May 6, 1958 L. B. RIES 2,833,532

CHECKER-BRICK AND CHECKER-WORK CONSTRUCTION FOR REGENERATORS

Filed Sept. 8, 1955 2 Sheets-Sheet 1

FIG. 1.

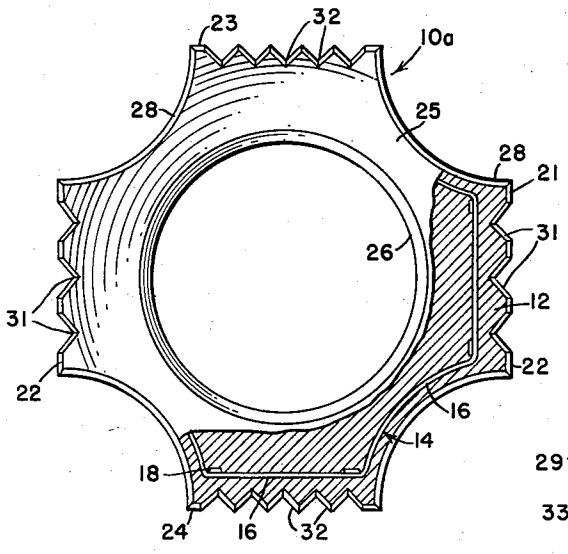


FIG. 2.

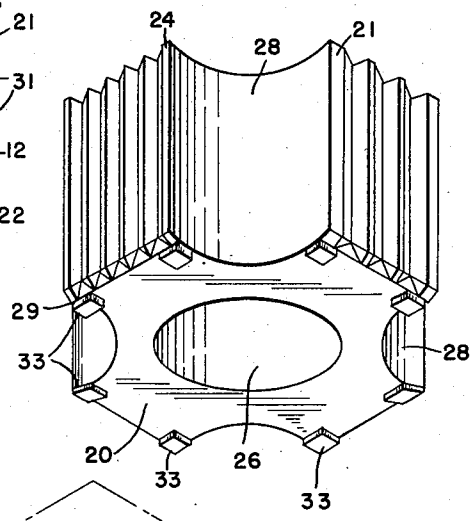
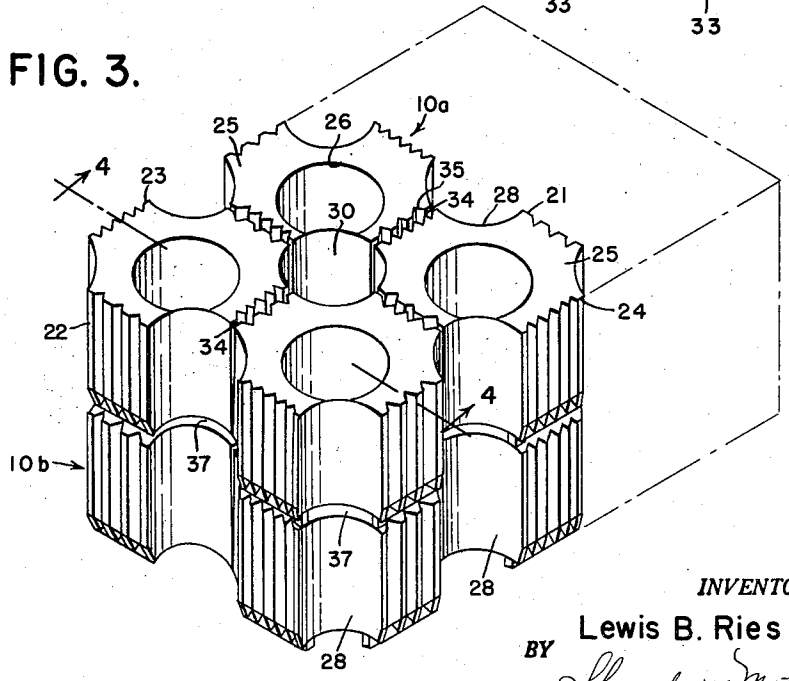


FIG. 3.



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FIG. 4.

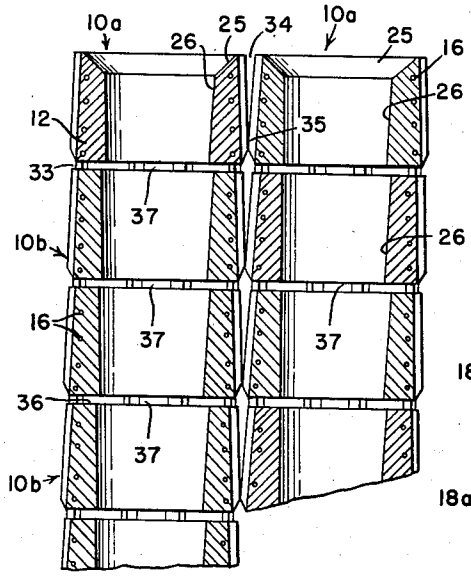


FIG. 5.

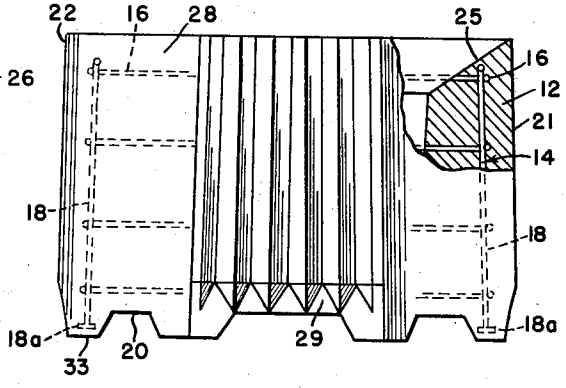


FIG. 7.

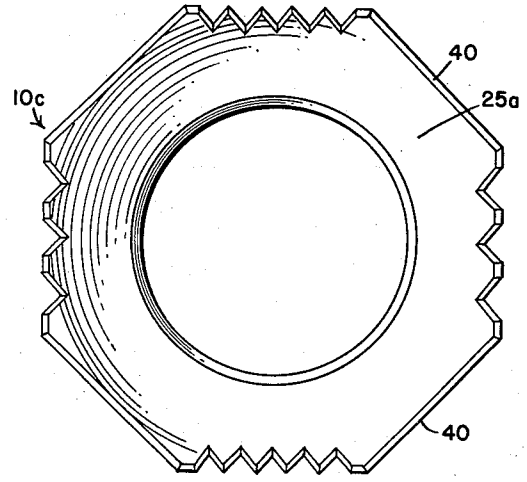
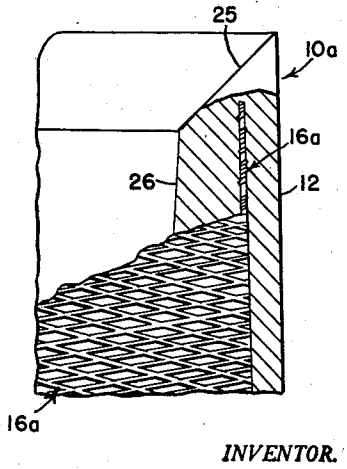


FIG. 6.



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CHECKER-BRICK AND CHECKER-WORK CONSTRUCTION FOR REGENERATORS

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Application September 8, 1955, Serial No. 533,115

5 Claims. (Cl. 263—51)

This invention relates to improvements in heat exchangers and is directed particularly to a new and improved design for checker-bricks and checker-work construction for regenerators.

Heat exchangers or regenerators used in connection with metallurgical furnaces consist of chambers in which are stacked checker-brick substantially to the full height of the chamber. The function of the checker-brick or checker-work construction is to absorb heat from the products of combustion produced in the burning of the fuel in the furnace and to give up the absorbed heat to air used in running or operating the furnace. In the operation of an open hearth furnace, for example, the conventional practice is to have a regenerator at each end of the furnace structure and while air is brought in at one end of the furnace through a regenerator where it absorbs heat from the previously heated checker-work therein, hot gaseous products of combustion are passed out through the regenerator at the opposite end of the furnace through the checker-work and heat is absorbed by the latter. At automatically determined intervals the flow of air and heated gases through the regenerators is reversed.

Various means are provided to measure the temperature of the waste gases coming from the checkers and when the temperature of such gases reaches a certain maximum, mechanism is actuated to reverse the flow of the air and waste gases through the exchangers or regenerators.

The efficiency of the regenerators is dependent to a great measure upon the efficiency of the heat absorbing capacity or ability of the checker-brick and this affects to a great extent the efficient functioning of the furnace.

Heat transfer is affected by many factors among which are not only the size and thickness of the brick but the amount of surface area with which the air and products of combustion may come into contact and, more importantly still, the cleanliness of such surfaces.

In view of the foregoing, a particular object of the present invention is to provide a new and improved form of checker-brick and checker-work construction, by means of which the efficiency of the regenerator is materially greater than that of generators of present known construction.

Another object of the invention is to provide a new and improved checker-brick which provides in the checker-work built up therewith, a greater exposed surface area for contact with the hot gases and the air whereby greater and more rapid heat absorption will be attained with consequent increased economy in the operation of the regenerators and the furnace.

Still another object of the invention is to provide, in a manner as hereinafter set forth, a new and improved checker-brick which can be easily and quickly set up in the formaiton of the checker-work without bringing into abutting relation any material amount of surface area, even though the checker-brick are placed in abutting, side-by-side relation, whereby the exposure of a maximum area for contact with heated gases and air is obtained.

One problem associated with the operation of the regenerator is the choking o fthe checkers by slag and dust carried over with the products of combustion. As a result of this choking of the checkers, the furnace must be closed down at more or less frequent intervals until the checkers are cleaned or replaced.

In the light of the foregoing, a further and important object of the present invention is to provide, in a manner as hereinafter set forth, a new and improved checker-brick for forming the top course in the checker-work, which is so constructed as to reduce to a minimum the accumulation of slag and dust upon the top of the checker-work.

Still another object of the invention is to provide, in a manner as hereinafter set forth, a new and improved form of checker-brick for use in all of the courses making up the checker-work construction which, while providing a maximum exposed surface area, is designed to reduce to a minimum the accumulation of dust and slag on the exposed surfaces so that the working efficiency of the regenerator is kept high over a longer period and the furnace does not have to be closed down for the cleaning or replacement of the checkers as frequently as is the case in the use of the checkers of present known construction.

Still another object of the invention is to provide, in a manner as hereinafter set forth, a new and improved checker-brick having side faces formed in a novel manner whereby the brick when set up in courses in the construction of checker-work will have the smallest amount possible of contacting surface area with flue passages formed between the opposing surfaces.

Another object of the invention is to provide, in a manner as hereinafter set forth, a new and improved checker-brick of approximately cubical form having a central vertical flue passage and side wall flutes or grooves arranged in a novel manner whereby when the bricks are set up in the formation of the checker-work the central vertical flue passages will align to form continuous vertical flues and the side wall flutes or grooves of each brick will cooperate with grooves or flutes of an adjacent brick to form intervening vertical air and gas passages.

A further object of the invention is to provide, in a manner as hereinafter set forth, a new checker-brick construction of such character that when the bricks are laid up in constructing the checker-work there will be formed transverse flues comunicating with vertical flues to thereby provide additional heat transfer surfaces between vertically spaced faces or surfaces of the superposed bricks.

An additional object of the invention is to provide a reinforced refractory brick which will withstand extremes of temperature and which will provide a large number of passages for the air and gases.

The foregoing and possibly other objects of the present invention are attained through the provision of a checker-brick of approximately cubical form having a central vertical passage therethrough which is slightly tapered to be of larger diameter at the top than at the bottom. Portions of the vertical corners or edges of the brick are cut away to form either flat or inwardly bowed surfaces and the vertical side faces of the brick between the cut away corner portions are formed with a number of vertical slots, grooves or flutes, the number and form of which on two opposite sides are different from the number and form of those on the other two opposite sides.

Each brick is provided on its lower face with a number of relatively small short feet whereby when the checker-bricks are laid one upon the top of the other

with the vertical passages aligned, horizontal or transverse passages will be formed.

When the bricks are laid up in horizontal courses the vertically fluted or channeled side faces will be in abutting opposed relation and the brick are laid up with channels of one form or type opposing those of a different form or type on the adjacent brick wall so that interengagement between the channeled side wall faces of adjacent bricks cannot occur and vertical air passages will be formed.

The checker-work construction produced by the use of checker-brick of the present invention consists of a number of horizontally disposed courses. The checker-brick of all of the courses with the exception of the uppermost one have flat or horizontal top surfaces. For the top or uppermost course the checker-bricks are of the same construction as the lower ones with the one exception that the top surfaces slope downwardly and inwardly from the outer horizontal corners to the central flue passage. By this construction the collection or deposit of flue dust upon the tops of the bricks of the top course is materially reduced.

The invention will be best understood from a consideration of the following detailed description taken in connection with the accompanying drawings forming a part of the specification with the understanding, however, that the invention is not confined to a strict conformity with the showing of the drawings but may be changed or modified so long as such changes or modifications mark no material departure from the salient features of the invention as expressed in the appended claims.

In the drawings:

Fig. 1 is a view in top plan of a checker-brick constructed in accordance with one embodiment of the present invention.

Fig. 2 is a perspective view looking at the under side of the checker-brick constructed in accordance with either of the first two described embodiments where the corner portions are channels or in accordance with the third described embodiment where the vertical corner portions may be flat surfaces.

Fig. 3 is a top perspective view of a portion of a checker-work construction made up in accordance with the present invention and with checker-brick of the first two described embodiments.

Fig. 4 is a vertical sectional view taken substantially on the line 4—4 of Fig. 3.

Fig. 5 is a view in side elevation of the checker-brick shown in Fig. 1, with a portion broken away.

Fig. 6 is a detail view of a portion of a brick showing the expanded metal reinforcement.

Fig. 7 is a top plan view of the third described embodiment of the checker-brick structure.

Referring now more particularly to the drawings it will be seen that two forms of the checker-brick are illustrated which are designated **10***a* and **10***b*. It will also be seen that these two forms of the checker-brick are in all material respects alike with one exception which is that the checker-brick designated **10***a* has its top surface sloping downwardly and inwardly from the outer top edges while the checker-brick **10***b* has its top surface at right angles to the sides of the brick and, therefore, horizontal when the brick is set up in the checker-work construction.

A third embodiment of the checker-brick construction illustrated in Fig. 7 is generally designated **10***c* and this will be hereinafter more particularly referred to.

As previously stated the form of the two bricks designated **10***a* and **10***b* is the same with the exception that brick **10***a* has a downwardly and inwardly sloping top surface while brick **10***b* has a flat horizontal or transverse surface. Accordingly the description will be directed specifically first to the brick which is generally designated **10***a*. The form of the brick can be generally described as being approximately cubical and the material of the body **12** may be any one of those materials conventionally used for forming checker-brick such as silica, magnesite or the like.

The body **12** is shaped in a mold or in any other suitable manner upon a suitable reinforcing structure which is generally designated **14** and which is shown particularly in Figs. 1 and 5 as comprising a series of vertically spaced encircling wires **16** joined at intervals, particularly where bends occur, by the vertical rods or wires **18**, the lower ends of which are bent to form small reinforcing frames **18***a* for the hereinafter described feet upon the under faces of the bricks.

The body **12** has a flat bottom face **20**, the four side faces **21**, **22**, **23** and **24** and a top face **25**.

Extending vertically through the center of the body **18** is a flue passage **26**, the top end of which is of slightly greater diameter than the bottom end as is clearly shown in Fig. 4.

As is also shown in Fig. 4 and in Fig. 5 the top face of the brick **10***a* slopes downwardly and inwardly from the outer horizontal top corners of the side faces to the central flue passage **26**. This forms a substantially funnel-like top which has a relatively steep inclination which causes dust and slag particles falling thereon to move inwardly toward the central passage **26** thus materially reducing the accumulation of dust upon the top of the brick.

Between the adjoining side faces of the brick are formed the vertical channels or corner recesses **28**. These channels or recesses **28** are here illustrated as being of approximately quarter circular and are formed in what would be the vertical corner portions of the substantially cubical brick. As will be readily apparent by the provision of these four vertically extending corner channels of approximately quarter circular cross-section, when four of the bricks are placed together in side-by-side relation to form a square structure these quarter circular channels where they come together in the center of the group form a substantially circular flue passage as indicated at **30** in Fig. 3 where a number of the checker-brick are shown assembled to form a portion of a checker-work construction.

The outer side faces **21**, **22**, **23** and **24** of the brick are inclined or sloped slightly so as to form the brick with a slight taper from the bottom to the top and these inclined, sloping or tapering side faces are formed with a plurality of grooves or flutes which extend from the top of the brick to within a short distance from the bottom as is clearly shown in Fig. 2 so that each side face has a low or narrow bottom portion **29** which is smooth or free of the flutes or channels.

The flutes or channels formed along two opposite bases of the brick as, for example, the faces **21** and **22**, are of different number and width from those formed along the other two opposite faces **23** and **24**. For example, the faces **21** and **22** are shown as having the V-shaped channels **31** of greater width than the channels **32** formed in the two faces **23** and **24**. With this arrangement, when the bricks are set up in side-by-side relation a face **21** of one brick may be placed against a face **23** of another brick and the channels cannot interlock. Obviously channels of other form may be provided and also if desired, each of the four faces may have a number and form of channel different from the others.

It is also to be understood that while the channels or recesses at the corners of the brick, designated **28**, have been shown and described as being quarter circular they may be of other form if desired, the principal purpose being for the formation, in the assembly of the bricks, of vertical flues or passages at the adjoining corners of the bricks.

As shown in Fig. 1, the encircling wires **16** forming a part of the reinforcement follow the outside cross-sec-

tional contour of the brick so that each of the horizontally disposed wires **16** has four straight portions each of which parallels an outer face of the brick and intermediate curved portions which follow the curvature of the corner channels or recesses **28**.

The vertical rods or wires **18** are preferably located in the angles where the ends of the curved portions of the wires **16** join the straight portions.

As previously stated the lower ends of each of the vertical rods or wires **18** are formed or shaped to provide small frames **18***a* and each of these frames **18***a* is embedded in a relatively short or low foot designated **33** which is an integral molded part of the bottom face **20** of the brick. Thus in the brick here illustrated there are provided eight of these feet, there being one at each end of each side face of the brick.

While the vertical reinforcing wires **18** have been illustrated and described as being adjacent to the ends of the side faces or in the angles formed between the straight portions and the curved portions of the horizontal reinforcing wires **16**, it is to be understood that the invention is not limited to the placement of the vertical wires in these positions and it is also to be understood that the feet **33** on the bottom of the brick may be located in other positions if desired. The number and positioning of the feet shown and described, however, has been found satisfactory.

It is also to be understood that the specific reinforcement consisting of the horizontal encircling wires **16** and the vertical wires or rods **18** shown and described is only one of a number of suitable reinforcements which may be employed. For example, use may be made, for reinforcing the brick structure, of the sheet material known as metal lathe or expanded metal which is used for supporting wall plaster. Fig. 6 shows a portion of a brick in which this expanded metal is shown and which is designated **16***a*. The brick structure is otherwise the same as any one of the three brick forms illustrated.

Fig. 3 illustrates a portion of a checker-work construction using the checker-bricks of the present invention. In setting up this checker-work the bricks are laid in side-by-side relation in horizontal courses or layers as is conventional practice and all of the courses from the bottom up, with the exception of the topmost course are made up of the checker-bricks designated **10***b* while the top course is made up of the checker-bricks designated **10***a*.

As stated when the checker-bricks are laid up in side-by-side relation the side faces of the bricks are opposed and are abutted one against the other as shown in Fig. 4 and as is also shown in this figure and in Fig. 3 when the bricks are so assembled a slight space will be formed between the opposing brick faces at the tops of the bricks as indicated at **34** and the opposing flutes or grooves will form vertical passages or flues **35**.

As hereinbefore stated the bricks **10***b* are of the same construction as the bricks **10***a* with the exception that the tops thereof are flat and these flat tops are designated **36**.

As shown in Fig. 4, when the bricks are set to form the checker-work construction they will be vertically aligned so that the central flue passages **26** will be aligned to form a continuous flue passage through the checker-work construction. As is also shown in Fig. 4 when the passages are in such aligned relation the smaller end of each passage **26** will be directly over the larger end of the passage of the underlying brick. Consequently, it will be apparent that no ledges will be formed at the tops of the bricks around the passages **26** upon which dust and dirt may accumulate as such dust in falling through one passage will be discharged directly into the next underlying passage below the top of the brick through which it is formed.

It will also be seen upon reference to Fig. 4 that, when the bricks are set up one upon the other, the feet **33** of each brick will rest upon the flat top surface **36** of the next underlying brick thus forming the horizontal or radial passages **37** through which air and hot gases may pass. This provides additional surface area for contact with the air or hot gases to increase the heat transfer value of the checker-brick construction.

In the checker-bricks designated **10***a* and **10***b* the vertical corner portions lying between the faces **21**, **22**, **23** and **24** have been illustrated and described as being in the form of channels, preferably of quarter circular transverse outline or other curved formation. However, it is also contemplated to make bricks having either a flat top or with the dished or funnel shaped top surfaces like the surfaces **25** of the bricks **10***a*, with flat vertical corner faces between the fluted side faces as illustrated in Fig. 7. In this figure the third modified form of the brick is generally designated **10***c* and the referred to vertical flat corner surfaces are designated **40**. The top surface of this modified form is designated **25***a* and may either be sloping like the surface **25** for the brick **10***a* or it may be flat like the surface **36** for the brick **10***b*. The other features of the brick construction for this modified form **10***c* are the same as in the first two forms and accordingly no detailed description of the same is given or believed to be necessary.

While no illustration has been made of a half brick it is believed that it is obvious that the brick in any one of the forms illustrated can be made in half form by which is meant that it can be made as though divided vertically in a plane passing through and perpendicular to two opposite side faces, where such a half brick may be desirable for filling out or completing the checker-work construction.

From the foregoing it is believed that it will be readily apparent that there is provided by the present invention a new checker-brick which is of such novel form that a checker-work construction built therewith will have many desirable advantages over checker-brick constructions made with bricks of present known design, which advantageous features have been particularly pointed out in the objects forming the first part of the specification.

I claim:

1. A regenerator construction comprising stacked superposed refractory bodies of substantially rectangular cross-section, the stacks being arranged in side-by-side relation forming layers made up of parallel rows, the bodies in said rows being in abutment at the bottom portions thereof with the opposing sides in upwardly diverging relation, said bodies having vertical passages therethrough and aligned to form vertical flues, said bodies each having vertical corner portions formed to provide other vertical flues when in assembly with corresponding portions of adjoining bodies in the layers, and the bodies of the top layer each having its top surface inwardly and downwardly sloping and merging with the vertical passage therethrough and means forming vertical passageways between said upwardly diverging opposing sides of the bodies.

2. A checker-brick comprising a refractory body of substantially rectangular cross section having substantially vertical side surfaces of a width less than the full width of the body and having top and bottom surfaces, the body having a vertical passage opening through said top and bottom surfaces, the portions of the body between said side surfaces being designed to form a portion of a flue surface in a prescribed association with a number of similarly designed surfaces, and said side surfaces being inclined inwardly from the bottom to the top said side surfaces each having a plurality of grooves formed vertically thereof.

3. A regenerator construction comprising stacked superposed refractory bodies of substantially rectangular cross-section, the stacks being arranged in side-by-side relation forming layers made up of parallel rows, the bodies in said rows being in abutment at the bottom por-

tions thereof with the opposing sides in upwardly diverging relation, said bodies having vertical passages therethrough and aligned to form vertical flues, said bodies each having vertical corner portions formed to provide other vertical flues when in assembly with corresponding portions of adjoining bodies in the layers, and the bodies of the top layer each having its top surface inwardly and downwardly sloping and merging with the vertical passage therethrough, said upwardly diverging opposing sides of the bodies being grooved vertically and the opposing grooves forming a number of vertical channels between the bodies.

4. A checker-brick comprising a refractory body of substantially rectangular cross section having substantially vertical side surfaces of a width less than the full width of the body and having top and bottom surfaces, the body having a vertical passage opening through said top and bottom surfaces, the portions of the body between said side surfaces being designed to form a portion of a flue surface in a prescribed association with a number of similarly designed surfaces, and said side surfaces being inclined inwardly from the bottom to the top, said side surfaces each having a plurality of grooves formed vertically thereof, the number of grooves differing on different surfaces.

5. A checker-brick comprising an indurated body of refractory material having a substantially cubical form,

the body having top and bottom surfaces and inclined side surfaces of a width slightly less than the width of the body, said inclined side surfaces being separated by vertical corner surfaces designed to form a portion of a flue when arranged in a prescribed association with a number of similar corner surfaces, the body having a vertical flue passage therethrough, said bottom surface being in a plane substantially at right angles to the flue, and supporting feet formed upon the bottom surfaces each adjacent to an angle of intersection between the bottom of an inclined side surface and the bottom of a vertical corner surface, said sloping side surfaces having grooves therein extending vertically thereof.

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