Oct. 7, 1947. S. P. KINNEY ET AL 2,428,461

CHECKER BRICK HEAT EXCHANGER

Filed July 8, 1944 5 Sheets-Sheet 1

FIG. 1.

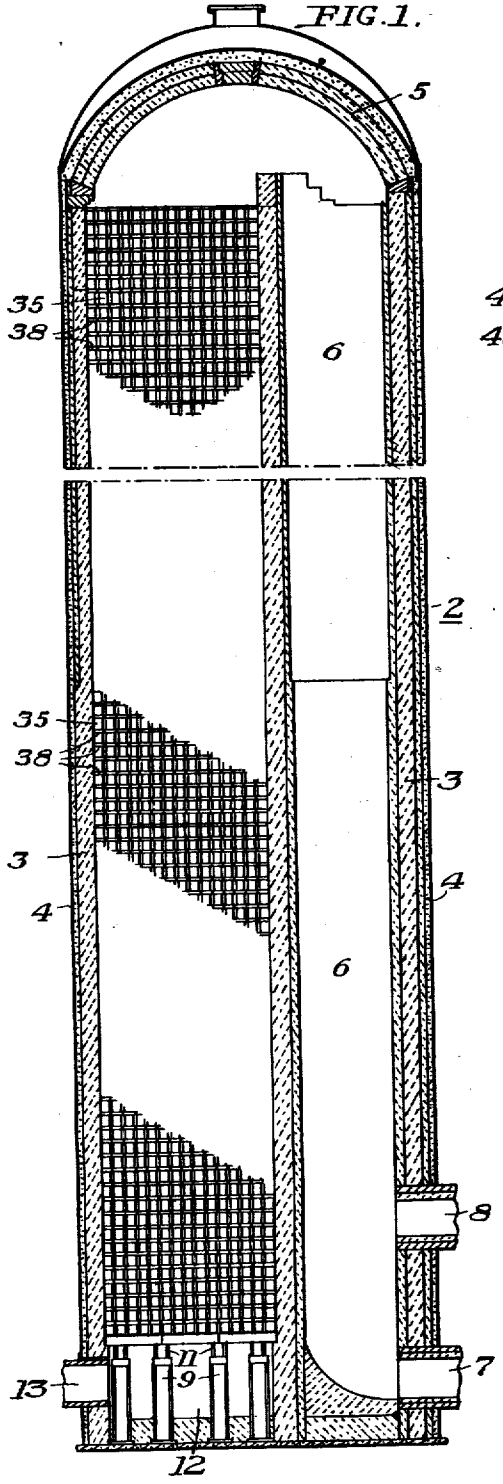


FIG. 2.

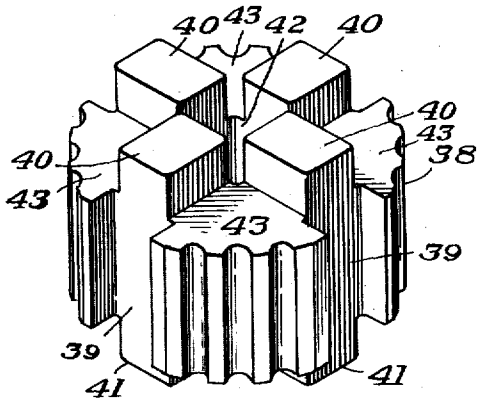
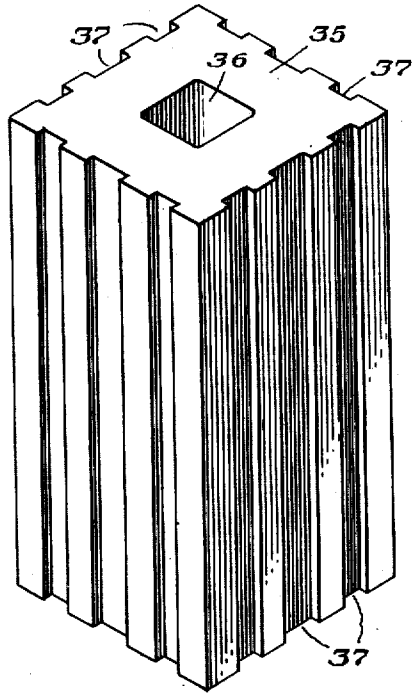


FIG. 3.



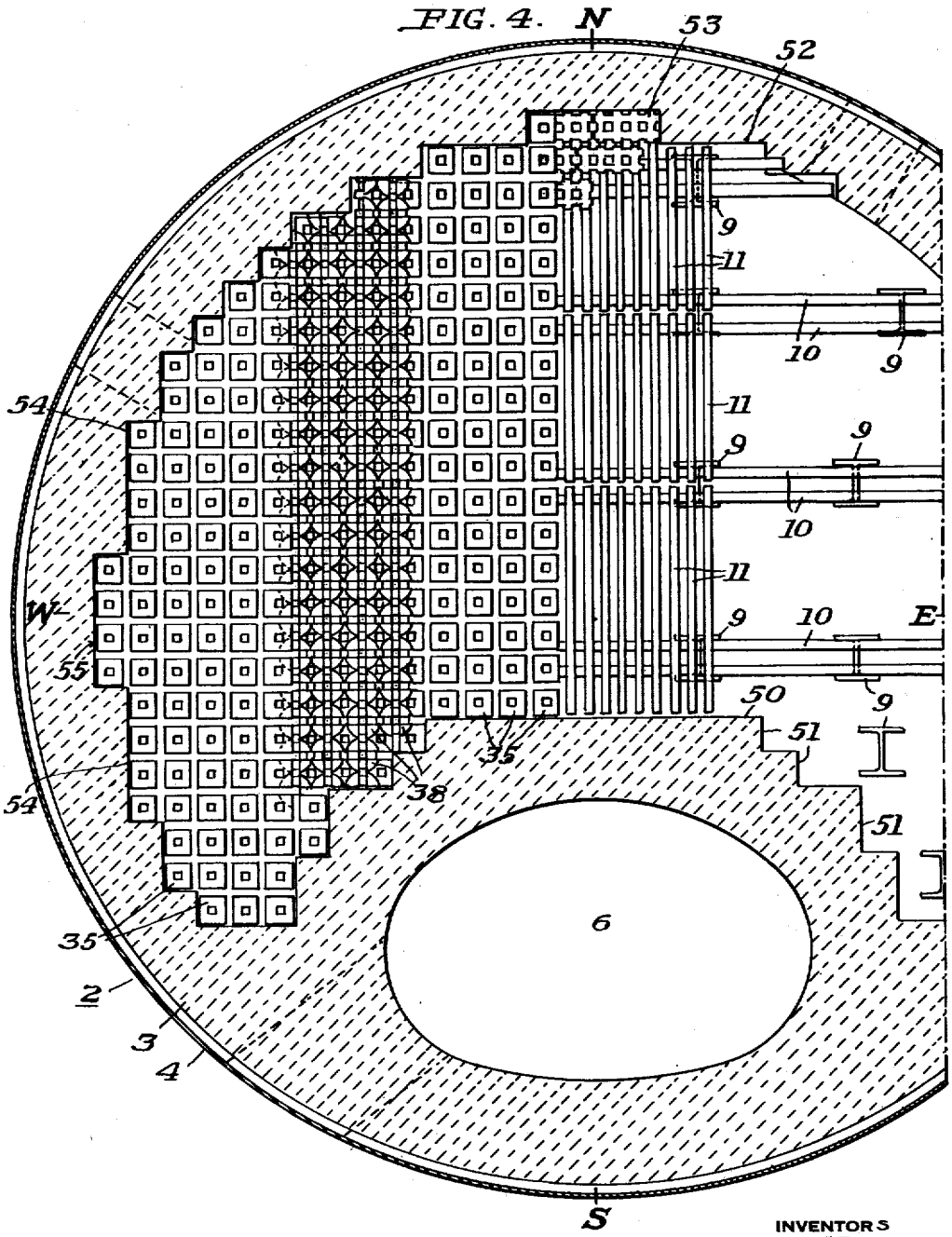
INVENTORS
Selwyne P. Kinney
Louis M. Hartwick
By their attorneys
Christy, Parmelee & Strickler

Oct. 7, 1947. S. P. KINNEY ET AL 2,428,461

CHECKER BRICK HEAT EXCHANGER

Filed July 8, 1944 5 Sheets-Sheet 2

FIG. 4.



INVENTORS

Selwyne P. Kinney

Louis M. Hartwick

by their attorneys

Christy, Parmelee & Strickland

Oct. 7, 1947. S. P. KINNEY ET AL 2,428,461

CHECKER BRICK HEAT EXCHANGER

Filed July 8, 1944 5 Sheets-Sheet 3

FIG. 5.

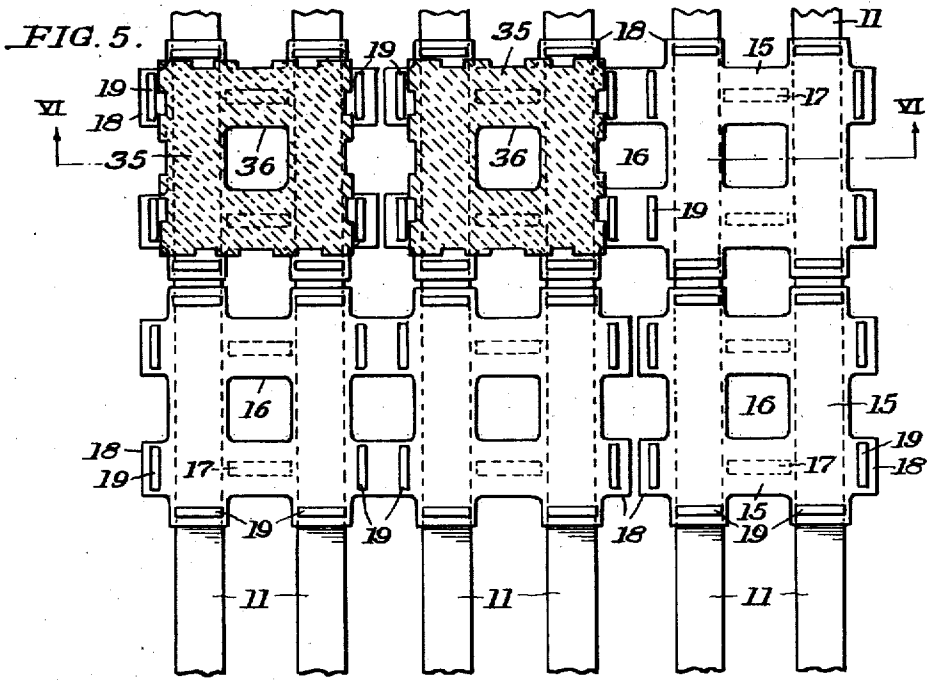


FIG. 6.

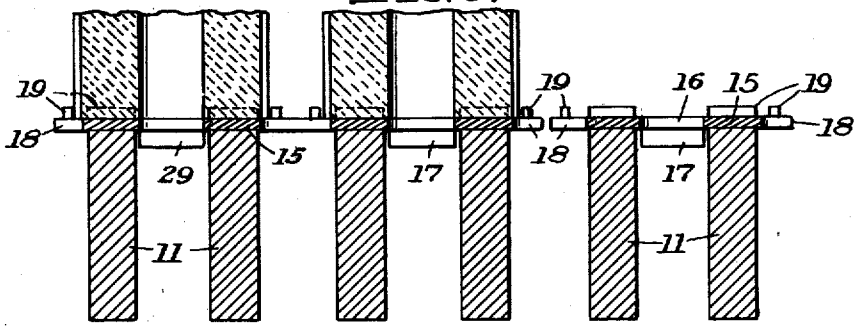
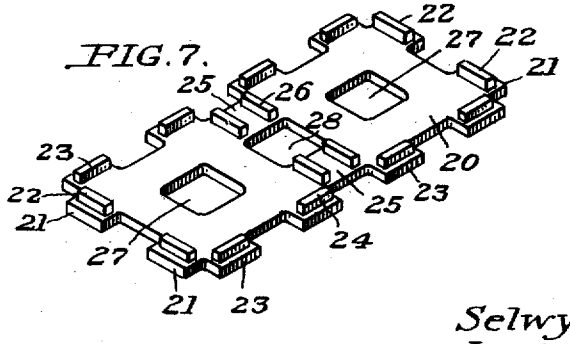


FIG. 7.



INVENTORS

Selwyne P. Kinney

Louis M. Hartwick

by their attorneys

Christy, Parmelee & Stickland

Oct. 7, 1947. S. P. KINNEY ET AL 2,428,461

CHECKER BRICK HEAT EXCHANGER

Filed July 8, 1944 5 Sheets-Sheet 4

FIG. 8.

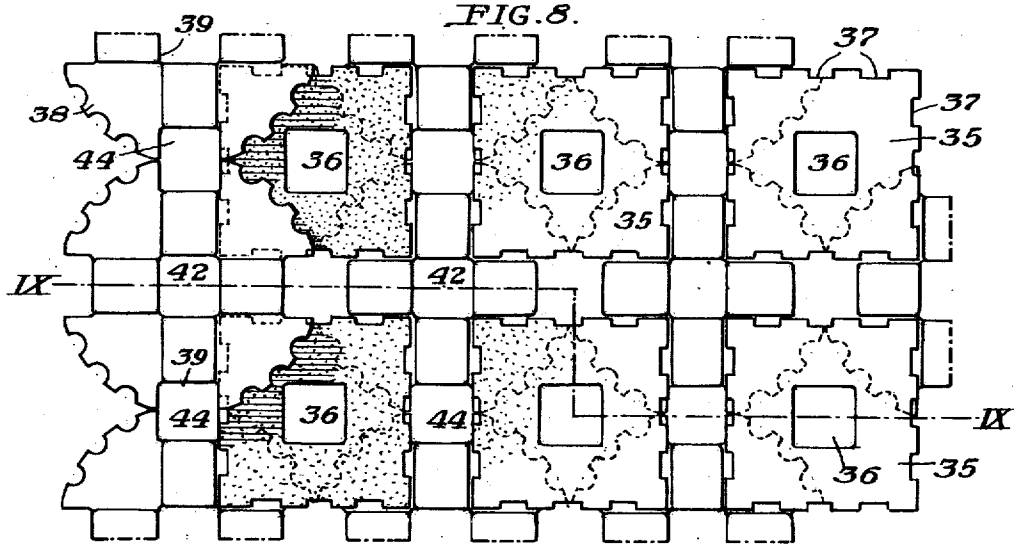
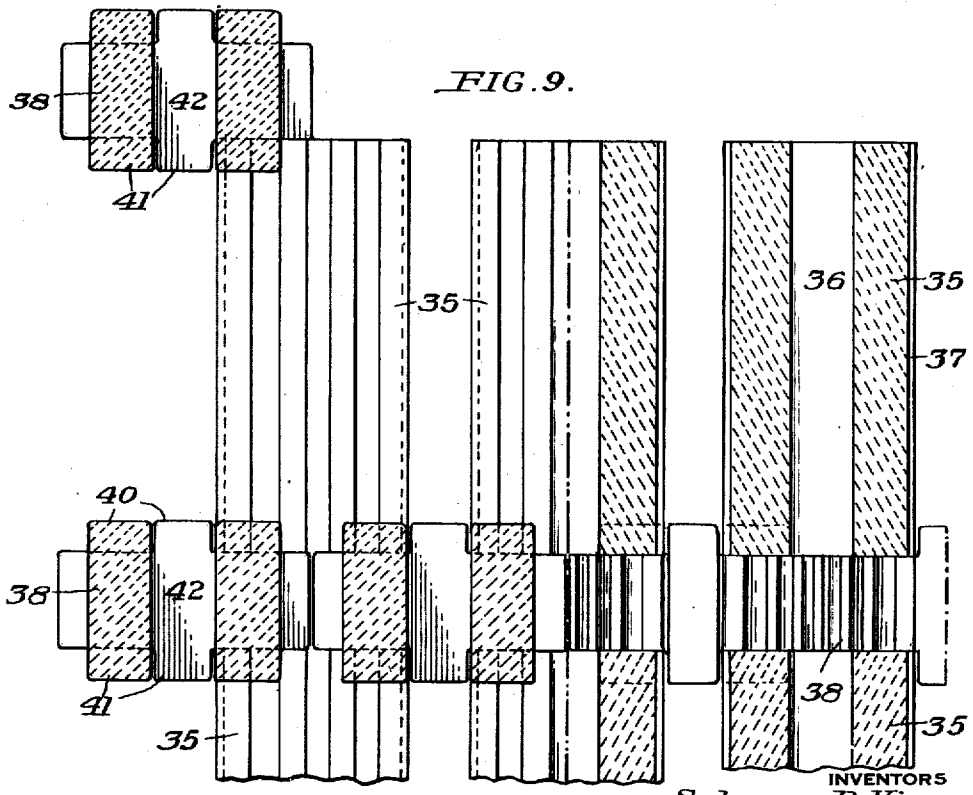


FIG. 9.



INVENTORS

Selwyne P. Kinney

Louis M. Hartwick

by their attorneys

Christy, Parmelee, Stickland

Oct. 7, 1947. S. P. KINNEY ET AL 2,428,461

CHECKER BRICK HEAT EXCHANGER

Filed July 8, 1944 5 Sheets-Sheet 5

FIG. 10.

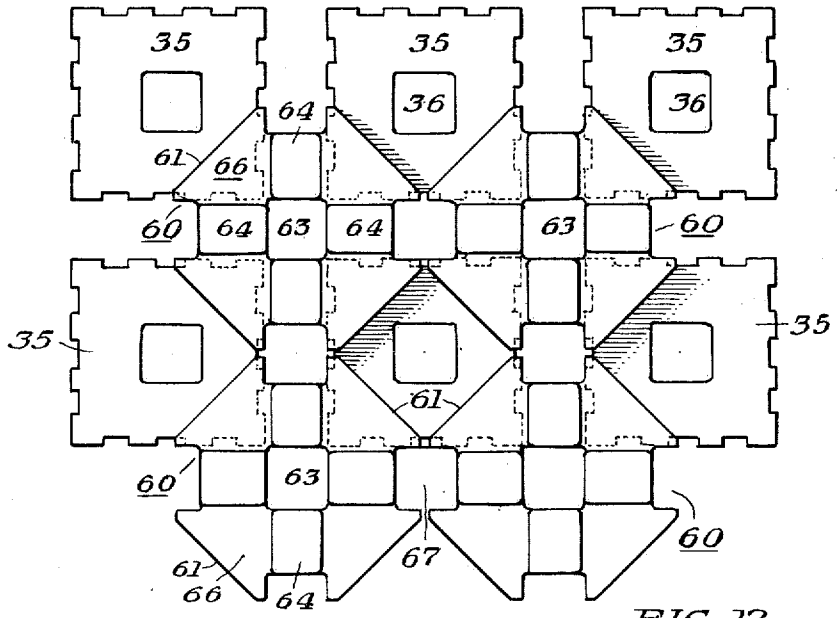


FIG. 11.

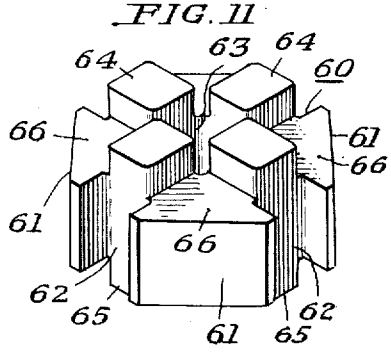
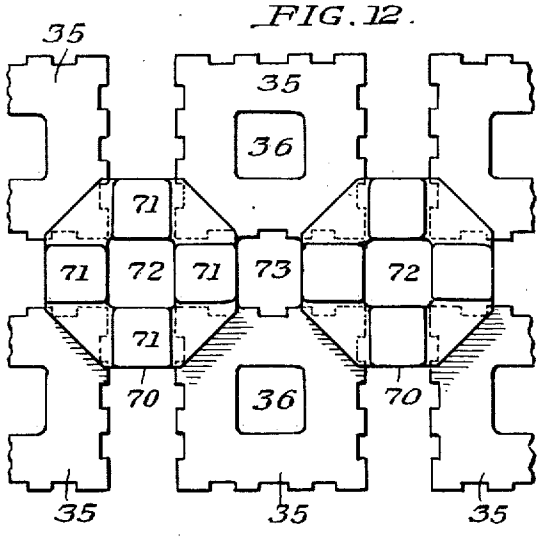


FIG. 12.



INVENTORS

Selwyne P. Kinney

Louis M. Hartwick

by their attorneys

Christy, Parmelee, Strickland

Patented Oct. 7, 1947

2,428,461

UNITED STATES PATENT OFFICE

2,428,461

CHECKER BRICK HEAT EXCHANGER

Selwyne P. Kinney, Crafton, and Louis M. Hartwick, Beaver, Pa., assignors, by mesne assignments, to S. P. Kinney Engineers, Inc., Pittsburgh, Pa., a corporation of Pennsylvania

Application July 8, 1944, Serial No. 544,102

20 Claims. (Cl. 263—51)

1

This invention relates to heat exchangers of the type in which bricks or refractory bodies, open to the circulation of gases therethrough, commonly referred to in the art as "checker bricks," are employed. The invention is particularly applicable to blast furnace stoves for which it is especially designed, but features thereof may be utilized in other types of heat exchangers as for example, regenerators or the like.

The conventional blast furnace stove comprises a vertical cylindrical metal sheathed refractory structure of the order of 80 or more feet in height. Within the structure is a vertically extending chamber or flue which is usually either round or oval in cross section, and which is known as a "combustion chamber." The cross sectional area of the combustion chamber is relatively small compared with the total cross sectional area of the stove. The space inside the stove around the combustion chamber, called the "checker chamber," is filled with a checker work brick or refractory blocks supported on a grate-like or grid structure near the bottom of the stove. In the operation of the stove, hot combustible gases from the top of the blast furnace are introduced into the bottom of the combustion chamber and combustion air is also introduced. The hot products of combustion enter the dome of the stove and are deflected down through the checker work, passing through the grating at the bottom of the checker work into a flue. This operation is continued until the upper part of the checker work becomes incandescent. The introduction of combustible gases is then stopped and air is blown through the stove in the reverse direction, whereupon the air becomes highly heated and is carried to the tuyères of the blast furnace. Usually there are a battery of stoves in conjunction with each blast furnace, and some of them are being heated up while others are being used to heat the blast.

The operation is obviously one in which there is a considerable heating and cooling of the structure with attendant expansion and contraction of the various component parts. This tends to break down the checker work and the checker work has to be rebuilt from time to time. Also there is a tendency for dust to become deposited in the checker work, particularly in the less active regions in a stove, where the gases channel through certain passageways, and many checker work constructions used in blast furnace stoves at the present time do not readily lend themselves to cleaning. Additionally, forces are set up in the interior of the stove tending to twist or

2

"spiral" the checker work, particularly in the upper portion thereof, and this twisting destroys the thermal efficiency of the checkers in that it tends to obstruct some of the passageways.

According to the present invention, there is provided a checker work which is comprised of two basically different sets of blocks arranged in alternate layers. One shape of block, constituting the principal mass of the checker work, is an inexpensive shape to produce, and one which presents a large surface area. The other block is essentially a positioning or locking block which spaces the blocks of the first series, holds them from shifting to any substantial extent in a horizontal direction, and keeps them spaced one from another horizontally and vertically. The checker work thus constructed can readily adapt itself to the forces of expansion and contraction under varying thermal conditions, and the blocks can adjust themselves to mechanical strains. The twisting of the blocks, however, is prevented by the manner in which they are interlocked. In addition the blocks provide a multiplicity of vertical flues which are continuously open from the top to the bottom of the checker work, which flues, however, and with certain exceptions, are in transverse communication so that the flow of gases is not confined, but can spread out laterally through the structure. As a matter of fact the gases are caused to expand and contract in moving vertically through the checker work creating a condition tending to give a highly effective heat exchange and prevent the deposit of dust while the continuous vertical nature of the flues is such that dust cannot collect in them. If, however, a flue becomes stopped through the spalling of the bricks or from the accumulation of dust, the operation of the stove is not interfered with, and the stove can be cleaned from time to time.

Additionally, the invention provides a novel arrangement under the checker work over the grating for supporting the checker work, keeping the lowermost layers of blocks in proper spaced relation, and at the same time in restricting the flow of gases through the stove.

Moreover, the invention provides a relation between the blocks and the walls of the stove so as to more effectively position the blocks in the stove and hold them from shifting.

Our invention may be readily understood by reference to the accompanying drawings, which illustrate certain embodiments of our invention, and in which:

Fig. 1 is a vertical section through a typical stove with our checker work therein;

Fig. 2 is a perspective view of one of the spacer or locking blocks;

Fig. 3 is a perspective view of one of the main blocks;

Fig. 4 is a transverse section on a larger scale, taken at various elevations through the stove of Fig. 1, showing the structure at various heights in the stove;

Fig. 5 is a top plan view of the supporting plate structure for holding the first columns of refractory blocks at the bottom of the stove;

Fig. 6 is a transverse section in substantially the plane of line VI—VI of Fig. 5;

Fig. 7 is a perspective view of one of the metal plates embodied in Fig. 5;

Fig. 8 is a top plan view of a section of the checker work;

Fig. 9 is a view partly in section and partly in elevation through some of the checker work;

Fig. 10 is a top plan view of a modified construction;

Fig. 11 is a perspective view of one of the spacing blocks shown in Fig. 10; and

Fig. 12 is a view similar to Fig. 10 of still another modification.

Referring first to Fig. 1, the stove designated generally as 2 has a refractory ring wall 3 of substantially circular cross section enclosed in a metal sheathing 4. The stove has a rounded refractory lined dome 5. In actual practice, these stoves are commonly 100 feet in height, but they may vary considerably. Eccentrically located in the stove is a vertically extending refractory flue-like structure 6 which constitutes the combustion chamber. The combustion chamber is commonly circular or elliptical in cross section. In the particular stove illustrated, and as clearly shown in Fig. 4, the combustion chamber 6 is generally elliptical transverse section. It extends upwardly to a point just under the dome, and as shown in Fig. 4, its cross sectional area is relatively small as compared with the total cross sectional area of the stove. The mains leading into the combustion chamber at 7 and 8 provide for the introduction of blast furnace gases and combustion air.

In the bottom portion of the stove outside the combustion chamber are a series of vertical columns 9 which support the transversely extending beams or load carrying members 10. Resting on these load carrying members are a plurality of sections of metal grating 11, the grating 11 being comprised of heavy metal bars, the length of which is at right angles to the long axis of the combustion chamber 6. The respective sections of grating are spaced from one another in end to end relation, so as to allow for expansion and contraction. The space 12 under the grating around the columns 9 forms a chamber which communicates with a flue pipe 13.

So much of the construction as has been heretofore described is generally known to the art, and forms no part of the present invention per se.

According to the present invention, cast steel plates as best shown in Figs. 5, 6 and 7 are set on the bars of the grate sections 11. These plates are made up of single and double or multiple units. Each single unit has a web portion 15 having a central opening 16 therethrough. On the under side of the plate on each two opposite sides of the opening 16 are downwardly extending lugs 17, these lugs being of a length such as to loosely fit between two of the grating bars 11 (see Fig. 6). The upper surface of the plate has two lateral lugs 18 on each of the four side edges

thereof, and each extension 18 has a lug 19 thereon.

The double supporting plate units are essentially the same as two of the single units secured together in side by side relation so as to span three of the grid bars instead of two. One of these double units is best shown in Fig. 7, and it comprises a flat web portion 20 having two extensions 21 at each end thereof, each of these extensions having an upstanding lug 22 thereon. There are four similar extensions 23 along each side edge, these extensions having lugs 24 thereon. Portions 25 of the web are designated "connecting portions," and these connecting portions have upstanding lugs 26 thereon. Except for the connecting portions 25, the double plates are the same as the single plates, there being an opening 27 centrally positioned in each section of the web portion, and there is an opening 28 between the two connecting portions 25. On the under side of the web are downwardly turned lugs 29 similar to the lugs 17 on the single plates, these lugs fitting between the bars 11. Obviously the plates may be extended to provide any convenient multiple of the single plates, the invention not being confined merely to double plates.

It will be seen that the supporting plates, both the single and the double units, are slidable along the bars 11 and have a loose fit thereon, but they are restrained by the lugs 17 and 29 respectively from shifting in a transverse direction, although the fit of the plates on the bars is loose enough to allow for normal expansion and contraction, allowing also a wide tolerance for irregularities. The supporting plates over the bars 11 provide in effect a supporting platform with the upstanding lugs, 19 in the case of the single plates, and 22, 24 and 26 in the case of the double or multiple plates, defining a plurality of equally spaced square recesses or enclosures, each with a hole, 16 or 27, at the center thereof, each enclosure being bounded on four sides by two of the upstanding lugs, and between each two square enclosures there is an opening, this being the opening 28 between two parts of a double plate or the openings designated 20 between the extension elements on the edges of the respective plate members.

As shown in Fig. 5, the single and double or multiple supporting plate units may be staggered so as to break joints in one direction. Also the single and double supporting plate arrangement enables the supporting plates to be fitted over the bars 11 in such manner as to most effectively and completely cover the entire area of the grating comprised of the bars 11.

Each of the square enclosures or seating recesses formed by the upstanding lugs on the supporting plate units is designed to receive a rectangular refractory block 35. The blocks 35 are of a dimension such as to fit within the lugs. As clearly shown in Fig. 3, their length is considerably greater than their width or breadth. Each of these blocks 35 has a central opening 36 therein so that the opening 36 registers with one of the openings, either 16 or 27, in the supporting plate units. The first course of refractory in the stove, beginning with the bottom, therefore comprises a course of these blocks 35. They are held in spaced relation to each other by the upstanding lugs on the supporting plates and they are held from shifting about by these lugs. Both lengthwise of the bars 11 and crosswise thereof are spaces between adjacent blocks 35. The wide faces of the blocks may be grooved or channeled to increase the heat radiating or absorbing sur-

face thereof, these grooves being designated 37.

The second course of refractory is comprised of blocks, preferably of the shape shown in Fig. 2, these blocks being generally of cylindrical form with an overall diameter somewhat greater than the width of the blocks 35, and with an overall length substantially less. These blocks are referred to as "spacer blocks" and are designated generally as 38. In addition to having fluted peripheral surfaces to increase the heat absorbing and radiating areas thereof, the blocks 38 have four vertical channels 39 in the periphery thereof at 90° from each other. Each spacer block has four projections 40 at the top thereof which are also 90° from one another, and which are positioned inwardly from the channels 39. Each of the spacer blocks 38 has similar lugs 41 on the bottom face thereof directly in line with the lugs 40. The spacer blocks have a generally square passageway 42 extending therethrough. The end of each block 38 thus is divided into four generally triangular or three-sided or substantially quadrant shaped flat surfaces 43 separated from one another by the projections 40 at one end of the block and by the projections 41 at the other end of the block.

The first course of spacer blocks is set on the first course of filler blocks 35 with the four quadrant shaped end surfaces thereof resting on the end surfaces of four of the filler blocks 35. The lugs 41 extend downwardly between the filler blocks 35 a short distance, as best shown in Fig. 9. The lugs 41 thus serve to space the upper ends of the course of the square filler immediately under it and to interlock with them, while another course of the filler blocks 35 may be laid on the spacer blocks, the succeeding filler blocks 35 of each course being in vertical alignment with the filler blocks immediately under and immediately over. Thus there is provided throughout the height of the stove alternate courses of filler and spacer blocks with all of the filler blocks in vertical alignment and all of the spacer blocks in vertical alignment with the downwardly extending lugs 41 on the spacer blocks projecting between and serving to space and hold the tops of the underlying filler blocks in proper spaced relation, and with the upstanding lugs of the spacer blocks likewise serving to properly space and hold the bottom ends of the course of filler blocks immediately above.

The spacer blocks 38 are, as shown in Fig. 8, preferably of a diameter such that the peripheries of adjacent blocks in the same courses substantially touch each other. The channels 39 in the peripheries thereof register to form vertical openings or passageways which are designated 44 in Figs. 8 and 9.

When the checker work is built up in this way with alternate courses of filler and spacer blocks, the vertical flues 36 down the centers of the filler blocks are in vertical alignment so that a poker can be passed down the entire height of the checker work through these alined vertical flues. Likewise the openings 44 formed by the channels in the spacer blocks 38 are in vertical alignment all the way down, and the openings 42 at the centers of the circular blocks are in vertical alignment all the way down.

Gases traveling from the top of the stove downwardly may flow in part down the flues 36 and may expand laterally to some extent between each course of spacer blocks. Other gases passing down the openings 42 and 44 can flow crosswise in each direction in the spaces between the filler blocks, thus sweeping against the surfaces of the filler blocks while gases at the same time are flowing through the central flues of the filler blocks. The straight line flow of gases around the outside of the filler blocks is prevented by the fact that the gases can expand crosswise in either direction between the filler blocks.

The filler blocks 35 have a vertical dimension which is considerably more than the vertical dimension of the circular or spacer blocks 38. Because of the lug formations on the spacer blocks, the spacer blocks are more expensive per ton than are the filler blocks 35 which can be formed by simple extrusion methods. Hence the relation of the spacer blocks to the filler blocks is such that the former constitute about 18% of the total refractory in the stove and the filler blocks constitute approximately 82%. This is taken of course as a typical example, and is not to be construed as a limitation, as it is clearly within the contemplation of our invention, although scarcely within the realm of commercial practise, to make both shapes of blocks of the same vertical height or otherwise vary the dimensions between the two block shapes.

It will be seen by reference to Fig. 8, for example, that the top and bottom of each square block (other than those around the perimeter of the checker work) is held in spaced relation to its adjacent square blocks by eight of the lugs 40 at the bottom thereof, and eight of the lugs 41 at the top. This is so because four spacer blocks have their surfaces 43 resting on the end of each square block, and two of the lugs which are 90° from each other on each spacer block project between each corner of each square block making a total of eight lugs at each end of each square block. This is of importance in resisting twisting strains in the mass of refractory as a whole, and even though one lug may occasionally break or be damaged, there are still several other lugs to prevent a given block from shifting. The interlocking of the lugs of the spacer blocks between the square blocks of course reacts to keep the spacer blocks from shifting also, and these spacer blocks are further braced by the fact that their peripheral surfaces are in contact with one another.

Each spacer block has four of the quadrant shaped areas 43 to support it on the underlying filler blocks, and to carry the weight of the overlying filler blocks, so that while the structure provides for the free circulation of gases through the stove, it avoids the concentration of crushing loads on refractory areas that are insufficient to withstand them.

This arrangement of the blocks also adapts itself to effective arrangement inside the stove to fill the space inside the stove, and at the same time prevent the shifting of the refractory mass or its tendency to twist about a vertical axis, as frequently happens in checker work of present design.

The manner in which the checker work may be fitted into the interior design of the stove, particularly the upper portion of the stove, is clearly shown in Fig. 4. The wall of the checker chamber on the N.-S. diameter of the stove is a wide flat surface designated 50, and there is a succession of step-like formations from this flat surface toward the ring wall, these stepped areas being designated generally as 51. The portion of the wall of the checker chamber opposite the wall 50 is a flat area 52 of a width substantially equal to the width of the area 50, but it is provided with a vertical channel or indentation 53 of a depth sufficient to accommodate a short row, one

tier wide, of rectangular blocks. Likewise in the E.-W. direction the two walls may be symmetrical and only the side on the W. end of the diameter is shown. It has a wide flat area 54 with a vertical channel or indentation 55 also of a depth sufficient to accommodate a single tier of rectangular blocks, and of a width such as to form a short row, i. e., a row of four blocks. There may then be a succession of steps or pilasters formed in the remaining portions of the ring wall, each step being in its depth and width equal to the dimension of a square block or a multiple of a square block. It may be noted that these steps or pilasters may extend the entire height of the checker chamber or throughout any portion of the height that may seem desirable. However, the arrangement is such as to always bring the sides of the filler or square blocks parallel with, or against, the flat or stepped surfaces of the interior of the checker chamber. Since the square blocks are braced at their tops and bottoms by spacing means, keying the blocks together, forces tending to rotate the entire checker work in a horizontal plane about a vertical axis are effectively resisted by the contact of the square blocks against squared wall surfaces inside the checker chamber.

From the foregoing it will be seen that the invention provides, through the metal plates at the bottom of the grating, means for definitely holding the lower ends of the lowermost ends of the refractories in fixed spaced relation, and that spacer blocks are provided alternately with filler blocks throughout the entire height of the checker chamber, these spacer blocks serving to positively hold, by eight spacing elements engaging each end of each block, the rectangular blocks in regular spaced relation, providing, as clearly shown in the left-hand side of Fig. 4, intersecting horizontal passageways between the filler blocks. The invention further provides an arrangement wherein the spacer blocks, in locking the vertical blocks together, are also locked from shifting about in a horizontal direction. At the same time the checker work is one in which there is a large area of refractory exposed for the absorption of and radiation of heat giving a large area of brick exposed to contact with gases for each unit of weight or volume of refractory. Also, because one set of blocks is of a more or less conventional shape, the interlocking elements being all provided on the spacer blocks, the greatest mass of refractory may be provided by inexpensive rectangular filler blocks with only a small percentage of the total mass constituted of the more expensive spacer blocks. Not only does the invention provide an ideal checker work insofar as it presents large areas for contact with the gases, but it provides a checker work in which vertical flues and openings are unobstructed from top to bottom. Incidentally the blocks may be easily and quickly laid.

In addition to this, our invention further contemplates a co-relation between the construction of the blocks and the ring wall of the checker chamber to most effectively resist horizontal movement of the blocks, or the so-called "twisting" or "spiraling" of the refractory. While the blocks are held in spaced relation, all elements of the construction provide enough looseness to accommodate expansion and contraction which can occur in transverse and vertical directions without imposing crushing strains on the refractory.

While we have shown the spacer block as preferably being of generally cylindrical contour, other shapes, ranging between a round and a square shape, may be used as shown for example in Figs. 10 and 11, where the rectangular blocks are of the same shape as shown in Fig. 3, and are designated by the same reference numerals, while the spacer blocks in this particular modification are also square, but with the square hole through the center 45° out of phase with the sides of the spacer block. In these figures, the spacer block is designated generally as 60. It has four square sides 61, and in each of the four corners there is formed a channel 62. There is a central opening in the block designated 63, this opening being square, but having its sides 45° out of phase with the sides 61 so that a diagonal line across two corners of the opening, if projected, would intersect the metal of two of the square sides 61. There are four upwardly extending lugs 64 on one end of the block set inwardly from the channels 62, and four similar lugs 65 similarly positioned on the lower face of the block. Between the projections on each end of the block are modified generally triangular or three-sided or quadrant shaped flat areas 66 adapted to engage and rest against a corresponding area of the square block which is placed immediately against it. These blocks are laid between the square blocks, as shown in Fig. 10, in such manner that the spacer blocks are corner to corner and the vertical channels 62 form ports or openings which, in Fig. 10, are designated 67. Except for the fact that there is somewhat less surface area exposed to the gases, and somewhat less mass to resist and distribute loads, the structure shown in Figs. 10 and 11 is the full equivalent of the structure first shown and described in detail in Fig. 2.

In the modification shown in Fig. 12, the rectangular or filler blocks are also the same as previously described, and are designated by the same reference numerals. The spacer blocks in this instance are hexagonal with a dimension between any two parallel faces approximately the same as the dimension from one side to the opposite of the square blocks. These spacer blocks are designated generally as 70, and they have four lugs 71 at each end thereof with a square central opening 72 through the block. In this instance, the spacer blocks are completely out of contact with one another. The lugs 71, however, serve to space the rectangular blocks, and vertical openings are provided between adjacent spacer blocks, as indicated at 73 in Fig. 12. This structure has an advantage over the structures previously described in that gases traveling through the vertical flues 36 of the rectangular blocks can expand horizontally in all directions at each course of spacer blocks, and more of the end area of the blocks is exposed to contact with the gases. By the same token, however, vertical loads are concentrated on smaller areas of the spacer blocks so that in exceptionally high checker work the crushing loads might be so concentrated as to approach a destructive value. Aside from these differences, the arrangement shown in Fig. 12 supports and spaces the filler blocks in the same way as the spacer blocks shown in Figs. 2 and 11.

While we have specifically mentioned some of the advantages of our invention, it will be understood that there are numerous other advantages, and that the invention is not limited to the particular modifications which are herein specifically shown and described, but the invention may be

otherwise embodied, and various changes and modifications are within the contemplation of our invention, and under the scope of the following claims.

We claim:

1. A spacer block for checker bricks comprising an integral refractory body having a central passageway therethrough and having four projecting lugs on each end surface thereof, the body having flat generally triangular end faces between the lugs adapted to rest against the flat ends of rectangular checker blocks.

2. A spacer block for checker bricks comprising an integral refractory body having a central square passageway therethrough and having four projecting lugs on each end surface thereof, the lugs being square with the sides of the opening, the body having flat three-cornered end faces between the lugs adapted to rest against the flat ends of rectangular checker blocks, said blocks having channels extending across the periphery thereof at 90° intervals and in line with the lugs, whereby when two of said blocks are placed in abutting relation with the channels registering, a passageway will be formed between them.

3. A spacer block for checker bricks comprising an integral refractory body having a central passageway therethrough and having four projecting lugs on each end surface thereof, the body having flat end faces between the lugs adapted to rest against the flat ends of rectangular checker blocks, the lugs at each end being in alignment, the block being generally circular.

4. A spacer block for checker bricks comprising an integral refractory body having a central passageway therethrough and having four projecting lugs on each end surface thereof, the body having flat end faces between the lugs adapted to rest against the flat ends of rectangular checker blocks, the lugs at each end being in alignment, the block being generally circular, there being channels formed in the periphery of the blocks at 90° intervals, the channels being in alignment with the lugs.

5. A checker work for heat exchangers comprising alternate courses of blocks of square section and spacer blocks, the blocks of square section in a course being substantially equally spaced in all directions, the spacer blocks having four lugs at each end thereof projecting between the square blocks to hold them in spaced relation, the spacer blocks having end faces between the lugs of three-cornered shape against which corners of the ends of the square blocks bear.

6. A checker work for heat exchangers comprising alternate courses of blocks of square section and spacer blocks, the blocks of square section in a course being substantially equally spaced in all directions, the spacer blocks having lugs at each end thereof projecting between the square blocks to hold them in spaced relation, the lugs on each end of the spacer blocks being separated about 90° from one another, the ends of the rectangular blocks contacting four different spacer blocks, the spacer blocks in turn contacting four different square blocks, the spacer blocks having their face portions between the lugs of generally triangular shape, the diameter of the spacer blocks being greater than the diagonal distance across the square blocks whereby the peripheries of adjacent spacer blocks may contact one another.

7. A checker work comprising alternate courses of blocks of square section and spacer blocks, the square blocks being substantially equidistantly spaced from the adjacent square blocks of the same course, the ends of the square blocks being interfitted with the spacer blocks, the spacer blocks each having four lugs on each each end face thereof which project between the adjoining square blocks, the spacer blocks having peripheral portions which may contact adjoining spacer blocks, the contacting areas having channels therein providing gas circulation passages between the contacting portions of the said spacer blocks, both the square blocks and the spacer blocks having axial passageways therethrough.

8. A checker work construction comprising alternate courses of rectangular and spacer blocks, the rectangular blocks of each course being equidistantly spaced from one another, the spacer blocks comprising substantially cylindrical refractory bodies having a central opening therethrough and having projecting lug elements at each end thereof, said lugs projecting between the rectangular blocks, the peripheries of the spacer blocks substantially contacting the peripheries of the adjoining spacer blocks in the same course, the blocks of both courses having an axial passageway therethrough.

9. A checker work construction comprising alternate courses of rectangular and spacer blocks of lesser axial length than the rectangular blocks, the rectangular blocks of each course being equidistantly spaced from one another and having a central passageway therethrough, the spacer blocks comprising substantially cylindrical refractory bodies having a central opening therethrough and having projecting lug elements at each end thereof, said lugs projecting between the rectangular blocks, the peripheries of the spacer blocks substantially contacting the peripheries of the adjoining spacer blocks in the same course, the contacting portions of the spacer blocks having vertical channels therein providing gas circulating openings between the contacting peripheral portions of the blocks.

10. A checker work comprising flat sided filler blocks each having a vertical passageway therethrough and having flat ends, the filler blocks being arranged in courses with the blocks in each course equidistantly spaced from one another, the courses being separated by and interfitted with intervening courses of spacer blocks, each spacer block bearing against the corners of four filler blocks but being clear of the passageways through the filler blocks, each spacer block having lugs on each end face thereof projecting between the filler blocks to maintain the spacing between the filler blocks, each spacer block having an axial opening therethrough.

11. A checker work comprising flat sided filler blocks each having a vertical passageway therethrough and having flat ends, the filler blocks being arranged in courses with the blocks in each course equidistantly spaced from one another, the courses being separated by and interfitted with intervening courses of spacer blocks, each spacer block bearing against the corner areas of four filler blocks but being clear of the passageways through the filler blocks, the spacer blocks each having four lugs on each end face thereof projecting between the filler blocks to maintain the spacing between the filler blocks, the filler blocks all being arranged in vertically aligned tiers, the spacer blocks also being in vertical alignment, the spacer blocks having axial openings therethrough.

12. A checker work comprising flat sided filler blocks each having a vertical passageway there-

through and having flat ends, the filler blocks being arranged in courses with the blocks in each course equidistantly spaced from one another, the courses being separated by and interfitted with intervening courses of spacer blocks, each spacer block bearing against the corner areas of four filler blocks but being clear of the vertical passageway therethrough, each spacer block having lugs on each end face thereof projecting between the filler blocks to maintain the spacing between the filler blocks, the filler blocks all being arranged in vertically aligned tiers, the spacer blocks also being in vertical alignment, the spacer blocks also having openings therethrough, openings being provided also in a vertical direction between the peripheries of adjacent spacer blocks.

13. A checker work comprising flat sided filler blocks each having a vertical passageway therethrough and having flat ends, the filler blocks being arranged in courses with the blocks in each course equidistantly spaced from one another, the courses being separated by and interfitted with intervening courses of spacer blocks, each spacer block bearing against the corner areas of four filler blocks but being clear of the vertical passageways therethrough, each spacer block having four lugs on each end face thereof projecting between the filler blocks to maintain the spacing between the filler blocks, the spacing blocks being substantially shorter in vertical direction than the filler blocks.

14. In a blast furnace stove construction, a supporting plate, supporting plate elements on the grate, said grate elements having lugs thereon defining spaced rectangular areas, rectangular blocks set endwise in such supporting plates and held in spaced relation to one another by the lugs on said supporting plates, a course of spacer blocks on the upper ends of the rectangular blocks, the spacer blocks resting on the end corner areas of the ends of four rectangular blocks and having four lugs which extend downwardly between the rectangular blocks to maintain the spacing of the upper ends of said blocks, the spacer blocks also having four lugs on the upper faces thereof in line with the lugs on the lower faces, and alternate courses of rectangular and spacer blocks thereabove with each spacer block other than the peripheral blocks in the course at each end engaging four filler blocks, and filler blocks at each end, other than the peripheral blocks, engaging the lugs of four spacer blocks, the spacer and filler blocks both having axial openings therethrough engaging four spacer blocks and the spacer blocks engaging four rectangular blocks.

15. In a blast furnace stove construction, a supporting plate, supporting plate elements on the grate, said grate elements having lugs thereon defining spaced rectangular areas, rectangular blocks set endwise in such supporting plates and held in spaced relation to one another by the lugs on said suporting plates, a course of spacer blocks on the upper ends of the rectangular blocks, the spacer blocks resting on the end corner areas of the ends of four rectangular blocks and having four lugs which extend downwardly between the rectangular blocks to maintain the spacing of the upper ends of said blocks, the spacer blocks also having four lugs on the upper faces thereof in line with the lugs on the lower faces, and alternate courses of rectangular and spacer blocks engaging four spacer blocks and the spacer blocks of each course engaging four rectangular blocks, the rectangular blocks being thus maintained in vertical alignment and the spacer blocks being maintained in vertical alignment, the spacer blocks in a course contacting one another at each of four points, the contacting portions being channeled to provide vertical passageways, the square blocks and the spacer blocks also having central vertical passageways therethrough, corresponding passageways in correspondingly positioned blocks being in vertical alignment.

16. In a blast furnace stove construction, a supporting plate, supporting plate elements on the grate, said grate elements having lugs thereon defining spaced rectangular areas, rectangular blocks set endwise in such supporting plates and held in spaced relation to one another by the lugs on said supporting plates, a course of spacer blocks on the upper ends of the rectangular blocks, the spacer blocks resting on the end corner areas of the ends of four rectangular blocks and having four lugs which extend downwardly between the rectangular blocks to maintain the spacing of the upper ends of said blocks, the spacer blocks also having four lugs on the upper faces thereof in line with the lugs on the lower faces, and alternate courses of rectangular and spacer blocks thereabove, with each four spacer blocks engaging at each end four rectangular blocks, and each rectangular block at each end engaging four spacer blocks, some of said supporting plate elements on the grate being of an area to receive and support a single rectangular block, others being of an area to support a multiple of rectangular blocks, the supporting plate elements having projections on the edges thereof to define openings between them, and having openings therethrough in the areas over which the rectangular blocks are set, the rectangular blocks having openings therethrough which register with said last-named openings, the spacer blocks also having openings therethrough.

17. For use in a blast furnace stove, a metal supporting plate having an opening therethrough, upstanding lugs on the supporting plate spaced outwardly from the opening, said lugs defining a rectangular area in which the end of a rectangular block may be set with the lugs serving to hold the block against movement, the plates having lateral extensions on the edges thereof for holding them in predetermined spaced relation with other like plates.

18. For use in a blast furnace stove, a metal supporting plate having an opening therethrough, upstanding lugs on the supporting plate spaced outwardly from the opening, said lugs defining a rectangular area in which the end of a rectangular block may be set with the lugs serving to hold the block against movement, the plates having lateral extensions on the edges thereof for holding them in predetermined spaced relation with other like plates, said plates having downwardly turned lugs spaced from each other, said lugs being adapted to extend between the bars of a supporting grate structure.

19. A blast furnace stove construction comprising a refractory shell having a vertical combustion chamber therein and a vertical checker chamber, the interior of the checker chamber along the outside of the flue comprising a flat surface, the wall of the checker chamber opposite said first flat surface also being flat, the wall areas at right angles to said first two flat surfaces also being flat, a checker work in the checker chamber comprised of alternate courses of rectangular blocks set endwise and spacer

blocks between the courses of rectangular blocks, the spacer blocks resting on the corners of four rectangular blocks and having upwardly and downwardly extending lugs that fit between the rectangular blocks and maintain them in spaced relation, the peripheries of adjacent spacers of a course contacting the peripheries of adjacent spacers the rectangular blocks all being laid in rows wherein the flat sides are parallel or perpendicular to the flat side wall areas on the interior of the checker chamber, areas of the interior of the checker chamber between said flat areas being offset around the interior of the checker chamber with flat step-like formations into which one or more of the rectangular blocks may set and maintain the regular spacing between the rectangular blocks.

20. A checker brick construction comprising courses of uniformly spaced blocks of square cross section, intervening courses of spacer blocks having lugs on both end faces thereof extending between the uniformly spaced blocks to hold them in spaced relation, the spacer blocks having substantially three-sided areas on the ends thereof between the lugs which engage the end corner areas of the uniformly spaced blocks, both blocks having central passageways therethrough, the

spacer blocks contacting at their peripheries the peripheries of adjacent blocks crosswise and lengthwise of the course, the centers of the spacer blocks being over the intersecting spaces between said first blocks.

SELWYNE P. KINNEY.
LOUIS M. HARTWICK.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,880,011	Boynton	Sept. 27, 1932
1,587,171	Morton	June 1, 1926
1,624,128	Amsler	Apr. 12, 1927
1,927,834	Hughes	Sept. 26, 1933
1,835,074	McKee	Dec. 8, 1931
1,860,368	Seaver	May 31, 1932
863,786	Curlett	Aug. 20, 1907

FOREIGN PATENTS

Number	Country	Date
461,458	England	1937
49,743	France	1939
121,536	England	1918