Jan. 18, 1938. L. M. BEALL 2,105,804

ARCH AND WALL CONSTRUCTION

Filed June 11, 1934 3 Sheets-Sheet 1

Fig. 1.

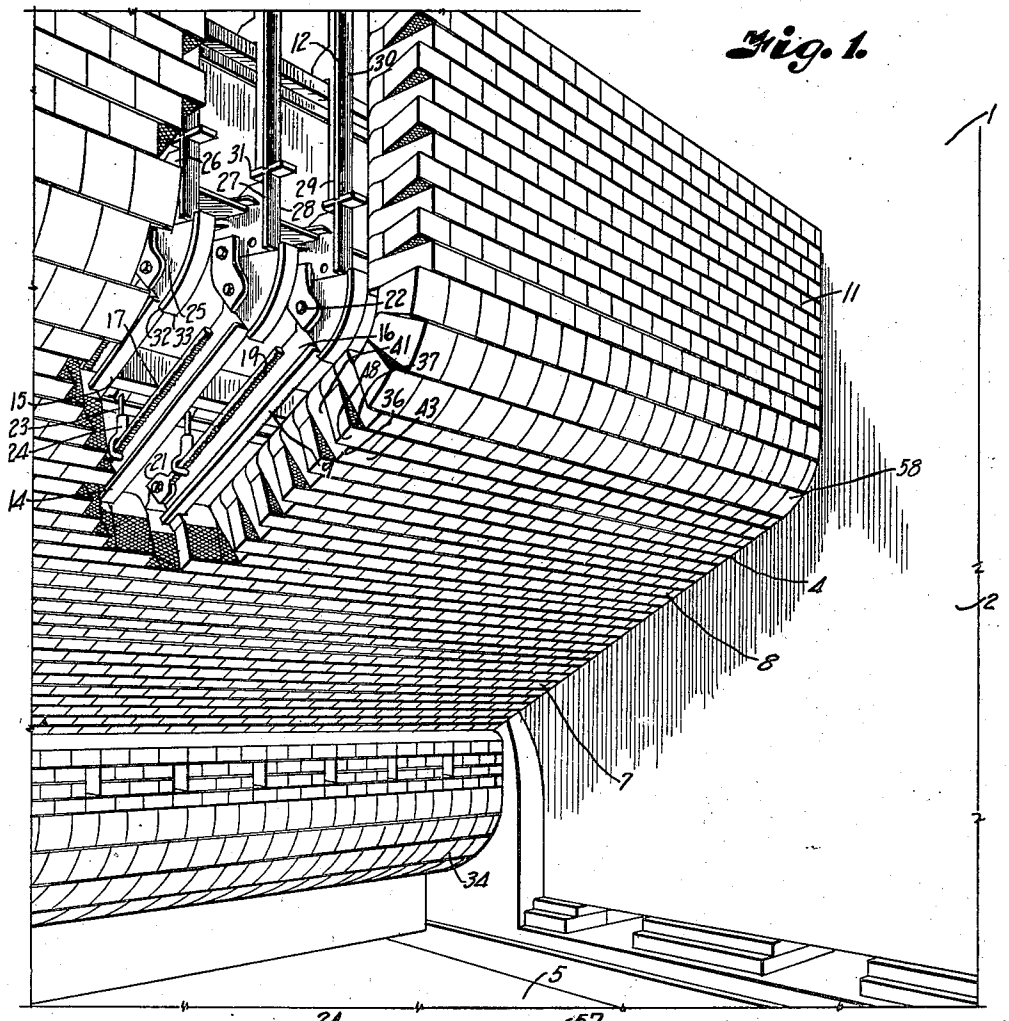
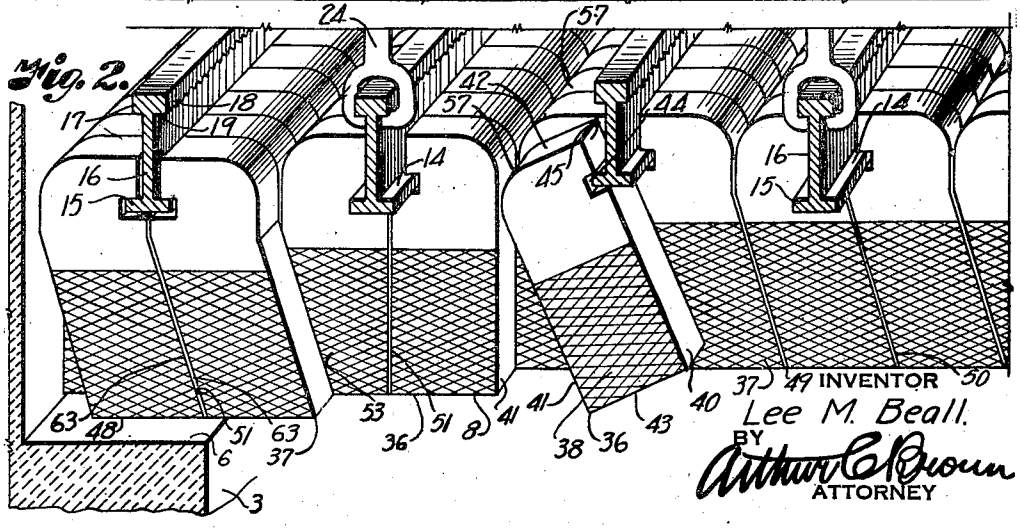


Fig. 2.



INVENTOR
Lee M. Beall.
BY
Arthur C. Brown
ATTORNEY

Jan. 18, 1938. L. M. BEALL 2,105,804

ARCH AND WALL CONSTRUCTION

Filed June 11, 1934 3 Sheets-Sheet 2

Fig. 5.

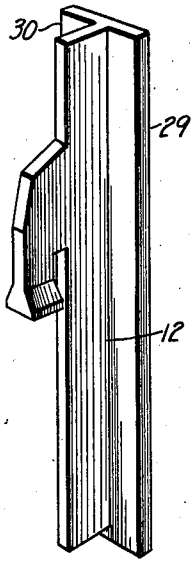


Fig. 4.

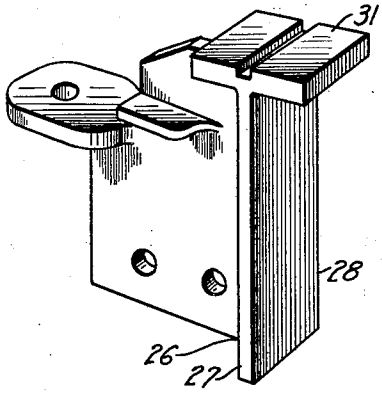
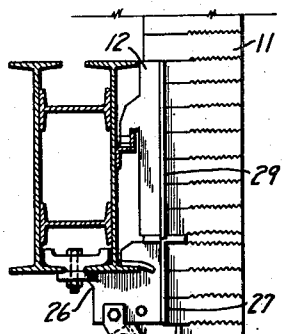


Fig. 3.



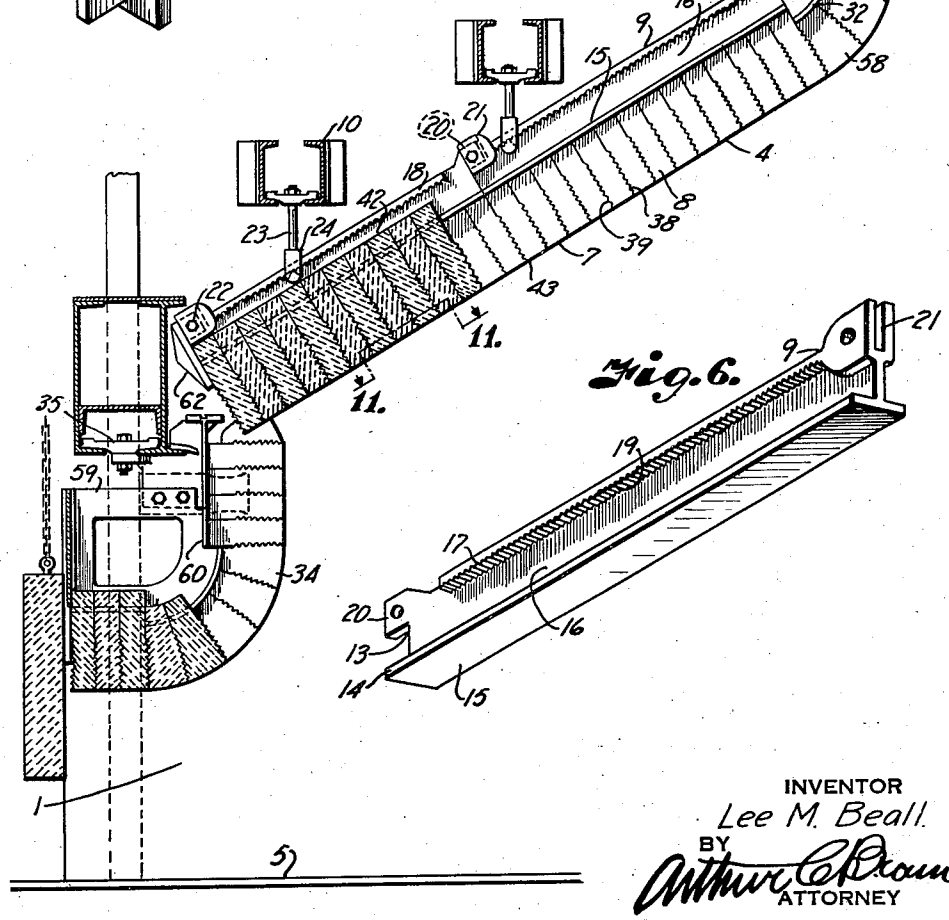


Fig. 6.

INVENTOR
Lee M. Beall
BY
Arthur C. Brown
ATTORNEY

Jan. 18, 1938. L. M. BEALL 2,105,804

ARCH AND WALL CONSTRUCTION

Filed June 11, 1934 3 Sheets-Sheet 3

Fig. 7.

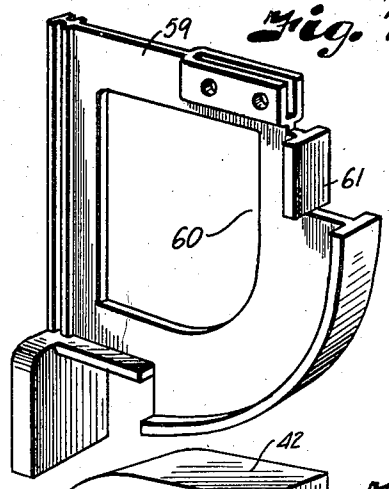


Fig. 8.

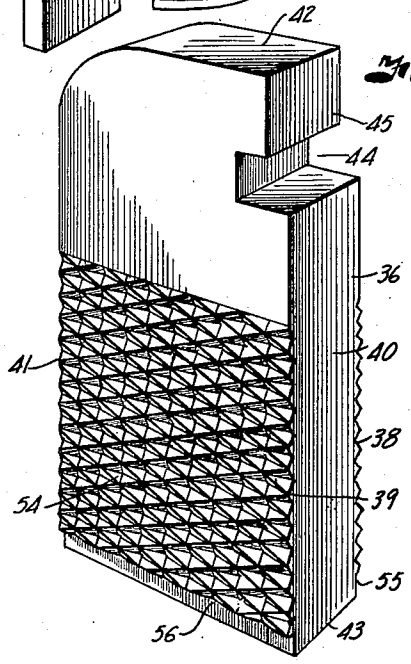


Fig. 9.

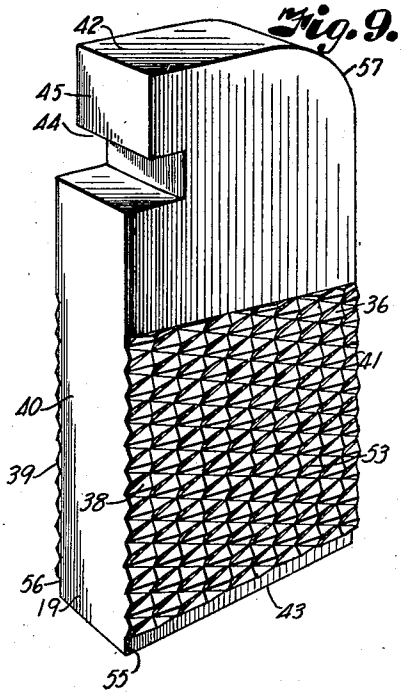


Fig. 10.

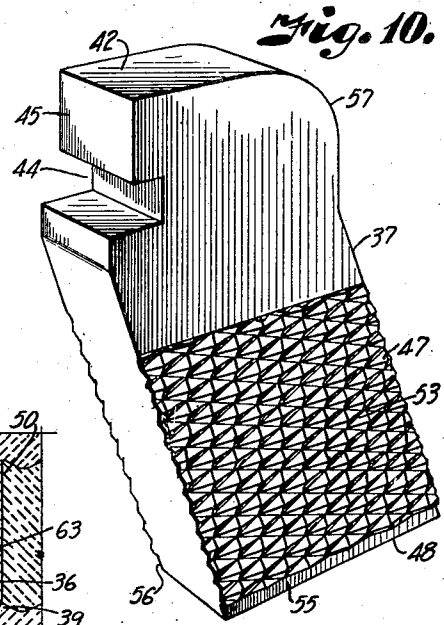
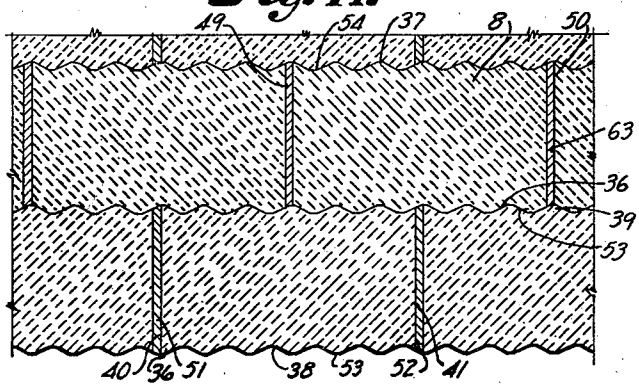


Fig. 11.



INVENTOR

Lee M. Beall.

BY

Arthur E. Brown

ATTORNEY

UNITED STATES PATENT OFFICE

2,105,804

ARCH AND WALL CONSTRUCTION

Lee M. Beall, Tulsa, Okla.

Application June 11, 1934, Serial No. 730,003

10 Claims. (Cl. 110—99)

This invention relates to arch and wall constructions and particularly to the arches and refractory walls of fire boxes in boiler or like furnaces.

Refractory arches and walls as heretofore constructed require repair and replacement after periods of intense furnace operations. Such repair is not only expensive in itself, but also increases cost of power plant operation, due to tying up of the power plant equipment during the outage periods.

I have found that rapid deterioration of the refractory walls is brought about in considerable measure by mechanical conditions produced in the fire box and acting to effect disintegration of the refractory material at temperatures below that of their softening point. For example, expansion and contraction under changing temperature conditions causes cracking and dropping off of portions of the refractory elements, leaving pockets which are rapidly increased in size because of spalling off of unsupported adjacent portions and by erosion produced by the increased turbulent effect of the gases playing in the pockets.

The slag collecting on and running down the refractory surfaces further wears away the refractory elements and may bridge the joints to such an extent as to interfere with the normal expansion and contraction of the fire box and the refractory elements.

It is, therefore, the principal object of the present invention to provide a refractory construction which will better withstand these ravaging effects within a fire box, thereby prolonging the operation periods of a furnace.

Other important objects of the invention are to provide a bonded tile arrangement in an arch, to facilitate installation and replacement of the refractory elements, to reduce cracking tendency of the elements under expansion and contraction, to prevent dropping out of portions of the elements, to prevent adjacent tiles from welding together, to prevent channelling effects of the slag, and to prevent fusing of the slag with the refractory elements at the joints.

In accomplishing these and other objects of the invention, I have provided improved details of structure, the preferred form of which is illustrated in the accompanying drawings, wherein:

Fig. 1 is a perspective view of the interior of a fire box equipped with refractory wall and arch construction embodying the features of the present invention.

Fig. 2 is an enlarged detail perspective sectional view through one side of the arch particularly illustrating the bonding of the refractory elements.

Fig. 3 is a vertical longitudinal section through the arch portion of the fire box.

Fig. 4 is a detail perspective view of one of the hanger castings.

Fig. 5 is a detail perspective view of one of the T bars for supporting the girder protection section of the arch.

Fig. 6 is a detail perspective view of one of the hanger sections for supporting the inclined portion of the arch.

Fig. 7 is a detail perspective view of one of the ignition arch tile hangers.

Fig. 8 is a detail perspective view of one of the straight refractory elements.

Fig. 9 is a similar view of the refractory element as viewed from the opposite side.

Fig. 10 is a similar perspective view of one of the angular refractory elements.

Fig. 11 is an enlarged detail section on the line 11—11, Fig. 3, particularly illustrating the bonding of the refractory elements and the gasket material inserted between the elements to prevent welding together of adjacent elements.

Referring more in detail to the drawings:

1 designates the fire box of a furnace such as employed in the firing of large boilers as used in commercial power plants and which includes side walls 2 and 3 and a fire arch 4 which extends across the fire box above a grate 5, as in conventional furnace design.

The side walls 2 and 3 of the fire box are lined with refractory material comprising blocks or tiles laid up in bonded relation in substantially the same manner as the brick on the exterior side and have their upper portions shaped to provide upwardly and rearwardly inclined ledges 6 conforming to the side contour of the arch 4 and whereon the sides of the arch overlap as shown in Fig. 2.

The arch 4 includes an inclined portion 7 which is also assembled from refractory blocks or tiles 8 and suspended in juxtaposed relation from hanger members 9 that are suspended or supported from girders 10 forming part of the structural frame work of the furnace. The arch also includes an upwardly extending girder protection section 11 comprising similarly assembled refractory tiles anchored to vertically positioned bars 12 in line with the hanger members 9, as best illustrated in Figs. 1 and 3.

The hanger members 9 include cast sections 13 of I-shaped cross section to provide laterally

extending tile supporting flanges 14 and 15, a central web 16 and ribs 17 and 18 having toothed lower faces 19. The respective sections are secured together to make the desired length hangers by providing the ends thereof with a tongue 20 and a socket 21, respectively. In the illustrated instance, the hanger members include two sections secured together by a bolt or the like 22 extending through the tongue and socket connection therebetween.

The lower ends of the hanger members thus constructed are suspended from the cross girders 10 by means of rods 23 which carry stirrups 24 engaging the teeth 19 of the ribs 17 and 18, while their upper ends are secured to arcuate shaped castings 25 supporting the nose of the arch as later described, the castings 25 being in turn supported by hanger castings 26 attached to the upper cross girder 10 which carries the girder protection section of the arch.

The castings 26 include vertical flanges 27 and 28 aligning with corresponding vertical flanges 29 and 30 on the bars 12 which have their lower ends extending above shelves 31 on the castings 26. The shelves 31 support the tiles which form the girder protection section 11 so that the nose and inclined portion of the arch can be replaced without disturbing the girder protection section.

The nose castings 25 include arcuate segments having tile supporting flanges 32 and 33 corresponding with the tile supporting flanges previously described.

It is a purpose of the present invention to avoid rapid deterioration of the arch by providing an improved form of tile of smaller size and shape to effect a bonded structure when they are connected to the hangers. The tiles are also so shaped that sections of the arch may be readily repaired without completely rebuilding the arch.

My improved form of tiles include alternate transverse courses of straight tiles 36 as shown in Fig. 9, and intermediate courses of angularly arranged tiles 37, as shown in Fig. 10 to provide a bonded arrangement of the head joints between the respective courses.

The straight tile 36 comprises a substantially rectangular shaped block having parallel front and rear bed faces 38 and 39, head faces 40 and 41 and end faces 42 and 43. The inner head face 40 has its upper end provided with a transverse notch 44 to accommodate the lateral flanges of the respective members as shown in Fig. 2, that portion 45 of the head face above the notch being inset from the lower portion 46 to accommodate the vertical web portions of the hangers so that the blocks can be suspended from the respective side flanges thereof in such a manner that when the head faces 40 of the tiles on the same hanger are in abutment and have their head faces 41 in abutment with those of tiles suspended on adjacent hangers, the tiles are firmly keyed in suspended relation on the hangers and the bottom ends 43 form the inner surface of the arch.

The angular blocks shown in Fig. 10 have their upper ends conforming exactly to the shape of the tiles illustrated in Fig. 9, but the lower ends 47 are offset angularly therefrom to position the end faces 48 thereof so that the head joints 49 and 50 are offset from the vertical center line of the hangers to lie substantially midway of the width of the straight tiles.

It is thus apparent that when the straight tiles are used in one course across the width of the arch and the angular tiles in the next course, the joints 49 and 50 will be offset from the similar joints 51 and 52 of the straight tiles to form a bonded arch construction with the longitudinal joints in broken or staggered form.

It is apparent, therefore, that slag collecting on the under surface of the arch cannot run directly down the joints from the top to the bottom thereof because the joints of one course are broken by the tiles in the adjacent course as clearly shown in Fig. 1.

In order to key the adjacent courses of tiles together in interlocking relation, one bed face is provided with a plurality of regularly arranged diamond shaped projections 53 and the other bed face with diamond shaped recesses 54 so that the projections of tiles in one course interengage recesses of those in the next course as shown in Fig. 11. The projections of one face and the recesses of the other face of the tile have portions of different elevation with respect to the face of the tile, which portions form a transverse interlock with the complementary portions of the adjacent tile.

To prevent the slag from running across the face of the arch from the top to the bottom thereof, the lower edge of the side faces of each tile are preferably provided with slight rabbet grooves 55 and 56 to make transverse channels extending entirely across the width of the arch and to form breaks in the smooth surface so that the slag will drop from the lower edges of the tiles. This is particularly advantageous in inclined arches, but may be eliminated in flat arch construction.

In order to facilitate insertion of the tiles as in making repairs and in assembly of the original arch, the upper corners opposite the notches 44 are rounded, as at 57, to permit straightening of the tile after the notched or hooked shaped end is engaged over the flange of the hangers as shown in Fig. 2. By thus rounding the corner to the tile, the tile is readily moved into parallel juxtaposed relation with the adjacent tile.

The nose tiles 58 are of the same construction as the tile shown in Figs. 9 and 10, but are of sector shape to conform to the nose of the arch.

The ignition arch brackets 59 are suspended from the front girder in corresponding spaced relation to the hanger members of the arch and carry flanges 60 and 61 for supporting tiles similar to those of the main arch.

In assembling an arch from my improved form of tiles 8, the ignition arch is constructed by applying straight tiles 36 on the flanges of the ignition arch brackets so that a course extends across the entire width of the fire box and the tiles at the end of the row overlap the shoulders 6. A course of angular tiles 37 is then applied to the hangers so that the joints thereof are in offset relation to the joints in the first course. Another course of straight tiles is applied to the hangers and so on until the nose of the arch is reached where the sector tiles are used.

After forming the nose, the vertical portion of the ignition arch is completed with the flat tiles. Stop castings 62 are then applied to the lower end of the hangers 9 and alternate courses of straight and angular tiles are hung from the flanges thereof until the nose of the arch is reached. The sector tiles are then applied to the castings 25 to form the rounded nose as shown in Fig. 1. When the nose is completed, the girder protection section of the arch is built up of the flat tiles in the same manner as the inclined portion of the arch.

It is desirable that as each tile is inserted, a

strip of gasket material such as asbestos cloth 63 be applied in the head joints of adjacent tiles as indicated in Fig. 11 to prevent escape of furnace gases therebetween.

The asbestos cloth is also very important as it prevents welding of adjacent tiles together under the extreme heat conditions in the fire box. The asbestos cloth appears to have a neutral action to slag and the two will not bond together. The tiles, therefore, remain loose so that they can freely accommodate themselves to expansion and contraction independently of each other. It is common experience with suspended arches that spaces are developed between some of the tiles, after the first firing, due to shrinkage of the tiles following their thermal expansion, and that upon subsequent operation of the furnace, slag will wash in these openings or cracks and cause erosion along the joints. The yieldable packing forms an expansion joint which accommodates expansion and contraction of the tiles without opening up the joints.

By forming the tiles in each section with joints extending in the plane of the hangers as well as between the hangers, the tiles are more easily assembled on the hangers because each individual tile is applied to the hanger at the point at which it is to be installed, as distinguished from other constructions wherein the tiles must be inserted upon or between the ends of the hangers and slid along the hangers into the position that it will assume in the arch structure. Another advantage is that the tiles being of smaller size are of lighter and more uniform weight, and are more easily handled and have less shrinkage. The smaller size also permits more uniform texture and better tensile strength throughout the thickness of the tile.

Also, due to the fact that each tile has a single bearing contact on the hanger, the bearing contact does not change if the tile should be moved out of the perpendicular, or, should the arch as a whole expand unevenly, shifting of the individual tiles would not cause breaking of their hook shaped portions.

When slag collects on an arch construction as described, it cannot run directly down the joints of the arch because of the transverse grooves formed by the horizontal joints and, therefore, cannot produce the cutting or erosive effects above referred to.

Due to the fact that the slag readily drips from the tiles, it does not tend to collect in the joints to cause welding together of adjacent tiles. The tiles are, therefore, free to move to accommodate themselves to expansion and contraction as the arch heats and cools.

Should any of the tiles tend to crack across the face thereof, the cracked portions cannot drop into the fire box since they are securely held by the interlocked projections on the adjacent tiles as is clearly shown in Fig. 11.

It is thus apparent that when the arch is completely assembled, the ends of the tiles provide a smooth or even surface and the construction is effective in large measure to counteract the effects which contribute to spalling of the refractories and their wearing away under conditions to which they are subjected in the furnace.

What I claim and desire to secure by Letters Patent is:

1. In a refractory construction including spaced supports, courses of straight tiles suspended from said supports, interposed courses of tiles suspended between the courses of straight tiles and having angularly extending lower ends positioned in overlapped relation to the ends of two adjacent straight tiles to provide bonded joints in the longitudinal direction of said supports, and a multiplicity of interengaged projections and recesses on contacting faces of the tiles which are positioned transversely of said supports and arranged close to one another and each comprising but a small fraction of the tile's area and thickness to prevent dropping out of portions of the tiles that may be cracked incidental to expansion and contraction in a direction transversely of the supports.

2. In a refractory construction including inclined spaced supports, courses of straight tiles suspended from said supports, interposed courses of tiles suspended between the courses of straight tiles and having lower ends positioned in overlapped relation to the ends of two adjacent straight tiles to provide bonded joints in the longitudinal direction of said supports, and a multiplicity of interengaged projections and recesses on contacting faces of the tiles which are positioned transversely of said supports and arranged close to one another and each comprising but a small fraction of the tile's area and thickness whereby the projections are kept in interengagement responsive to weight of the tiles tending to move them toward the lower ends of the supports to prevent dropping out of portions of the tiles that may be cracked incidental to expansion and contraction of the tiles in a direction transversely of the supports.

3. In a refractory construction including inclined supports having lateral flanges, courses of straight tiles having notched upper ends for engaging the flanges, interposed courses of tiles having notched upper ends engaging the flanges and suspended between the courses of straight tiles and having lower ends positioned in overlapped relation to the faces of two adjacent straight tiles to provide bonded joints in the longitudinal direction of said supports, and a multiplicity of interengaging projections and recesses on the faces of the tiles extending parallel with said courses transversely to the direction of said supports, said projections and recesses being arranged close to one another and each comprising but a small fraction of the tile's area and thickness whereby the projections are kept in interengagement responsive to weight of the tiles tending to move them toward the lower ends of the supports to prevent dropping out of portions of the tiles that may be cracked incidental to expansion and contraction of the tiles in a direction transversely of the supports.

4. In a refractory construction including inclined spaced supports having lateral flanges, courses of straight tiles having notched upper ends for engaging the flanges, interposed courses of tiles having similar shaped notched ends and angularly offset lower ends positioned in overlapped relation to the lower ends of two adjacent straight tiles to provide joints in the longitudinal direction of the supports, and a multiplicity of regularly arranged and interengaging substantially diamond-shaped key portions on the overlapping faces of the tiles whereby the key portions are kept in interengagement responsive to weight of the tiles tending to move them toward the lower ends of the supports to prevent dropping out of portions of the tiles that may become cracked incidental to expansion and contraction

of the tiles in a direction transversely of the supports.

5. In a refractory construction of the character described in combination with spaced supports, a course of straight tiles engaged with said supports and a juxtaposed course of angularly offset tiles engaged with the supports and having lower ends of substantially the same dimensions as the lower ends of the straight tiles, and a multiplicity of complementary projections and recesses of uniform size and shape and arranged in regular pattern whereby the projections on the bed face of one tile interengage the recesses of an adjacent tile.

6. An arch comprising alternately arranged courses of straight and angular tiles, interlocking means on said tiles to prevent independent sliding movement of the tiles in one course relatively to the contacting tiles in adjacent courses, and means suspending the tiles.

7. An arch comprising alternately arranged courses of straight and angular tiles having interengaging diamond shaped key portions arranged on bed faces of the respective tiles to prevent independent movement of the tiles in one course relatively to the tiles in a juxtaposed course, and means suspending the tiles.

8. An arch comprising an arch support, and juxtaposed courses of tiles having tiles in one course in staggered relation to the tiles in the adjacent courses, and means suspending the tiles from the arch support, the tiles having bed faces provided with interengaging seats to interfit with projections on contacting faces of similar tiles in a juxtaposed course.

9. A furnace arch structure comprising a plurality of refractory tiles each having a face formed with a plurality of interlocking portions of different elevation with respect to said face distributed alternately both longitudinally and transversely thereof, and means engaging said tiles at their upper ends to support them in depending position and collateral association with interlocking portions of one tile intermeshed with interlocking portions of another.

10. A furnace structure comprising a plurality of refractory tiles arranged in courses and each having a face formed with a plurality of narrow interlocking portions of different elevation with respect to said face arranged alternately in rows both longitudinally and transversely thereof, the tiles in respective courses being disposed in staggered relationship to those in juxtaposed courses with said interlocking portions of respective tiles of one course in interfitting relationship with interlocking portions of like faces of a plurality of tiles of a juxtaposed course.

LEE M. BEALL.