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A. G. McKEE

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HEAT EXCHANGE DEVICE

Filed April 25, 1929

3 Sheets-Sheet 1

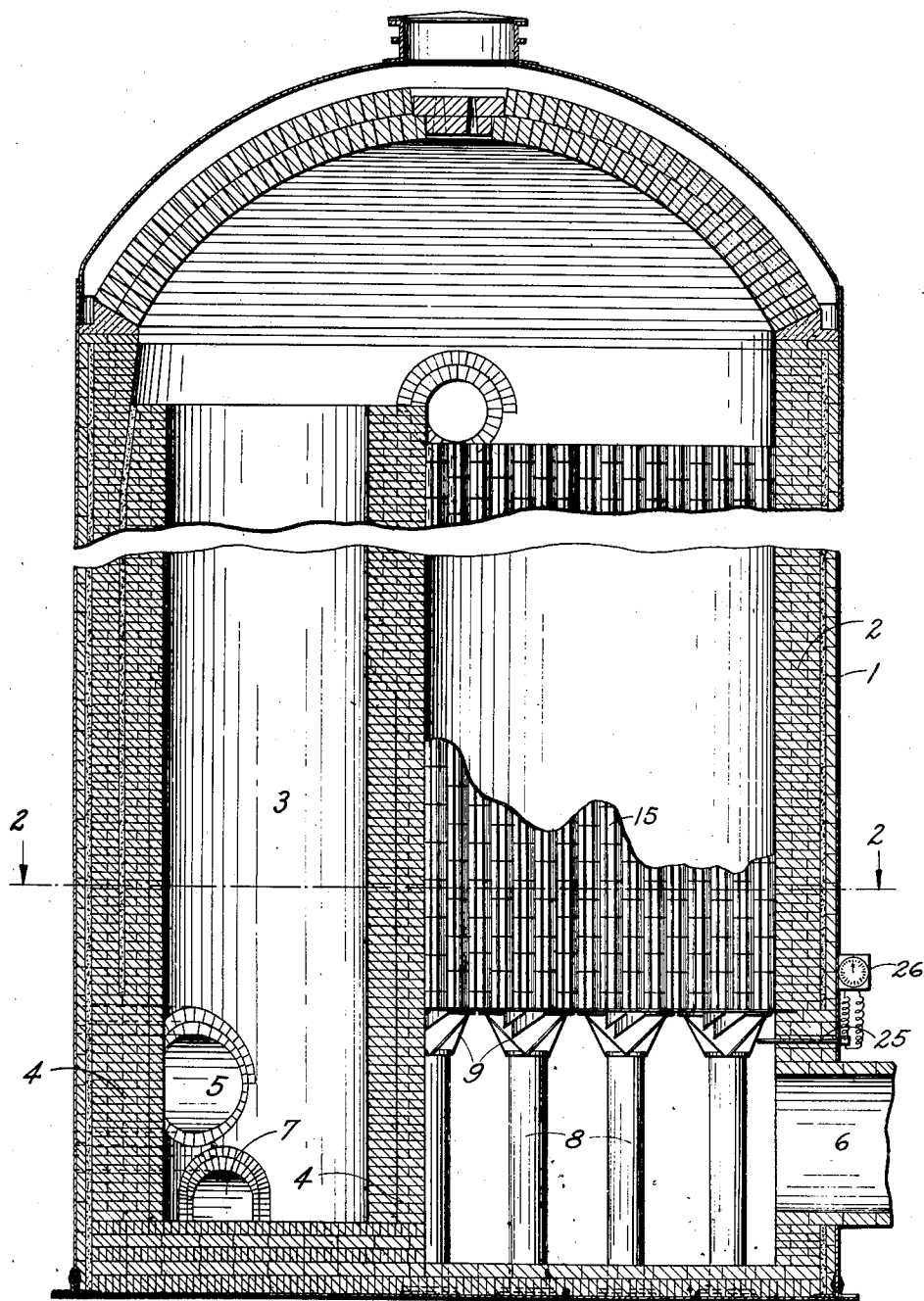


Fig. 1

INVENTOR
ARTHUR G. McKEE
BY
Rickey & Watts
ATTORNEY

Dec. 8, 1931.

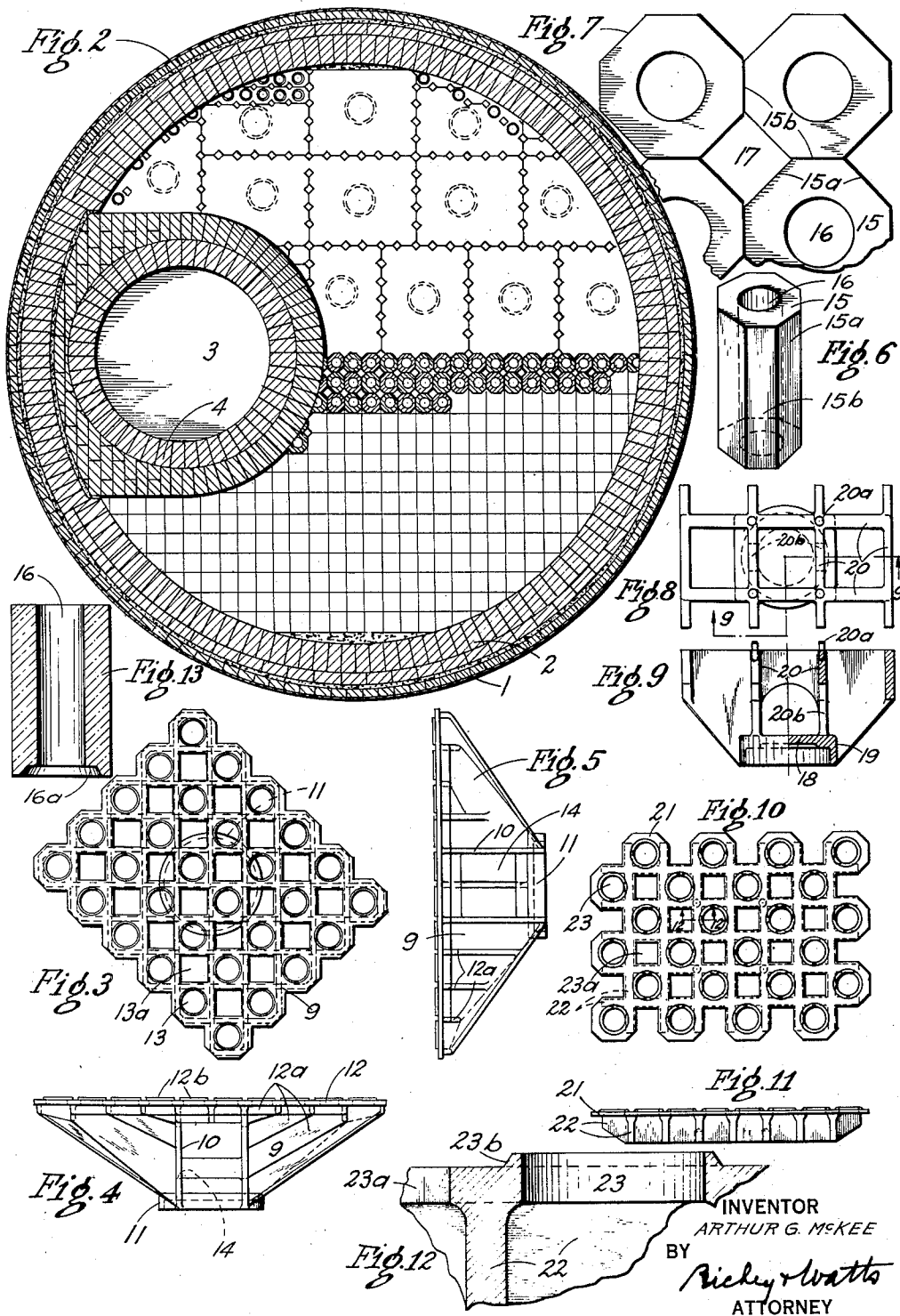
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INVENTOR
ARTHUR G. McKEE
BY
Rickey & Watts
ATTORNEY

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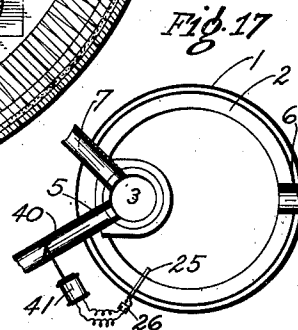
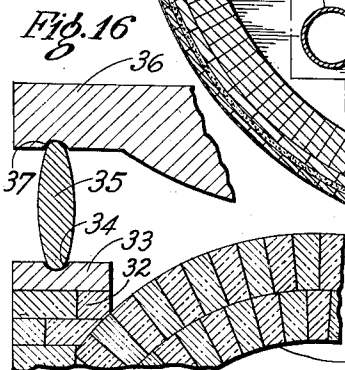
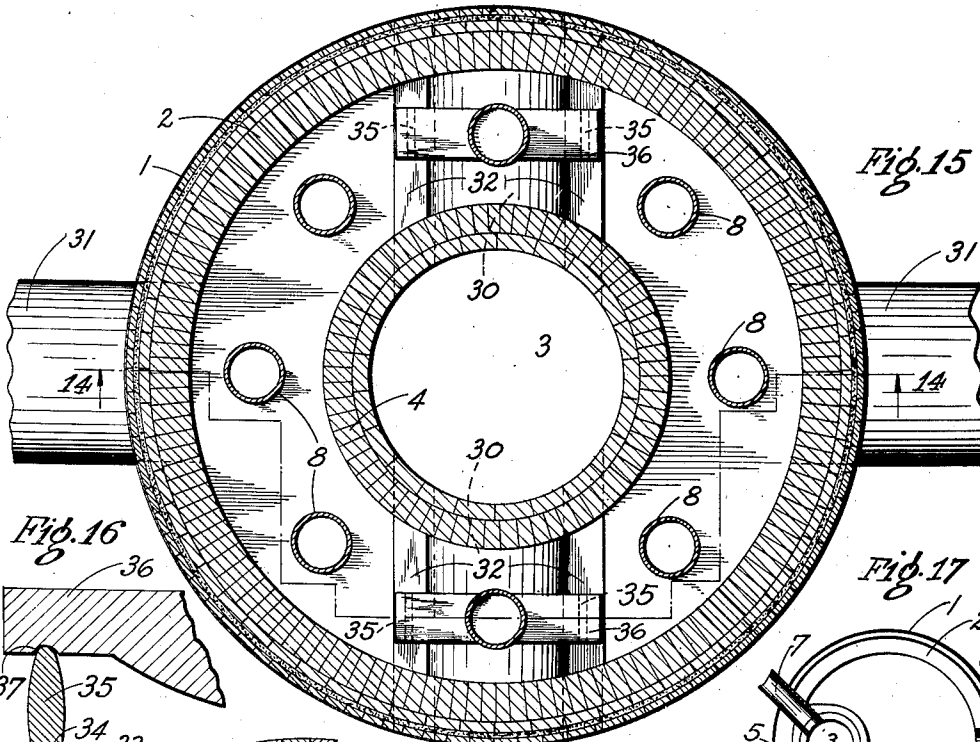
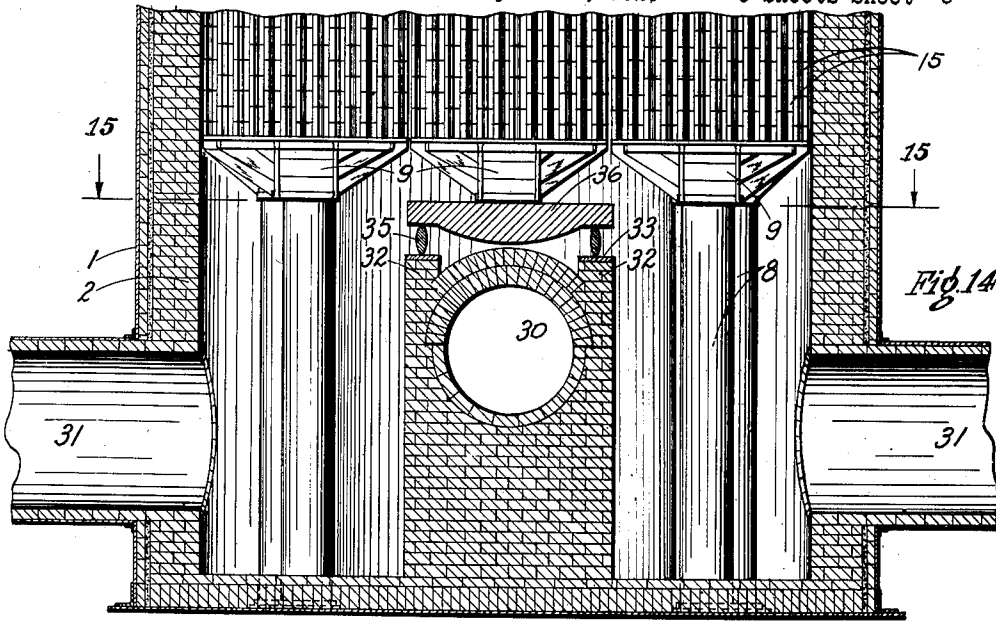
A. G. McKEE

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3 Sheets-Sheet 3



INVENTOR
ARTHUR G. McKEE
BY *Rickey & Watts*
ATTORNEYS

UNITED STATES PATENT OFFICE

ARTHUR G. MCKEE, OF CLEVELAND, OHIO

HEAT EXCHANGE DEVICE

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This invention relates to heat exchange devices of the class in which a plurality of loosely assembled members are alternately heated to high temperatures and cooled through a considerable temperature range by contact of gases therewith. It involves a new and improved means of and method for supporting such members whereby the expansion and contraction of the members take place without setting up any serious lateral or vertical strains, and for preventing harmful or destructive stresses on the members of the device.

One adaptation of my invention is a hot blast stove.

Heretofore, so far as I am aware, hot blast stoves have been constructed as follows:

A circular or elliptical combustion chamber was built inside the stove shell. It rested on the bottom of the shell and was tied into the brickwork lining of the shell from its lower end up to the top of the checkwork. A plurality of closely spaced brick piers rested on the bottom of the stove shell outside of the combustion chamber and supported on their tops a plurality of horizontally arranged brick arches tied together and to the circular brick wall inside the shell of the stove. These arches in turn carried on their tops other smaller horizontally arranged brick arches at right angles to the first arches and similarly tied into each other, the arches therebeneath, the lining of the stove, and the combustion chamber walls. Flat fire bricks or tiles spanned the spaces above the second arches and were spaced apart distances corresponding to the spacing of the checkers or tiles thereon. Circuitous and more or less restricted gas passages were thus provided through the arches and between the bricks to the checkers. The checker brick or tile were built on these flat bricks or tiles to the desired height.

There are many disadvantages inherent in such a construction among which are the following:

To insure adequate support for the checkers during the life of the stove the supporting structure of piers, arches and fire brick tiles have been built strongly and tied to-

gether into substantially an integral whole which not only seriously impeded the flow of gases therethrough by decreasing the area of passage and interposing angular bends in their line of travel thereby increasing the losses due to friction and turbulence but also was ill adapted to withstand the wide and sudden temperature changes. Due to the contraction and expansion incident to the recurrent temperature changes the supporting structure often cracked and disintegrated with resultant destruction of the stove lining. When any such failure occurred the cost of repair was very high and often required the rebuilding of the checkers as well as the supporting structure for the reason that it was impossible to replace arches with new ones and have them take up their share of the superimposed load without first removing the checkers.

Since the fire brick used in the supporting structures has small compressive and almost negligible tensile strength but still must carry the heavy load of the checkers the volume of the fire brick in the supports has been increased to such an extent that the areas of the passages for air and gas were correspondingly decreased to an amount less than was desirable with an incident increase in the frictional resistance to the movement of the gases and a very unequal distribution of the gases.

By my invention I am able to provide a heat exchange device, for example, a hot blast stove in which the supports for the checker work will last as long as or longer than the balance of the stove; in which the gas passages through the supporting structure are as large as or larger than the checker openings and very direct; in which the distribution of the gases is as free as is possible because of direct passages of very large area in which much stronger supports for the tiles can be built within the space allotted; in which ample room can be provided for access to all supports for inspection, cleaning or repairs; in which the checkers are supported in units so that each unit may expand and contract independently of and without damage to the others; in which the walls of

the checkers or tiles may safely be formed of the proper thickness for the most efficient operation of the stove; in which such repairs as may be needed by any of the checker-work units or their supports can be readily made without disturbing other similar units or imposing any added weight on such other units; and in which practically the entire lower edges or surfaces of the lowermost horizontal course of checkers or tiles are resting on the supporting means.

In the drawings accompanying and forming a part of this specification in which I have illustrated one embodiment of my invention

Fig. 1 is a fragmentary view of a central vertical section of a hot blast stove embodying my invention;

Fig. 2 is a top plan view, partly in section, of the stove of Fig. 1, and indicating certain of the supporting members;

Fig. 3 is a top plan view of one form of tile support constructed in accordance with my invention;

Fig. 4 is an elevation of the tile support being taken from the front of Fig. 3;

Fig. 5 is an elevation of the tile support, taken at right angles to the view of Fig. 4;

Fig. 6 is a perspective view of an improved checker or tile;

Fig. 7 is an enlarged top plan view of several assembled tiles;

Fig. 8 is a top plan view;

Fig. 9 is a side elevational view partly in section of part of a modified form of tile support;

Figs. 10 and 11 are top plan and side elevational views of another part of the modified form of tile support;

Fig. 12 is an enlarged sectional view taken on line 12—12 of Fig. 10; and

Fig. 13 is a sectional view of a tile from the bottom course;

Fig. 14 is a side elevation partly in section taken on line 14—14 of Fig. 15 of a hot blast stove of the central combustion chamber type embodying my invention;

Fig. 15 is a horizontal sectional view taken on line 15—15 of Fig. 14; and

Fig. 16 is an enlarged fragmentary view showing the details of the beam supporting strut;

Fig. 17 is a diagrammatic showing of temperature controlling means for a hot blast stove.

Figures 1 to 16 inclusive show a hot blast stove of a more or less conventional type comprising an outer shell 1 with suitable lining walls 2. A combustion chamber 3 is formed by walls 4 which rest on the bottom wall of the shell 1 and are spaced apart from the lining walls 2. This stove 1 is provided with an inlet 5 for gases to be burned in chamber 3, with one or more outlets 6 for the escape of gaseous products of combustion flow-

ing from chamber 3 and with a suitable passage 7 through which heated air may flow when the stove is reversed and air to be heated is brought in through passages 6.

To support the checkerwork within the stove shell and outside of the combustion chamber 3 I provide supporting members so constructed and supported as to be independent of each other, and each being free to expand and contract vertically and laterally without contacting with the others. Preferably such members take the form of a plurality of supporting columns or posts 8 which rest on the bottom wall of the shell 1. These posts are preferably cylindrical, hollow castings composed of metals or alloys resistant to the gases which contact therewith and having sufficiently high compressive and tensile strengths at the highest temperatures to which they are subjected to support the loads imposed thereon. For example, cast iron, chromium steel or chromium nickel steel and their alloys may be used for these posts. Non-metallic materials may be used for columns if desired, but occupy more space than the metal columns. Each post 8 carries at its upper end a cap 9 of suitable shape dependent on its particular location in the stove, the several caps being spaced apart from each other sufficiently for expansion and constituting a horizontal, perforated wall extending throughout the space within the lining 2 and outside of the combustion chamber walls 4.

Each cap 9 is independent of all the other caps and together with its post 8 forms a supporting unit for checkers or tiles disposed thereabove which is free to expand and contract vertically and laterally independently of the other units. The cap of Figs. 3, 4 and 5 consists of a cylinder 10 having an annular flange 11 at its lower end to locate the cap on the top of a post 8; a grid or perforated plate 12 at the upper end and webs or ribs 12a from the cylinder 10 to the under side of the plate 12 between the round openings 13 or square openings 13a in the plate. Since some of the openings 13 and 13a are above the post 8 and annular flange 11, enlarged openings 14 are provided through sides of cylinder 10 and webs 12a to permit gas to flow through such openings 13 and 13a.

The caps 9 are preferably composed of cast metal but since they are subjected to greater tensile stresses than the posts 8 and also to substantially the same compressive stresses it is preferable to use metal compositions such as chromium or chromium nickel steels for the caps although other materials having sufficient strength at the high temperatures and sufficient resistance to the action of the stove gases may be used.

Upon each plate 12 is supported a horizontal course of checkers or tiles 15 with the entire bottom surface of each tile engaging the

plate 12 and with the round holes 16 through the tiles aligned with passages 13 in the plate. Raised ribs 12b on the plate about the openings serve to position the tiles of the lowest course on the plate. The tiles of the lowest course are chamfered around the bottom of the central hole 16, as indicated at 16a, Fig. 13, to fit the ribs 12b, Fig. 4, or 23a, Fig. 12, as the case may be. Additional courses of checkers or tiles 15 are similarly supported on the first course and other courses are added until the desired vertical height of checkerwork has been attained. The tiles 15 are preferably not bonded to each other nor otherwise connected together, and are not connected to the lining walls 2 or walls 4, and the caps 9 are also not connected to walls 2 or 4 or to each other. The tiles are laid without being crowded closely together, thus leaving each tile as well as each group free to expand slightly in a horizontal direction without destructive contact with its neighbor and also free to expand vertically. As a result each post or column 8 and its cap 9 supports the group of tiles covering a given area and extending to the full height of the heat exchanging space, and each such group may be considered as a unit or member which can expand and contract laterally and vertically without any destructive contact with the adjacent groups or members or the walls 2 or 4, and which can be repaired, replaced or renewed wholly or in part or cleaned independently of the other units or members.

The entire weight of each such unit is transmitted by its column 8 to the stove foundation.

The tiles 15 (see Fig. 6) are preferably octagonal in horizontal section with their alternate outer side surfaces 15a wider than the remaining side surfaces 15b so that when the tiles are assembled as above described with the narrower surfaces 15b of adjacent tiles in contact with each other, the wider surfaces 15a define square passages 17 between the tiles which align with the corresponding square passages 13a in plate 12. In this manner the tile walls define round holes 16 and passages 17 are formed between the tile of the maximum desired size from the standpoint of efficient stove operation and at the same time the walls of the tiles are kept at the desired minimum thickness. It will be readily understood that tiles of exactly octagonal form or of any other suitable forms may be used.

In Figs. 8 to 12 is shown a modified form of cap which is made up of two separable parts. One part, which I have named a column cap, comprises a disc 18 to seat on the top of a column 8 and a depending flange 19 to locate the disc on the column, and a plurality of upstanding ribs 20 united to the disc and flange and to each other and terminating at their tops in the same horizontal plane. At the intersection of certain of the walls 20, holes are formed to receive dowel pins 20a

which project up into and serve to locate the separable grid or plate 21 on the column caps. Certain parts of the ribs 20 are cut away at 20b to form gas passages. The grid or plate 21 resembles the plate portion 12 of the cap of Figs. 3, 4 and 5 but has shallow strengthening ribs 22 integral with the underside of the plate and extending between the perforations 23, and 23a. Tile locating ribs 23b, similar to the ribs 12b, Fig. 4, project above the top of plate 21.

The columns 8 and caps are so designed that the center of the superimposed load of tiles, is, in each case, approximately on the center of the column, thus avoiding any eccentric loading of the columns 8.

The columns 8 are so located in the stove shell that when the columns caps 12 or caps and grids, 20 and 21, respectively, are assembled, the marginal projections and recesses match in such a manner as to form square openings 13a or 23a between them. In assembling, clearance is also allowed between adjacent marginal projections of the grids. Support is thus provided for all the tiles and space is allowed for free expansion or contraction of the grids.

The column caps and grids of Figs. 8 to 12 are preferably made of some material such as mentioned for caps 9.

In addition to the above mentioned advantages my invention enables me, without increasing the height of the stove, to increase the amount of heat exchanging capacity of a hot blast stove by an amount corresponding to the additional layers of checker tile which I employ in the space heretofore occupied by the several arches and bridges of the checker work supporting means in prior art hot blast stoves, this being accomplished by the relatively small vertical dimensions of the caps as compared with the much greater vertical dimensions required by the prior art arches and bridges. I also obtain a larger amount of heating surface due to the smaller openings and thinner walls of the checkers, the use of such checks being made possible by supporting the entire bottom ends of the checker walls on a rigid, non-distorting structure.

The improved construction above described with its capacity for being rapidly and highly heated is well adapted to use with temperature indicating and controlling means. In fact it is desirable to employ some such means to prevent abnormally high temperatures in the space surrounding the supporting means, such as the columns and caps illustrated.

In Fig. 1 is shown a pyrometer tube 25, which may be of any suitable form and construction, and which projects into the stove space in which the columns 8 are located. A temperature indicator or recorder 26 disposed outside of the stove shell 1 is connected to the pyrometer. An attendant may reg-

ulate the temperature in the stove as desired by observing the indicator or recorder and control the combustible gas accordingly.

Figs. 1 and 2 show a hot blast stove with the combustion chamber adjacent to one side wall. In Figs. 14 to 16 I have shown a stove in which the combustion chamber is centrally disposed in the shell. Conduits leading from outside the shell to the combustion chamber are required with such a construction but would interfere with certain of the checkerwork supports of Figs. 1 and 2 unless provision is made for supporting the checkerwork over the conduits in some other manner.

In Figs. 14 to 16, the stove shell 1 has a lining 2, a combustion chamber 3, checkerwork 4, posts 8 and caps 9 for supporting checkerwork 15. Conduits 30 extend from the outside of shell 1 to chamber 3 and afford passageways for combustible gas to enter the combustion chamber or for air blast to enter or leave the stove. Outlets 31, similar to outlets 6 of Fig. 1, permit escape of products of combustion and entry or escape of air blast.

The conduits 30 are formed by brickwork. I have extended the brickwork at either side of each conduit, as at 32, to form piers. On each pier is placed a metal plate 33 having a knife edge recess 34 in its upper surface. Knife edge members 35 rest in recesses 34 and carry beams 36 recessed at 37 to receive the members 35. The beams 36 each carry a cap 9 and serve as substitutes for posts 8 to support caps 9 over conduits 30. If desired, one knife edge 35 may be eliminated by continuing the pier 32 on up until plate 33 contacts with beam 36 when the latter is in its normal position.

In erecting the apparatus of Figs. 14 to 16 the posts 8 and caps 9 are put in place, then beam 36 is rested on members 35 and held in place until cap 9 is lowered onto beam 36 after which wedges may be inserted between cap 9 on beam 36 and adjacent caps 9. Then the checkerwork can be laid and the wedges can then be removed. The members 35 will permit free expansion and contraction of beam 36 while adjacent caps 9 will prevent any dislodgment of members 35.

In Fig. 17, which shows means for automatically regulating the temperature of a hot blast, 40 designates a valve in the conduit 5 of Fig. 1 for varying the amount of combustible gas admitted to the combustion chamber 3. 41 designates a motor actuating device of any well known type for actuating valve 40. The thermostat 25 and indicator 26 of Fig. 1 are connected by any suitable well known electrical means to the motor device 41 so that when the temperature in the space surrounding posts 8 reaches a predetermined temperature the valve 40 will be actuated to decrease or cut off the supply of combustible gas and thereby prevent further rise in tem-

perature. When the temperature falls below the predetermined temperature the valve 40 will be opened to admit more combustible gas. In this manner the temperature about posts 8 can be controlled as desired.

Having thus described my invention what I desire to secure by Letters Patent is defined in what is claimed, it being understood that various changes, modifications and alterations may be made in the above described embodiment of my invention without departing from the spirit and scope of the invention.

What is claimed is:

1. A stove checker supporting structure composed of independent units, free to move vertically, independent of each other, and provided with expansive clearance laterally, each resting on a unit support independent and free of contact with the adjacent supporting units.

2. Stove checker supporting units, each comprising a single column supporting a concentrically loaded cap out of contact with adjacent supporting members.

3. A stove checker supporting structure including a plurality of units, each unit of which is composed of a gas and heat resistant metal of adequate strength at stove temperatures to carry the load of tiles superimposed thereon and supporting practically the entire bottom surface of the bottom course of checker tiles, each unit being centrally supported on a column, independently of the adjacent supporting structures and brickwork.

4. A hot blast stove comprising a lined shell, a combustion chamber therein and a plurality of vertical groups of checkers each group being independently supported without supporting contact with adjacent groups, the said shell, shell lining, chamber and groups forming structurally independent units capable of individual expansion and contraction without destructive engagement with adjacent units.

5. In a hot blast stove, a heat exchanging unit comprising a column, a column cap and a plurality of checkers arranged vertically above and supported by the column and its cap arranged to permit unrestrained expansive and contractive movement.

6. In a hot blast stove, a column, a perforated cap seated on the column and supported solely thereby, and a plurality of hollow checkers supported on the cap and arranged to define passages aligned vertically with the perforations in the cap.

7. In a hot blast stove, a plurality of independent, adjacent, upright groups of superimposed checker tiles defining vertical gas passages, and a plurality of means each supporting one of said groups for expansion and contraction of each group independent of the remaining groups.

8. In a hot blast stove, a plurality of independent adjacent, upright groups of super-

imposed checker tiles defining vertical gas passages, and a plurality of means each supporting one of said groups for expansion and contraction of each group independent of the remaining groups, the said means having vertical perforations aligned with the said passages.

9. In a hot blast stove, a plurality of independent supporting columns resting on the stove foundation, and a plurality of groups of adjacent superimposed checker tiles, each group being supported by a column for expansion and contraction independently of the remaining groups.

10. A hot blast stove including checkerwork composed of independent, vertically extended groups of units, and means supporting each entirely independently of other such groups.

11. A hot blast stove including a lined stove shell and a plurality of groups of adjacent vertically extending columns of checkerwork units, each group of units being spaced apart from adjacent groups and being supported independently of such other groups.

12. A hot blast stove comprising a lined stove shell, a combustion chamber within the shell, and a plurality of vertically extended groups of checkerwork units within the shell, each supported on a column means resting on the bottom wall of the shell and being independent of and spaced apart from other such groups of units and from the shell lining for independent expansion and contraction.

13. A hot blast stove comprising a lined stove shell, a combustion chamber therein having its walls supported on the bottom wall of the shell and spaced apart from the lining of the shell for independent expansion and contraction, and a plurality of vertically extended groups of checkerwork units within the shell, each group of units being supported on a column resting on the bottom wall of the shell and being independent of and spaced apart from other such groups of units, and from the combustion chamber walls and from the shell lining for independent expansion and contraction.

14. In a hot blast stove, a column, a perforated cap on the column, and a horizontal course of upstanding hollow checkers supported on the cap with substantially their entire lower surfaces engaging the cap and with their passages aligned with perforations in the cap.

15. In a hot blast stove, a horizontal course of checker tiles defining vertical gas passages, and column means supportingly engaging substantially the entire lower surfaces of said tiles, said means having perforations in alignment with and at least as large as the said gas passages.

16. In a hot blast stove, a horizontal course of checker tiles defining vertical gas passages,

and column means of substantially the same horizontal extent as the course of tiles supporting the tiles and having perforations in substantially vertical alignment with the said gas passages.

17. In a hot blast stove, a horizontal course of checker tiles defining vertical gas passages and occupying substantially the entire area between the stove lining and the combustion chamber walls, and a plurality of disconnected means each supporting a portion of the said tiles independently of the remaining tiles and supporting means.

18. In a hot blast stove, a plurality of independent, checkerwork supporting units, each unit being free to expand and contract laterally and vertically without contacting with any of the other units.

19. In a blast furnace stove, a plurality of columns and column caps for supporting the checkerwork so constructed and supported as to be entirely independent of each other and each being free to expand and contract vertically and laterally without contacting with the other columns or caps.

20. In a hot blast stove, a central combustion chamber having inlet and outlet conduits, checkerwork above said conduits and means for supporting the checkerwork in independent groups, said means including a beam extending across one of the conduits carrying a group of checkerwork and supported by expansion and contraction permitting means.

In testimony whereof I hereunto affix my signature this 23d day of April, 1929.

ARTHUR G. McKEE.