July 8, 1924. 1,500,240

R. E. GRIFFITH

FURNACE ROOF CONSTRUCTION

Filed Nov. 3, 1922 3 Sheets-Sheet 1

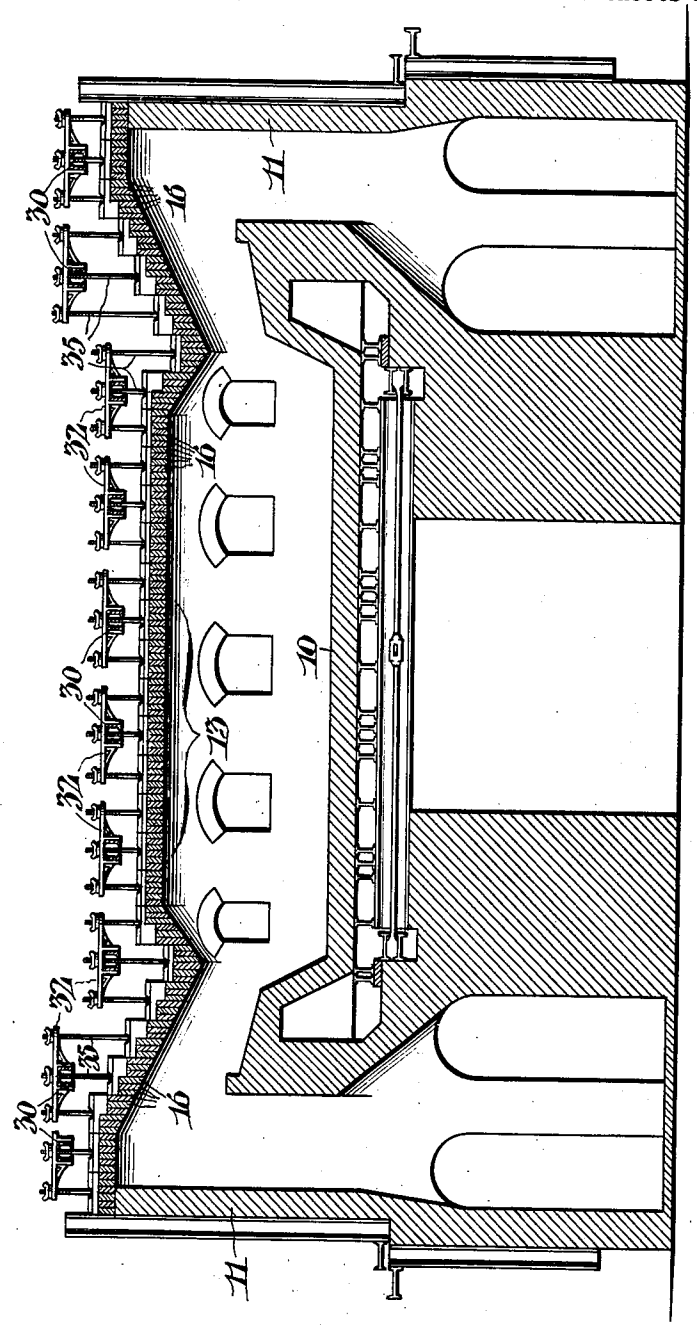

FIG. 1.

WITNESSES:
John C. Bergner
Alfred E. Stechinger

INVENTOR:
Raymond E. Griffith,
BY Fraley & Paul
ATTORNEYS.

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FURNACE ROOF CONSTRUCTION

Filed Nov. 3, 1922 3 Sheets-Sheet 2

FIG. II.

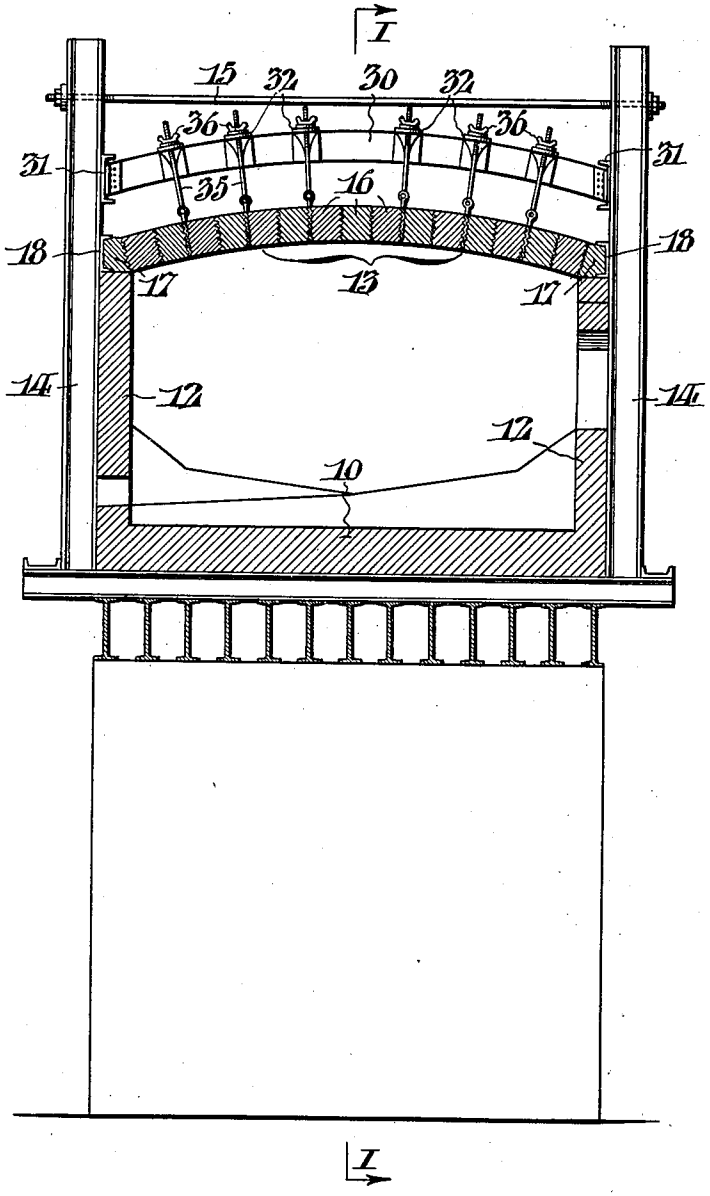

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FIG. III.

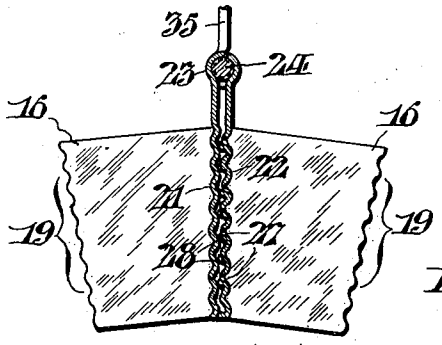


FIG. V.

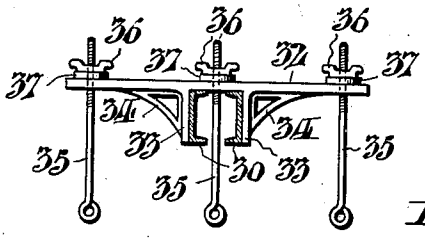
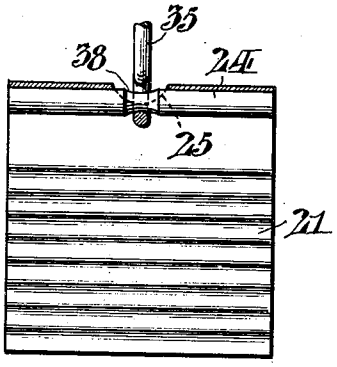


FIG. IV.

FIG. VI.



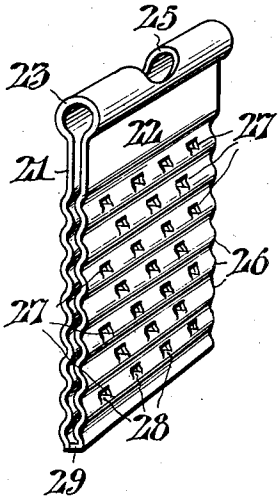


FIG. VII.

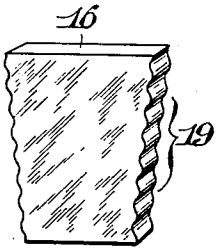
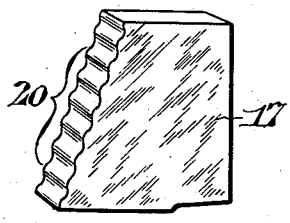


FIG. VIII.



WITNESSES:

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Patented July 8, 1924. 1,500,240

UNITED STATES PATENT OFFICE.

RAYMOND E. GRIFFITH, OF PHILADELPHIA, PENNSYLVANIA.

FURNACE-ROOF CONSTRUCTION.

Application filed November 3, 1922. Serial No. 598,754.

To all whom it may concern:

Be it known that I, RAYMOND E. GRIFFITH, a citizen of the United States, residing at Philadelphia, county of Philadelphia, and State of Pennsylvania, have invented certain new and useful Improvements in Furnace-Roof Construction, of which the following is a specification, reference being had to the accompanying drawings.

This invention relates to the construction of metallurgical furnaces, and more particularly to the roof construction of high temperature furnaces, such as basic open hearth and electric steel furnaces, reverberatory copper smelting and other types of furnaces where chemical action is destructive to the refractory roofs and linings.

An object of the invention is to permit the construction of furnace roofs of refractory brick of a chemical constitution having capacity to resist the corrosive action of slag and furnace gases but which have heretofore been discarded for such use in favor of brick of greater physical strength but which are not resistant to corrosive action.

The invention contemplates the provision of structural details for the purpose of accomplishing the above stated objects, which consists in bonding elements inserted between the bricks in the course of roof construction to permit expansion and contraction of the roof without disintegration when heating and cooling, and a novel suspension means whereby the roof structure is supported from above at selected or salient points against internal strains due to its own weight and so that the roof may remain intact even when fractured or partly disintegrated.

Another object of the invention is to provide refractory brick for the roof construction of metallurgical furnaces in which the bonding faces are so formed as to permit interlocking of the brick and hence the mutual support thereof so as to ensure a solid structure capable in a high degree of resisting disintegration.

The inventive concept involved in the performance of the certain objects outlined above is capable of receiving a variety of mechanical expressions, one of which for the purpose of illustrating the invention is shown in the accompanying drawings, but it is to be expressly understood that such drawings are for the purpose of illustration only and are not designed to define the limits of the invention, reference being had to the appended claims for this purpose.

In addition to the foregoing this invention comprehends improvements in the details of construction and arrangement of the correlated parts to be hereinafter described and illustrated by reference to the accompanying drawings, in which Figure I is a view in longitudinal section of an open hearth furnace of conventional type having a roof structure embodying my improvements.

Figure II is a view of the furnace in transverse section.

Figure III is a detail view in section of a combined expansion plate and suspension member forming part of the present invention and illustrating its cooperative relation to the brick of a roof structure.

Figure IV is a view in perspective of one of the expansion plate hangers.

Figure V is a view in elevation of a hanger yoke forming part of a suspension unit.

Figure VI is a view in longitudinal section of an expansion plate hanger, and a portion of a supporting member.

Figure VII is a view in perspective of an arch block used in roof construction; and

Figure VIII is a view in perspective of a skew back block forming part of the end construction of a roof span.

In the usual type of roof construction for furnaces wedge-shaped refractory brick are employed to form an arched roof spanning the entire width of the furnace and supported solely by virtue of inherent stability residing in arched construction, the end thrust of the roof being taken up and confined within heavy metallic columns stayed together so that any expansion of the roof occurring must necessarily result in upward bowing of the roof, since the confining structure mentioned prohibits any lateral expansion of the roof. Owing to the tremendous strains to which the roof is subjected during expansion, a type of building unit or brick is employed which will resist the compression strains and for this reason silica brick is usually used. This material is however open to the objection that because of the acid constitution of such brick they are easily corroded and disintegrated by the reaction of molten basic slag or the pene-

trating corrosive laden gases of the basic open hearth and other melting and smelting furnaces. The present invention contemplates the utilization of refractories which are more resistant to chemical action among which may be mentioned magnesite and chrome brick, which however have failed of extensive adoption by reason of their physical weakness and incapacity to efficiently withstand compressional strain.

The principles of construction employed in the use of this type of refractory material include the support by suspension of the roof structure so as to relieve internal compression due to end thrust at the sides of the roof, and the bonding of the brick so as to permit expansion or contraction of the bond itself without subjecting the brick to the strain of heat expansion.

The exact means whereby the above stated principles are carried out may be varied and hence I have therefore shown one illustration only which will be sufficient to indicate to others skilled in the art the manner of employment of the apparatus and to suggest any alterations that may be necessary to meet the requirements of specific instances of usage.

Proceeding to a description of the drawings 10 indicates the hearth of a conventional form or reverberatory open hearth steel furnace including the end walls 11, the side walls 12 and the roof structure indicated comprehensively at 13. The sides of the furnace structure are supported by the provision of opposed pairs of longitudinally spaced buck stays 14 tied together by means of the rods 15 in the usual manner.

The roof structure, in accordance with the usual method is formed of refractory arch blocks 16 of wedge formation assembled to form an arched or upwardly bowed roof which is supported along its edges upon skew back blocks 17 rested upon the walls 12 and abutting against longitudinal channel beams 18 which are enclosed by the buck stays 14. The brick 16 may be of the usual type of basic refractory material having smooth sides, but for the purpose of my invention are preferably corrugated along their bonding faces by the formation therein of transverse ridges and grooves 19 so as to cause interlocking of the brick when assembled. In a similar manner the bonding faces of the skew back blocks 17 are corrugated as at 20 for interlocking engagement with the adjacent blocks of the span. By reason of the interlocking engagement of the brick the structure is rendered self sustaining and more resistant to disintegration, since upon fracture thereof the fragments will tend to remain in place.

In conjunction with this type of roof construction I employ what I term expansion bonding plates which are also utilized as hanger members forming part of a suspension rigging to be described. The suspension plates and the manner of their use are shown in Figures III, IV and VI from which it will be noted that they consist of a strip of metal, of any kind found suitable for the purpose and bent transvesely to form spaced plates 21 and 22. The point of flexure of the strip is rounded to cylindrical formation as shown at 23 to permit a pin or rod 24 to be inserted therein, said portion 23 being cut away to form an opening 25 for a purpose to be presently noted. The plates 21 and 22 are corrugated to provide transverse ridges and grooves 26 for interlocking and intimate bonding engagement with the grooved faces 19 of the refractory elements. One of the plates, shown in the drawing at 22 is punched at frequent intervals to form uncompleted openings 27 the remaining portions of the metal being bent inward to form yielding spacing lips 28; and the end of one of the plates, namely 22 in the instance given is bent laterally to form a rib 29 which contacts with the adjacent end of the other plate to retain said plates in spaced relation and to form a fusible seal.

During the construction of the roof one of the bonding elements is interposed between adjacent bricks 16 at points which are deemed salient in resisting gravity to effect a substantial support for the roof, in transversely spaced relation as seen in Figure II, and in longitudinal spaced relation as shown in Figure I. It will be noted from Figure I that the hangers in any longitudinal course are arranged in end to end engagement and at varying levels to conform to the shape of the roof.

The suspension rigging consists of a plurality of lateral supporting beams 30 arranged in longitudinal spaced relation to a number sufficient to ensure ample support for the structure and preferably curved to follow the contour of the roof span. The ends of said beams 30 abut against and are supported by longitudinal beams 31 secured to the inner faces of the buck stays 14 at the proper elevation.

Supported upon the transverse beams 30 are a plurality of hanger yokes shown in detail in Figure V and comprising a plate 32 formed with depending spaced flanges 33 to engage opposite sides of the beam 30, which may be either of unit construction or composed of two channel irons as shown. The flanges 33 are strengthened by the provision of ribs 34 integrally connecting said flanges and the bar 32, the latter being apertured at spaced points to receive the threaded ends of vertical eye bolts 35 having their looped ends depending to enter the openings 25 of the bonding elements and to

receive the hinge pins or rods 24. By means of this arrangement the expansion plates are supported in groups of three, although the number may be varied or the manner of grouping may be otherwise varied to conform to the requirements of specific circumstances.

A wing nut 36 is applied to the protruding threaded end of each eye bolt and washers 37 are interposed between the wing nuts and the upper faces of the bars 32, so that by rotating the wing nuts the expansion plates or bonding elements may be elevated or lowered either during the construction of the roof or for a purpose to be presently described.

Each pin or rod 24 may be formed with a reduced portion 38 at a point embraced by the loop of the eye bolt so as to ensure centralization of the parts as shown in Figure VI. After the roof structure is completed and the parts assembled, and during the gradual heating of the furnace the roof expansion is taken up by yielding of the spacing lips 28 which permit the blocks to expand and the plates 21 and 22 to move together without inducing any compressional strains in the blocks themselves. Before the maximum operating temperature of the furnace is reached the lip 29 of each hanger will fuse and the metal will unite with the surface of the adjacent blocks to form a seal at the side of the roof exposed to the heat of the furnace, and the roof structure will thus be thoroughly sealed and rendered impervious to the escape of gases and supported efficiently without permitting internal strains which may tend to fracture the refractory material. If, however the joints between the bricks at one or more points should not have been properly sealed by fusion of the metal, nor the roof sufficiently expanded to close the joints an effective sealing and compactness of the structure may be procured by loosening the wing nuts 36, to an amount required in order to permit the roof to move downward slightly or to settle far enough to close the joints, without entirely relieving the supporting rigging of the weight of the roof, so that the rigging may still sustain a sufficient proportion of the total weight of the roof and thereby avoid crushing of the brick. By adjusting all of the wing nuts a general raising or lowering of the roof may be accomplished, or a local change in elevation of any portion of the roof may be effected by judiciously adjusting the nuts of the hangers supporting that portion of the roof to be affected. Because of the corrugated surfaces of the hanger plates an efficient bond is ensured between the blocks and hanger plates tending to prevent the roof material from falling away from the hanger plates. By appropriate adjustment of the wing nuts 36 wherever deemed necessary the weight of the roof may be equally distributed throughout the supporting rigging and excessive strains at any point in the roof may be taken up in this manner.

From the foregoing it will be seen that relatively soft or friable brick may be used in furnace roof construction as the expansion plates or bonding elements will effectively act to relieve the brick of all strain during heat expansion of the structure. In fact the brick is relieved of all strain even that incidental to the weight of the structure since the rigging will support the weight of the roof thus relieving the roof of end thrust at the ends of the span which is present in ordinary arch construction having only end supports for the roof.

During the operation of furnaces it frequently develops that cracks originate and spread along the roof causing the release of large pieces which fall into the furnace resulting in serious losses and delay. It will be seen that with my improved construction this disadvantage will be largely eliminated as any portion that may crack away from the main portion of the roof will be held in place between the expansion hangers or between the hanger and an adjacent brick, the corrugations between the brick or between the brick and hangers effecting sufficient mechanical bond.

Other advantages will readily occur to those familiar with the art to which this invention appertains.

Having thus described my invention, I claim:

1. In a metallurgical furnace, a roof structure composed of refractory elements, noncombustible inserts between the refractory elements to permit expansion of the structure by heat with the imposition of minimum strain within the elements, and means supporting the roof structure against internal strains incidental to its own weight.

2. In a metallurgical furnace, a roof structure composed of refractory elements, noncombustible yielding means inserted between the elements to permit expansion of the structure by heat with the imposition of minimum strain within the elements, and means supporting the roof structure against internal strains incidental to its own weight.

3. In a metallurgical furnace, a roof structure composed of refractory elements, means effecting bonding engagement with the adjacent faces of said elements, and yielding means interposed between said last mentioned means to permit expansion of the structure by heat with the imposition of minimum strain within the elements, and means supporting the structure against internal strains incidental to its own weight.

4. In a metallurgical furnace, a roof structure composed of refractory elements, a cor-

rugated bonding element inserted between the faces of the adjacent elements having capacity to permit expansion of the structure by heat with the imposition of minimum strain within the elements, and means engaging said bonding elements to support the roof structure agaist internal strains incidental to its own weight.

5. In a metallurgical furnace, a roof structure composed of refractory elements, a bonding element inserted between the faces of adjacent elements comprising plates adapted for intimate bonding connection to said elements, yieldable spacing elements formed with one plate and engaging the other to retain said plates in spaced relation and thereby permit expansion of the structure by heat with the imposition of minimum strain within the elements, and means supporting the structure against internal strains incidental to its own weight.

6. In a metallurgical furnace, a roof structure composed of refractory elements, a bonding element inserted between the faces of adjacent elements, comprising a strip of material bent to form spaced plates, said plates being corrugated to effect intimate bonding connection to said elements, one of said plates being formed with integral yieldable lips engaging the other plate to retain said plates in spaced relation and thereby permit expansion of the structure by heat with the imposition of minimum strain within the elements, and means supporting the structure against internal strains incidental to its own weight.

7. In a metallurgical furnace, a roof structure composed of refractory elements, a bonding element inserted between the faces of adjacent elements comprising a strip of metal bent upon itself to form spaced plates, said plates being corrugated to effect intimate bonding connection to the elements and one of said plates being punctured to provide inwardly extending yieldable lips retaining the plates in spaced relation, to thereby permit expansion of the structure by heat with the imposition of minimum strain within the elements, pins inserted in the bights of said bonding elements, and a suspension rigging located above the roof and engaging said pins to support the structure against internal strains incidental to its own weight.

8. In a metallurgical furnace, a roof structure composed of refractory elements, and non-combustible yieldable bonding elements interposed between the refractory elements to permit expansion of the structure by heat with the imposition of minimum internal strains.

9. In a metallurgical furnace, a roof structure composed of refractory elements, and bonding elements inserted between said refractory elements, composed of plates adapted for effective bonding connection to said refractory elements, and yieldable spacing means between the plates to give way under expansion of the structure by heat and to reduce internal strains to a minimum resulting from such expansion.

10. In a metallurgical furnace, a roof structure composed of friable refractory elements having their bonding faces wholly and transversely corrugated, and a suspension means engaging the roof structure at salient points along the span to support the structure against internal strains incidental to its own weight.

11. In a metallurgical furnace, a roof structure composed of friable refractory elements having their bonding faces wholly and transversely corrugated, and a suspension rigging mounted above the structure and having connections to said roof structure at points across the span and longitudinally of the structure to support the same against internal strains incidental to its own weight.

12. In a metallurgical furnace, including the side walls and buck stays, a roof structure of friable refractory elements having the bonded faces wholly and transversely corrugated, and a rigging comprising lateral beams supported upon the buck stays in longitudinal spaced relation, and hanger elements arranged at salient points along the span to resist gravity and having effective hinged engagement with the roof structure to support the latter against internal strains incidental to its weight.

13. In a metallurgical furnace, including side walls and vertical buck stays, a roof structure composed of friable refractory elements having the bonding faces wholly and transversely corrugated, a suspension rigging supported by the buck stays, and transversely corrugated hanger members forming part of said suspension rigging engaging the roof structure and adapted to raise or lower said roof structure to effect structural compactness.

14. In a metallurgical furnace, a roof structure composed of friable refractory elements having the bonding faces wholly and transversely corrugated, a rigging above the structure to support the same including transversely corrugated hanger elements engaging the roof structure at salient points to resist gravity, and means for permitting vertical adjustment of said hanger elements independently to effect local raising or lowering of the structure to ensure compactness.

15. In a metallurgical furnace, including side walls and buck stays, lateral beams supported upon the buck stays, and transversely corrugated hanger elements carried by said beams including depending rods having hinged engagement with the roof structure at salient points to resist gravity, and adjustable elements for threaded con-

nection to said rods adapted to effect local or general raising or lowering of the roof structure.

16. In a metallurgical furnace, a roof structure composed of refractory elements in bonded relation having the bonding faces wholly corrugated for interlocking engagement to render said roof structure self sustaining.

17. In a metallurgical furnace, a roof structure composed of refractory elements in bonded relation having their meeting faces wholly and transversely corrugated to effect interlocking of the elements.

18. A hanger for the roof suspension of metallurgical furnaces, comprising a transversely corrugated and flexible bonding element adapted to be incorporated in the roof structure, and a supporting element hingedly connected to said bonding element having capacity to effect vertical adjustment of said element when the parts are assembled and supported.

19. A hanger for the roof suspension of metallurgical furnaces, comprising a bonding element in the form of connected spaced plates having yieldable spacing means and adapted to be incorporated in the roof structure, and a supporting rod having a threaded adjustable element for cooperation with any suitable support to effect vertical adjustment of said bonding element.

20. A hanger for the roof suspension of metallurgical furnaces, comprising a bonding element adapted to be incorporated in the roof structure and comprising a U-shaped metallic plate having yieldable spacing elements therebetween, a pin inserted in the bight of the plate, an eye bolt having its loop receiving said pin and its opposite end threaded, and a nut applied to said end.

21. A bonding element for interposition between the refractory brick of a roof structure for furnaces, comprising spaced members adapted for intimate bonding engagement with the adjacent faces of the brick and yieldable means retaining said members in spaced relation.

22. A bonding element for interposition between adjacent brick of a furnace roof structure, comprising a plate bent to U-formation and corrugated to effect intimate bonding engagement with the brick, one of said plates being punctured to provide yieldable lips engaging the other plate to retain said plates in spaced relation.

23. A bonding element for interposition between brick of a furnace roof structure, comprising plates, means retaining the plates in spaced relation, and a fusible lip closing the space between the plates and adapted to fuse and close the space when heated.

24. A building block for the roof construction of metallurgical furnaces having its bonding faces wholly and transversely corrugated to provide interlocking engagement of the blocks.

In testimony whereof, I have hereunto signed my name at Philadelphia, Pennsylvania, this 31st day of October 1922.

RAYMOND E. GRIFFITH.

Witnesses:
JAMES H. BELL,
E. L. FULLERTON.