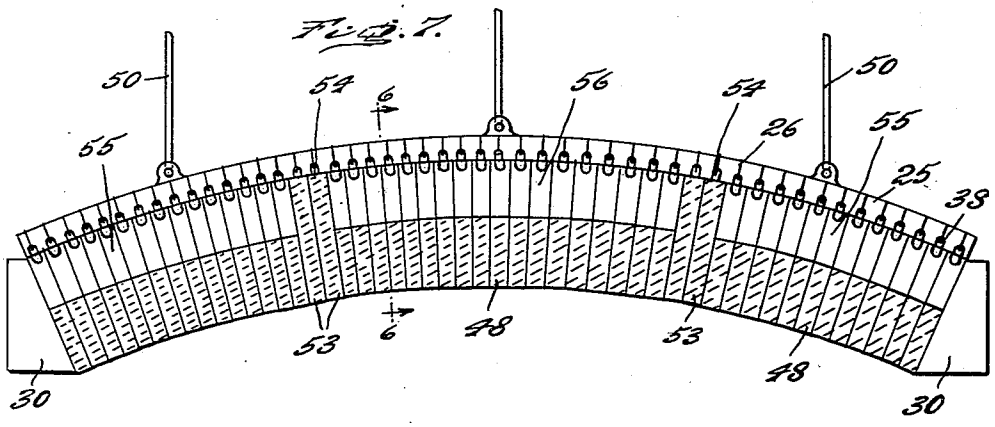


Fig. 10.

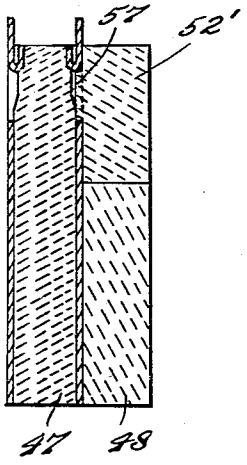


Fig. 8.

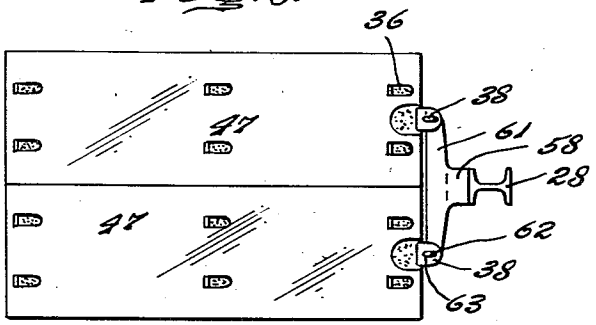
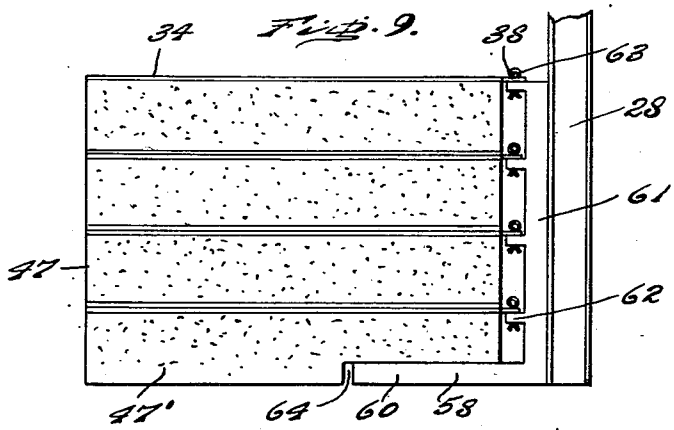


Fig. 9.



INVENTOR
Russell Pearce Heuer
BY
ATTORNEYS.

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2,781,006

REFRACTORY WALL AND ROOF MAKING

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

Application September 10, 1952, Serial No. 308,749

4 Claims. (Cl. 110—99)

The present invention relates to refractory structures employing basic refractory brick with comolded metallic surface plates and with mechanical means of support, and to methods of making the same.

A purpose of the invention is to provide a basic refractory brick with a comolded metallic surface plate having supporting means integral with the surface plate, preferably in the form of a hanger tab.

A further purpose is to support the brick by uniting the supporting means on the surface plate to a structural support by a hanger, which will desirably be formed of wire.

A further purpose is to provide the integral hanger means on the surface plate initially at a location within the confines of the brick, and then to bend or otherwise deform it to a position at which it is accessible to the hanger, suitably by reversely bending so that the hanger means protrudes out of a dished recess or well and also protrudes beyond the end of the brick.

A further purpose is to dish or depress a portion of the surface plate and to locate the hanger means in the dished or depressed portion so that during manufacture and shipment the hanger means does not extend beyond the confines of the brick and so is protected.

A further purpose is to provide hanger tabs or the like integral with surface plates on opposed sides of the brick, and capable of extending out from the sides at the same end of the brick.

A further purpose is to secure integral supporting means on surface plates of basic refractory brick extending beyond the end of the brick most distant from the heated face.

A further purpose is to construct a composite furnace roof using ribs consisting of at least one row of supported brick attached to supporting structure running above the same by hangers connected with hanger tabs integral with metallic surface plate on the brick and having an intervening row or rows of brick relatively shorter than those first mentioned and free from separate suspension, and permissibly to interpose between the relatively longer brick at the cold end supplemental brick which increases the thickness at any points where this is desired.

A further purpose is to place the surface metallic plate of the separately supported and longer brick in the transverse joints of the roof and desirably also to employ internal metallic plates in the same brick lying in a radial direction in the arc of the roof.

A further purpose is to provide auxiliary skewbacks to receive the supplemental brick where desired, the same being built into the rows of relatively shorter brick between the main skewbacks.

A further purpose is to provide lateral projections on the supplemental brick and to engage the same in lateral recesses of the metallic plates.

A further purpose is to extend hanger tabs or other supporting means integral with the metallic plates from one end of wall brick and to unite the same to supporting structure, desirably by pins connected to lugs.

A further purpose is to mold the hanger tabs into the brick by forming them on the surface plates before molding, applying pressure to the basic refractory through the surface of one plate or two opposite plates, imbedding projections in the refractory by comolding as the brick is formed and desirably at the same time forming a dished recess in the plate or each plate and in the adjoining refractory at the hanger tab location near one end and preferably extending to the end.

Further purposes appear in the specification and in the claims.

In the drawings I have chosen to illustrate a few only of the numerous embodiments in which my invention may appear, selecting the forms shown from the standpoints of convenience in illustration, satisfactory operation and clear demonstration of the principles involved.

Figure 1 is a fragmentary transverse section of an open hearth steel furnace of the general character in which the roof of the invention is employed.

Figure 2 is a fragmentary enlarged section on the line 2—2 of Figure 1.

Figure 3 is a fragmentary top plan view of a suspended brick of the character employed in the invention.

Figure 4 is a fragmentary section on the line 4—4 of Figure 3.

Figure 5 is a diagrammatic central vertical section showing the molding of a refractory brick according to the invention.

Figure 6 is a fragmentary sectional perspective of a roof according to the invention, the section being taken lengthwise, and corresponding to a section on the line 6—6 of Figure 7.

Figure 7 is an arcwise section of a roof of the invention.

Figure 8 is a top plan view of a refractory wall according to the invention.

Figure 9 is a fragmentary side elevation of the wall of Figure 8.

Figure 10 is a fragmentary longitudinal section of a furnace roof embodying a variation, and omitting the supporting structure and hanger for convenience.

In the prior art considerable use has been made of basic refractory brick and mechanical means of support in the construction of furnaces such as open hearth steel furnaces. This use includes construction of suspended roofs, walls and so-called suspended ends and slag pockets. This construction is typically shown in my U. S. Patents 2,154,813, 2,155,165 and 2,547,322.

Considerable use has also been made in the prior art of composite structures in which some of the brick are mechanically supported and some are sprung. Figures 1 and 2 illustrate a furnace 20 having a hearth 21 and a roof 22. The roof consists of rows of relatively elongated brick 23 extending arcwise of the furnace and having interposed rows of relatively short brick 24. The relatively long brick are desirably independently supported from overhead structure 25 suitably by hangers 26 (desirably bands of wire) which extend through hanger openings 27 in the brick 23 near the cold ends. The overhead structure 25 is supported from a steel framework 28.

The intermediate relatively shorter brick 24 are desirably sprung from skewbacks 30 at the front and back of the furnace. The destruction of the hot end of the brick is suggested by the dotted lines in Figure 2.

One feature of the composite structure as in Figures 1 and 2 is that the relatively shorter sprung arch brick 24 can be supplemented with additional brick applied at the cold end after the roof is partly consumed as shown in Figure 2. This supplemental brickwork increases the life of the roof.

It has been found by the present inventor that these

prior art constructions can be considerably improved. The relatively long brick in accordance with the present invention are made from basic refractory material, such as chromite, or magnesia or mixtures thereof well known in the art. A typical refractory composition is disclosed in my U. S. Patent No. 2,087,107.

It is desirable to use metallic plates in certain of the joints between the individually supported brick, and I prefer to employ the surface metallic plates in the transverse joints.

The refractory brick are preferably formed by comolding the metallic plates with the refractory mix and applying the molding pressure through the plates. This is shown desirably in Figure 5, in which a mold consists of a bottom die **31**, side walls **32** and a top die **33**, the top and bottom die relatively moving toward one another (in the form shown by downward movement of the top die) in the direction of the arrows. On one of the die faces, and preferably on both as shown, is placed an oxidizable metallic surface plate **34**, of any suitable metal which will oxidize and integrate with the basic refractory mass **35** of the brick.

The metal preferably used is steel or iron, including plain carbon steel and stainless steel, although permissibly on low temperature installations aluminum and copper may be employed. The plate is of sheet material, desirably having a thickness between approximately 1/32 inch and 1/4 inch depending on the installation.

At intervals over the surface of the plate and protruding in the direction of the refractory there are interlock projections **36** which are conveniently formed by lancing from the plate, and are comolded and united in the refractory.

In the preferred embodiment the surface plate is suitably connected as by welding to an internal plate or plates **37** which extends transversely from the surface plate preferably in line with the internal plate or plates extending from the opposite side. Each of the internal plates **37** desirably extends slightly less than one-half way through the brick. The question of whether there are holes in the internal plates **37** and interlock projections laterally therefrom, or both, is within the choice of the designer from the standpoint of the present invention.

The upper plate is suitably held on the upper die, desirably by a magnetic clutch not shown.

The detail of the formation of the brick with the internal plates is shown in my copending application Serial No. 301,942, filed July 31, 1952 for Refractory Roof. The internal plates preferably extend in a radial direction in the curved arch and on the radial joints plates are omitted, or merely wire mesh (not shown) is used.

The plates to be comolded are cut to size and if desired formed into U shape, and assembled with the internal plates if these are to be employed. In order to accomplish the molding operation the lower plate is placed in the empty mold at the bottom, the basic refractory material **35** is put on top of it, in the form of loose particles and then an upper plate is placed above the refractory material and suitably on the lower face of the upper die. The dies are brought together and apply molding pressure to the plates to form the brick.

In accordance with the present invention the plates are made with parts integral therewith which after molding form support means for the brick. A preferred way of accomplishing this is to stamp out from the plate when it is originally made a hanger tab **38** suitably adjoining one end, the hanger tab being desirably cut away from the sheet on 3 sides around a separation band **40**, but integrally united to the plate on one side **41**, preferably directed toward the adjoining end of the brick. The side **41** is adapted to form a fold line. The hanger tab desirably has a hanger opening **42** punched therein when it is made, and desirably has a deformed lip **43** at its free end which is accessible at the outside of the finished brick to pry up the tab.

The hanger tab is desirably located in a recess or well **44** formed in the plate and by comolding formed in the refractory, the recess resulting from deformation of the plate portion at **45** away from the major plane of the plate, preferably accomplished as part of the molding of the brick. The dies suitably have projections **46** which form the recess **44** and support the tab so that in molding it is extended along the bottom of the recess within the confines of the brick and remains that way when the brick is formed. This protects the hanger tabs from damage during manufacture and shipment of the brick. The recess preferably extends to the end **45'** of the brick.

Where desired the recess **44** can be preformed in the plates.

After the brick are molded and have reached the point of assembly, the hanger tabs are suitably bent reversely on one or both plates at the same end of the brick as shown, the bend being acomplished along the side **41** of the tab as shown in dot-and-dash lines in Figure 4. The length of the hanger tab with respect to the position of the bend and the location of the opening **42** is such that the tabs extend at the cold end beyond the end of the brick and the holes **42** are located beyond the end of the brick as shown in Figure 6.

The assembly into the roof structure as shown in Figure 6 is accomplished by extending rows of relatively elongated basic refractory brick **47** as just described preferably arcwise of the roof, and interposing one or more rows of relatively shorter brick **48** between the same. All of these brick have their major axes generally vertical.

The brick **47** according to the invention are suitably individually supported or suspended by extending hangers **26** (desirably loops of wire twisted at the ends) through the holes **42** in the upwardly extending hanger tabs and around the supporting structure **25**, which as shown in Figure 7 is desirably of arcuate form and will conveniently be interconnected to the main frame **28** of the furnace by suspending rods **50**.

It will of course be understood that the refractory brick are preferably key brick as indicated by the tapering radial sides **51** in Figure 3.

The intermediate shorter refractory brick **48** are desirably sprung from the skewbacks **30**.

In the construction of Figure 6 the metallic plates are present on the transverse joints between the elongated brick **47** and the shorter intermediate brick **48**, but are not present on the radial joints.

The roof is assembled by first placing a form in the furnace at the desired location. The brick are placed in the required position between skewbacks to form an arc in the shape of the form provided. After the brickwork is assembled, supporting bars are placed above those brick provided with the special supporting means. When the supporting bars are in position it is merely necessary to bend up the hanger tabs which are part of the surface plate on each side into a position where it can receive the hanger, thread the hanger through the openings in the two opposed tabs, wrap the ends of the wire around the support and twist the wire to tighten it. The individually supported brick are of substantially greater length than the brick which are supported wholly by the skewbacks, the brick **47** for example being 20 inches long and the intervening brick **48** about 12 inches long. The thickness of the brick will desirably be about 3 inches and the width about 6 inches at the top, and decreasing with the radial taper required to provide the necessary curvature (in Figure 6 this keying has been omitted for convenience in illustration).

During service the roof will become thinner and at a certain stage, when the unsupported brick have become about 3 inches thick, supplemental brick **52** are desirably placed above the sprung brick **48** as indicated by dot-and-dash lines (Figure 6). This will build up the outside contour of the roof approximately into line with the cooler ends of brick **47**.

By using the means of support in which the wires are placed in a location beyond the cool end of the brick, it is possible to obtain a greater thickness of the secondary course of brick and therefore make better utilization of the refractory structure. The supplemental brick introduced at **52** are preferably key-shaped similar to the shape used in the original sprung section and, of course, of dimensions suitable to accommodate themselves to the curvature of the arch. These supplemental brick should also be provided with comolded plates on the transverse joints and internally molded plates extending radially. Key shapes permit the roof to be placed at an angle to the horizontal for use in open hearth port roofs and the like.

The original courses of shorter brick **48** with the individual support are held in position by the main skewbacks of the furnace and the supplemental brick are also supported by such main skewbacks. It is preferred, however, to build auxiliary skewbacks **53** into the roof as shown in Figure 7 by extending brick **54** which form part of the courses with the brick **48** at the cool end to the same length as the individually suspended brick **47**. This then permits the insertion of a supplemental brick in the spaces **55** between one main skewback and the next auxiliary skewback, and also in the spaces **56** between two auxiliary skewbacks. Of course any desired number of auxiliary skewbacks may be placed across the arc. Likewise brick will, where desired, be placed in one of the positions **55** or **56** without necessarily being placed in another of the positions **55** or **56**, since certain parts of the roof are likely to wear more rapidly. The supplemental brick employed between one skewback and an auxiliary skewback or between two auxiliary skewbacks are desirably key brick which have comolded plates on the sides which form the radial joints, and these plates oxidize during use and expand to hold the supplemental brick tightly between the skewbacks.

In some cases it may be desirable to employ small projections on the side of a brick **48** to hold the supplemental brick against the elongated brick **47**. Thus in Figure 10 a supplemental brick **52'** is shown having a projection **57** which extends into the recess or well **44** near the top of the brick **47**. In forcing the projection **57** down from the top the tab **38** will permissibly yield slightly to allow the projection to enter the recess in the plate.

In all of the foregoing discussions I have indicated the use of basic refractory brick with comolded steel plates. For certain purposes the supplemental brick need not be basic refractory. Acid refractory such as silica can be used between the rows of basic refractory. The original roof can be constructed with rows of silica brick at **48** supported by the skewbacks between rows of individually supported basic refractory brick **47**. This will form the so-called Zebra construction which is much better than ordinary silica roofs for metallurgical furnaces. If the original shorter brick **48** supported wholly by the skewbacks are silica, the supplemental brick **52** will in some cases be silica. This practice is subject to modification by making the original shorter brick **48** supported by the skewbacks of basic refractory and the supplemental brick **52** of silica. The furnace in some cases will be constructed with parts of the roof basic and other parts exposed to less severe conditions of Zebra construction either on the original roof or in the supplemental sections which are placed in position after the roof has been in service.

The principles of the invention are applicable not only for suspended roofs but also for vertical and other types of walls, used for example in furnace ends and slag pocket sections. When used in vertical walls the major axis of the brick lies horizontal as compared to the vertical or radial position of the major axis of the brick in a roof.

Figures 8 and 9 show a structural support for a group of brick (8 are included in the portion shown). A structural support **58**, suitably of steel, has a foot **60** extending toward the interior of the furnace and a vertical

extension **61** which is provided at positions corresponding to the top of each brick with lugs **62** which have vertical openings interconnecting with the supporting or hanger tabs **38** through cotter pins **63** passing through the openings in the tabs and in the lugs. The structure suitably mounts two columns of brick **47**. The lowermost brick is a special brick **47'** which has a bottom recess **64** near the cool end which receives the foot **60** extending under each column of brick.

It is usually sufficient in a horizontal structure to bend out only the upper hanger tab on each brick, but it will be evident of course that where desired both the upper and lower hanger tab can be attached to the cotter pin **63**. The support **58** is secured to the furnace frame **28** as by bolting or mechanical fitting.

One of the important advantages of the invention is that the hanger tab when bent back lies within the major planes of the outsides of the plates **34** on the two sides of the brick, and therefore it does not tend to form a projection in the way of proper seating of adjoining brick.

It will be evident that curved sections can equally well be used by employing curved structural support and refractory brick with radial sides.

I am familiar with the fact that it has been proposed to use mechanically supported brick with a metal sheath, the sheath being provided with parts external to the brick itself and intended to be used as supporting means. Such brick were made by placing premolded brick in the sheath or by molding loose refractory into a preformed sheath. This presents difficulties in molding, however, and is unsatisfactory because the sheath is already in its intended form before pressing begins and no pressure can be exerted from a moving pressing die on the contained refractory through the external casing. I have found that it is necessary to comold the brick with metallic plates which are adaptable to a pressing operation which applies the pressure from a moving die through the metallic plates, the plates relatively moving in achieving their final intended form or relative position with respect to their position when introduced into the mold. The present invention permits the use of this desirable pressing operation and incorporates the support means integral with the comolded plates. Thus the final brick has desirable properties from proper pressing, and at the same time the comolded plate is intimately associated with and integrated to the brick by the comolded union of the projections and suitably also of the internal plate with the refractory.

When reference is made in the claims to the side surface or wall of the brick, it is intended to include the end surface or wall of 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 process and apparatus 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. A basic refractory brick comprising a body of basic refractory, an oxidizable metallic plate on one side surface of the brick comolded therewith, having projections from the plate united to the refractory by comolding, having a depressed well in the plate and the refractory at the side adjoining one end and having a hanger tab in the well which is integral with the plate, cut out therefrom around three sides and joined to the plate in the well at a side adjoining said end of the brick, the tab being adapted to be reversely bent, and when reversely bent having a length which extends beyond the adjoining end of the brick and having a hanger opening accessible beyond the end of the brick.

2. In a refractory roof, a plurality of spaced rows of relatively elongated basic refractory brick having their

major axes vertical and having oxidizable metallic plates comolded with the brick and united thereto on opposed side surfaces of each row, the plates having at the sides adjacent the upper ends recesses accessible at the sides and the upper ends, at least one row of first relatively short brick between the rows of relatively elongated brick, the top of relatively short brick in said rows of first relatively short brick being disposed below any of said plate recesses which are located at a position in the adjacent rows of said relatively elongated brick corresponding to the position of the supplemental relatively short brick herein below referred to, and at least one row of supplemental relatively short brick above the first relatively short brick between the rows of relatively elongated brick, the supplemental relatively short brick having projections engaging in the recesses in the plates of the relatively elongated brick.

3. In a refractory roof, a plurality of spaced rows of relatively elongated basic refractory brick having their major axes vertical and having oxidizable metallic plates comolded with the brick and united thereto on opposed side surfaces of each row, the plates having at the sides adjacent the upper ends recesses accessible at the sides and the upper ends, and having hanger tabs integral with the plates extending upward from the recesses, supporting structure above the rows of relatively elongated brick, hangers connecting the hanger tabs and the supporting structure, at least one row of first relatively short brick between the rows of relatively elongated brick, the top of relatively short brick in said rows of first relatively short brick being disposed below any of said plate recesses which are located at a position in the adjacent rows of said relatively elongated brick corresponding to the position of the supplemental relatively short brick herein below referred to, and at least one row of supplemental relatively short brick above the first relatively short brick between the rows of relatively elongated brick, the supplemental relatively short brick having projections engaging in the recesses in the plates of the relatively elongated brick.

4. A basic refractory brick comprising a body of basic refractory, a metallic plate on a side surface of the brick comolded therewith, having projections from the plate united to the refractory by comolding, having a depressed well in the plate and the refractory at the side adjoining one end and having a hanger tab in the well which is integral with the plate, cut out therefrom apart from being joined to the plate in the well adjacent said end of the brick, the tab being adapted to be reversely bent, and when reversely bent having a length which extends beyond the adjoining end of the brick and accessible beyond the end of the brick.

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