

[54] **COMBUSTION CHAMBER BURNER
THROAT CONSTRUCTION**

3,285,315 11/1966 Voorheis..... 431/8 X
3,641,951 2/1972 Binasik et al. 110/1 A

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[21] Appl. No.: **216,201**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 1,653, Jan. 9, 1970, Pat. No. 3,641,951.

[52] U.S. Cl. **110/1 A, 431/187**

[51] Int. Cl. **F23m 5/02**

[58] Field of Search..... 431/350, 187, 8;
110/1, 182.5

References Cited

UNITED STATES PATENTS

2,192,682 3/1940 Anderson..... 431/187 X

[57] **ABSTRACT**

A burner throat that is shaped in accordance with the shape of the combustion chamber in which the throat is installed to afford flame shaping so that the flame is distributed throughout the combustion chamber. A burner throat formed of a plurality of individual segmental bricks, the totality of which define the throat shape. Each brick is shaped in respect to its position in the throat to direct the flame appropriately within the combustion chamber. A burner throat formed at the site of installation with a plurality of appropriately shaped segmental bricks.

10 Claims, 10 Drawing Figures

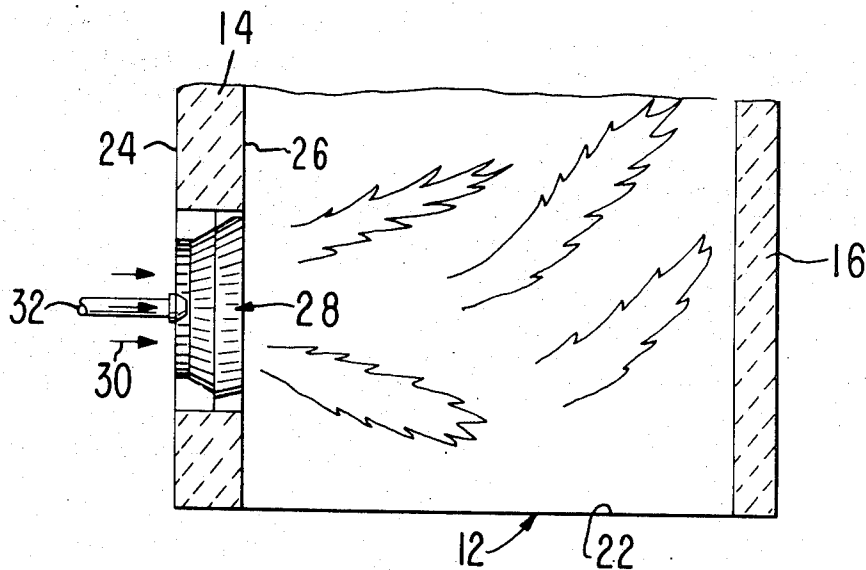


FIG. 1

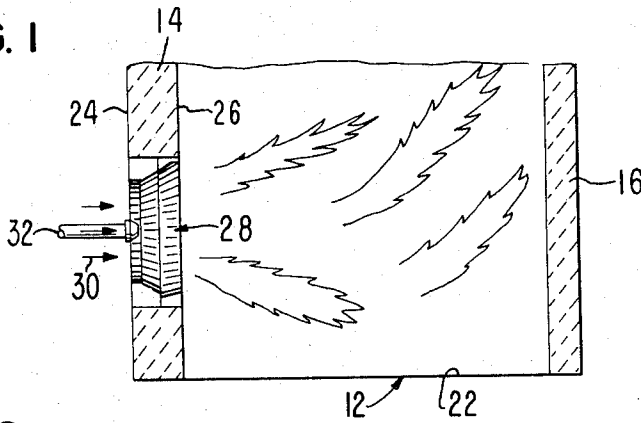


FIG. 2

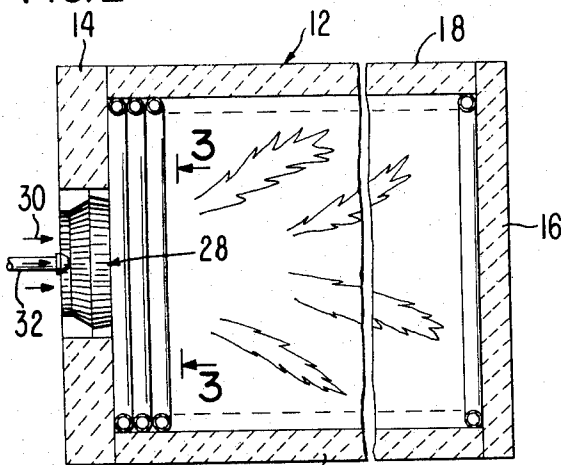


FIG. 4

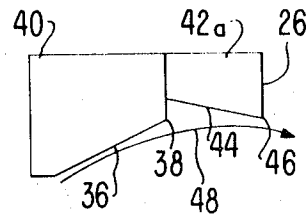


FIG. 5

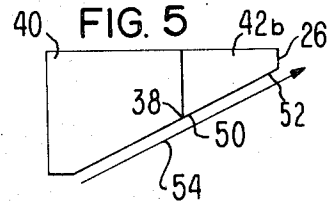


FIG. 6

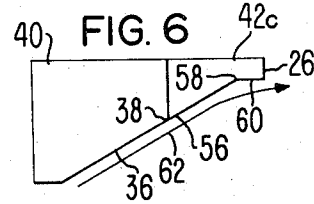
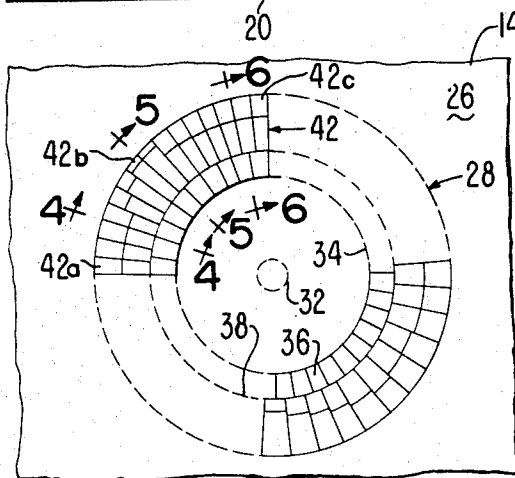


FIG. 3



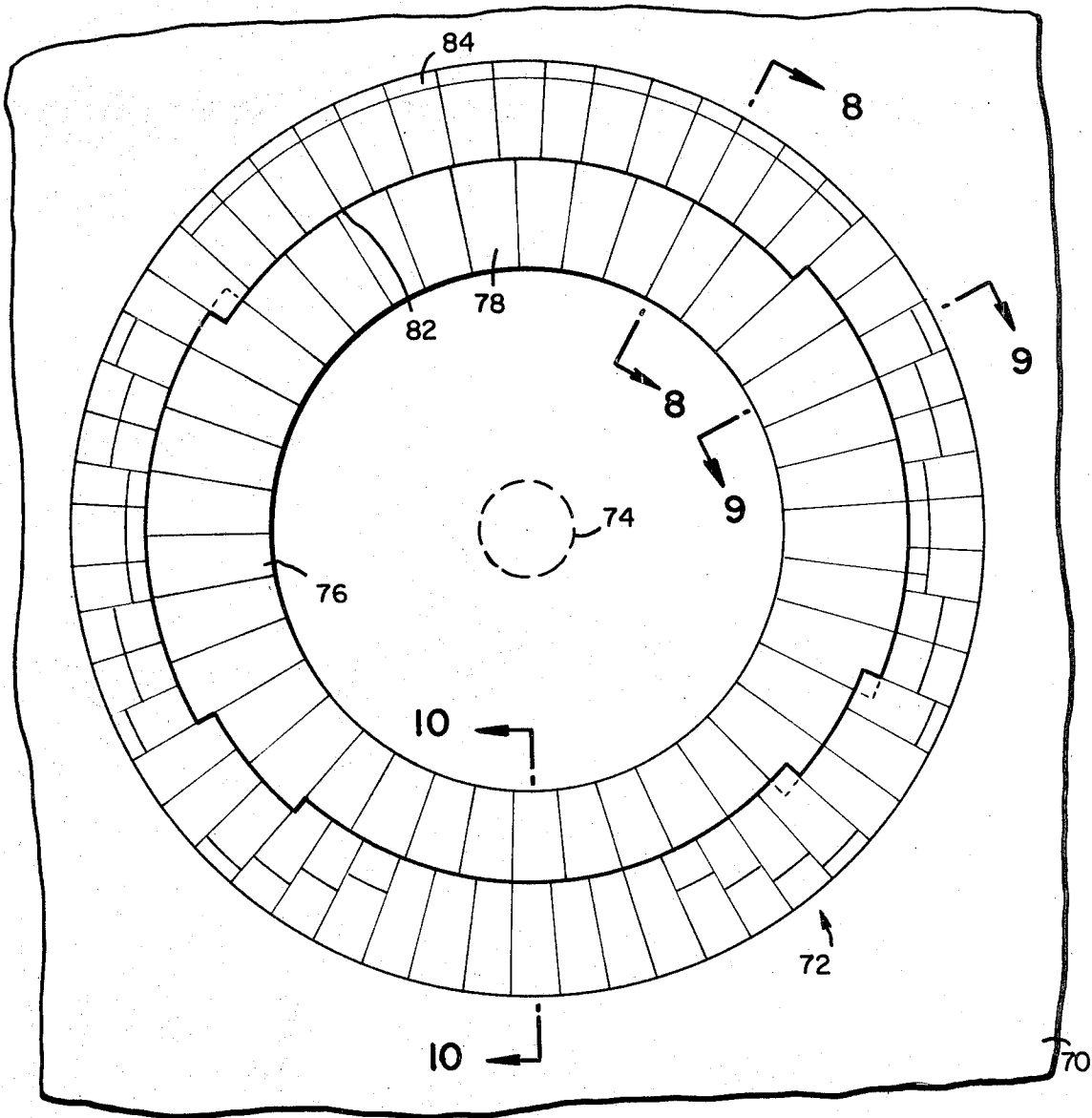


FIG_7

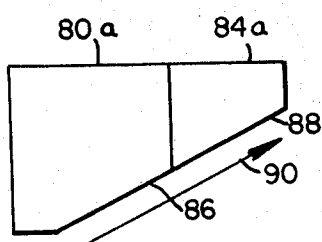


FIG_8

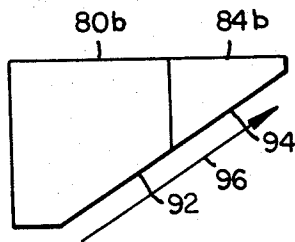


FIG_9

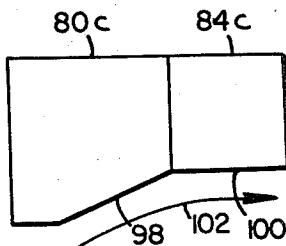


FIG_10

COMBUSTION CHAMBER BURNER THROAT CONSTRUCTION

This application is a continuation-in-part application of our earlier copending Pat. application, Ser. No. 1,653, filed Jan. 9, 1970, for "Combustion Chamber Burner Throat Construction" and now U.S. Pat. No. 3,641,951.

This invention relates to a burner throat construction for a furnace or like combustion chamber and more particularly to a burner throat configured to afford flame shaping so that the flame substantially totally fills the combustion chamber with which the structure of the invention is used.

Optimum operation of a combustion chamber is achieved by substantially filling the combustion chamber with flame. For example, in combustion chambers of water tube boilers, the interior surface of the combustion chamber is lined with water tubes, and the efficiency and amount of steam production varies in direct proportion to the degree to which the flame fills the combustion chamber and heats each of the tubes uniformly. Firing such combustion chamber through a central burner throat opening requires special care, particularly in combustion chambers having a rectangular cross section. This is so because the typical burner throat produces a flame having a more or less circular cross section, which does not deliver adequate flame to the corners at which the walls of the combustion chamber intersect. The present invention has for its principal object the provision of a burner throat construction that affords flame shaping so that the flame substantially fills the combustion chamber including the corners thereof. This object is achieved by providing a noncircular burner throat that has relieved or outwardly flared portions opposite the corners of the combustion chamber whereby the flame created by the burner can leak out radially of the central axis of the burner throat, thereby to fill the corners of the combustion chamber.

Another object of the present invention is to provide a burner throat construction, the particular shape of which can be readily adapted to existing combustion chambers without modification of the combustion chamber. This object is achieved by providing a burner throat construction that is formed of segmental tiles wherein the shape and position of each tile can be established to achieve the desired flame shaped in accordance with the size of the combustion chamber.

In attaining the previously stated object, the invention provides a plurality of throat tiles or bricks that have throat defining faces which diverge radially outward toward the inner surface of the burner wall in which the throat is installed. Each of the individual tiles or bricks is tapered so that a plurality of such bricks can be fit together to define a complete burner throat structure. By this expedient, the necessity for casting large sections of a burner throat wall is eliminated. In a preferred form of the invention, the outer surfaces of the totality of the arch bricks is circular whereas the inner surface, the primary surface as far as flame shaping is concerned, is irregular in accordance with the shape of the combustion chamber. Thus, the burner throat may be formed by outer and inner rings if bricks or tiles, the outer ring diverging outwardly uniformly and the inner ring diverging irregularly to afford flame shaping. According to an alternative embodiment of the present invention, both the outer ring and inner ring of throat

tiles may diverge irregularly to afford a greater degree of flame shaping.

The foregoing together with other objects, features, and advantages, will be more apparent after referring to the following specification and accompanying drawing in which:

FIG. 1 is a partially diagrammatic elevation view of a combustion chamber provided with a burner throat according to the present invention;

FIG. 2 is a partially diagrammatic plan view of the combustion chamber of FIG. 1;

FIG. 3 is taken along line 3—3 and is an elevation view of the burner throat looking axially thereof from the interior of the combustion chamber;

FIG. 4 is a side view of a specific segment of the burner throat taken along 4—4 of FIG. 3;

FIG. 5 is a view of still another segment of the burner throat taken along line 5—5 of FIG. 3;

FIG. 6 is a view of yet another segment of the burner throat taken along line 6—6 of FIG. 3;

FIG. 7 is an elevation view, similar to FIG. 3, of a burner throat according to an alternative embodiment of the present invention looking axially thereof from the interior of the combustion chamber;

FIG. 8 is a side view of a specific segment of the burner throat taken along line 8—8 of FIG. 7;

FIG. 9 is a view of still another segment of the burner throat taken along line 9—9 of FIG. 7; and

FIG. 10 is a view of yet another segment of the burner throat taken along line 10—10 of FIG. 7.

Referring more particularly to the drawings, reference numeral 12 indicates a combustion chamber formed by a front wall 14, a rear wall 16, and sidewalls 18 and 20. The combustion chamber also includes a floor 22 and a roof not shown. The interior surfaces of the walls, roof, and floor delimit the boundaries of the combustion chamber. Front wall 14 has an outer face 24 and an inner face 26 between which extends a burner throat opening 28. Air is supplied to the combustion chamber through throat opening 28 by suitable ducts not shown along a path indicated by arrows 30. Fuel such as oil or the like is supplied through a suitable burner nozzle 32.

Burner throat 28 defines a circular opening 34 at outer face 24 of front wall 14. Opening 34 is concentric with nozzle 32. The outer portion of burner throat 28, that is, the portion between circular opening 34 and a plane intermediate outer face 24 and inner face 26, defines an inwardly diverging frusto-conical surface 36 which terminates in a circle at 38 that has a diameter larger than that of circular opening 34. Frusto-conical portion 36 permits air traveling along path 30 into the burner throat to expand or diverge uniformly radially outward of the central axis of the throat. The radial divergence is uniform or symmetrical about the central axis of the throat, because circle 38 is concentric with outer circular opening 34.

Although frusto-conical surface 36 can be formed by a single refractory body, it is preferred that it be formed by a plurality of refractory tiles 40 which as can be seen in FIG. 3 taper in a radial sense so that the totality of the tiles circumferentially fill the throat opening. In the example shown in the drawing, forty throat tiles are included, as a consequence of which each throat tile tapers at about a 9° angle.

Extending between circle 38 and inner face 26 of wall 14 are a plurality of specially configured refractory

bricks 42. Each individual brick 42 has a specific shape so as to form a throat with a shape suitable for substantially filling the combustion chamber. More particularly, bricks 42a which are adjacent to sidewalls 18 and 20 are shaped to guide the flame inwardly so that it does not impinge on the sidewalls which are relatively close to the axis of the throat. With reference to FIG. 4, brick 42a defines adjacent circle 38 a relatively wide throat shape as indicated at 44 and at inner face 26 a relatively confined throat opening portion indicated at 46. Thus air moving through the throat opposite brick 42a is deflected inwardly along the path indicated by arrow 48, and the flame follows a corresponding path as a consequence of which the flame does not directly impinge on the sidewalls of the combustion chamber. Obviously, the degree to which portion 46 converges with respect to portion 44 of brick 42a can be established at any suitable amount depending on the distance from the throat opening to the wall adjacent which the brick is positioned.

A brick 42b, which is in approximate alignment with and adjacent to the corner formed by the intersection of sidewall 20 and the roof of the combustion chamber, is formed to permit substantial flame to bleed outwardly so as to fill the corner with flame. With reference to FIG. 5, brick 42b flares outwardly from a point 50 adjacent circle 38 to a point 52 on inner wall 26. Consequently, the air moving through the throat past brick 42b causes the flame to bleed or expand outwardly along a path indicated by arrow 54 so that the corner of the combustion chamber opposite brick 42b is supplied with adequate flame.

A brick 42c, positioned at the top of the throat and adjacent to the roof of the combustion chamber, is configured to permit only a slight degree of flame divergence to avoid impingement of the flame on the roof of the combustion chamber, but to permit the flame to expand upward to fill the combustion chamber with flame. Brick 42c, as can be seen from FIG. 6, has a point 56 adjacent circle 38 that lies in the same radial position as the circle to form a smooth transition between frusto-conical portion 36 and flame forming portion of the throat structure. Brick 42c continues smoothly to a point 58 inwardly of circle 38 from which the brick surface has a portion 60 approximately parallel to the central axis of the opening that extends to inner surface 26. The portion of the brick surface between points 56 and 58 permit the flame to spread somewhat and the straight portion 60 deflects the air and the flame somewhat inwardly along a path indicated by arrow 62.

In designing a burner throat embodying the present invention, after the position of the throat in wall 14 is established, the distances from the burner throat to the sidewalls and top and bottom walls are determined as is the location of wall intersections which are typically more remote from the burner throat than wall surfaces. Appropriately shaped bricks 42 are selected to achieve a flame shape to fill the combustion chamber. At regions of the burner throat opposite relatively close combustion chamber walls, bricks of the type designated 42a are installed to deflect the flame inwardly so as to avoid direct flame impingement on the walls. At regions of the throat opposite intersections of the walls, which are typically remote from the burner throat, bricks conforming generally to the shape of brick 42b are installed to permit the flame to diverge or bleed

outwardly thereby to fill the corners. At regions of the throat where the burner wall is located intermediate the two extremes just described, bricks of the general form indicated at 42c are installed. Obviously the bricks intermediate the three specific forms shown in the drawings can be installed with different degrees of taper to achieve smooth continuity between various regions in the combustion chamber.

Because the entire burner throat is formed of a plurality of individual bricks, design and fabrication of the throat are expedited. Fabrication is expedited, because instead of relatively massive castings of refractory material, the throat can be formed on the job by placement of the individual bricks at the appropriate positions. Design of the throat is expedited because virtually any shape combustion chamber can be accommodated by appropriately selecting and positioning bricks of various shapes and degrees of divergency or convergency.

Thus it will be seen that the present invention provides an improved burner throat construction that can be adapted to virtually any shape combustion chamber to fill the chamber uniformly with flame. Moreover, the throat of the present invention, since it is constructed of a plurality of relatively small elements, can be readily fabricated on the job.

Referring to FIGS. 7-10, an alternative embodiment of the present invention will now be described in detail. Reference numeral 70 indicates the front wall of a combustion chamber, substantially identical to the combustion chamber previously described. Front wall 70 includes a burner throat opening 72. Air is supplied to the combustion chamber through front opening 72 by suitable ducts (not shown). Fuel, such as oil or the like, is supplied through a suitable burner nozzle 74.

Burner throat 72 defines a circular opening 76 at the outer face of front wall 70. Opening 76 is concentric with nozzle 74. According to this embodiment of the present invention, the outer portion 78 of burner throat 72, that is the portion between circular opening 76 and a plane 82 intermediate the outer face and the inner face of front wall 72, defines an irregularly outwardly diverging surface adapted to shape the flame to substantially fill the combustion chamber.

More particularly, outer portion 78 of burner throat 72 comprises a plurality of refractory tiles or bricks 80 which, as can be seen in FIG. 7, taper in a radial sense so that the totality of the tiles or bricks 80 circumferentially fill the throat opening. In the example depicted in FIGS. 7-10, 37 outer throat tiles 80 are included, as a consequence of which each throat tile tapers at approximately a 9.7° angle.

The inner portion of burner throat 72, that is the portion between plane 82 and the inner face of front wall 70, is formed of a plurality of refractory bricks or tiles 84. Inner bricks 84 are substantially identical to bricks 42 described with regard to the previously described embodiment. Thus, each individual brick 84 has a specific shape so as to form the inner portion of the throat with a shape suitable for substantially filling the combustion chamber with flame.

As referred to hereinbefore, each outer brick 80 has a specific shape so as to form a burner throat adapted for flame shaping, in accordance with this embodiment of the present invention. More particularly, as illustrated in the present example, three types of outer bricks 80 having three different degrees of divergence

are provided. Specifically, outer bricks 80a, which are preferably primarily adjacent to the roof of the combustion chamber, diverge or flare outwardly with a first degree of divergence. With reference to FIG. 8, outer brick 80a includes a flame shaping surface 86 diverging outwardly with a first degree of divergence. For illustrative purposes, outer brick 80a is illustrated in FIG. 8 in conjunction with inner brick 84a, having a flame shaping surface 88. As is apparent from FIG. 8, the air moving through the throat opening adjacent outer brick 80a will expand outwardly in accordance with the degree of divergence of flame shaping surface 88 of brick 80a, thus following a path indicated by arrow 90 in FIG. 8. As will be more readily apparent hereinafter, the degree of divergence of brick 80a, hereinbefore referred to as the first degree of divergence, preferably corresponds to an average or normal degree of divergence. Thus, by employing bricks 80a primarily adjacent the roof of the combustion chamber, an average degree of flame divergence is afforded to permit the flame to expand upward to fill the combustion chamber. Of course, the overall flame shaping afforded by a specific brick 80a additionally depends upon the shape of the particular brick 84 employed therewith.

An outer brick 80b, which is preferably disposed adjacent the sidewalls of the combustion chamber, is formed to permit the flame to bleed substantially outward so as to fill the side portions of the combustion chamber with flame. With reference to FIG. 9, brick 80b has a flame shaping surface 92 which flares outwardly with a second degree of divergence, different from and greater than the first degree of divergence of brick 80a. Thus, brick 80b may be regarded as having a wide flare to permit substantial outward bleeding of the flame. Brick 80b is illustrated in FIG. 9 in conjunction with an inner brick 84b having a flame shaping surface 94. As is apparent from FIG. 9, the flame shaping surfaces 92 and 94 of bricks 80b and 84b, respectively, cooperate to permit the flame to expand outwardly in accordance with the outward flare thereof. Thus, the flame will flare outwardly along the path illustrated by arrow 96. As is apparent from a comparison of FIGS. 8 and 9, path 96 flares outwardly to a greater degree than path 90, so that the second degree of divergence of brick 80b will permit a greater degree of outward flame expansion than the first degree of divergence of brick 80a.

A brick 80c, primarily employed at the bottom of the throat adjacent the floor of the combustion chamber, is configured to permit only a slight degree of flame divergence to avoid direct impingement of the flame on the floor of the combustion chamber, and thus to direct the flame axially to substantially fill the combustion chamber. Brick 80c, as can be seen from FIG. 10, has a flame shaping surface 98 that diverges outwardly with a third degree of divergence differing from and less than the first degree of divergence of brick 80a. Thus brick 80c may be regarded as having a narrow flare so as to permit only slight outward bleeding of the flame. Outer brick 80c is illustrated in FIG. 10 in conjunction with inner brick 84c, having a flame shaping surface 100. It is thus apparent that the flame will follow the contour of the surfaces 98 and 100, so that the flame will be directed along a path indicated by the arrow 102. As is apparent from a comparison of FIGS. 8 and 10, path 102 diverges substantially less than path 90. Accordingly, it is apparent that the third degree of di-

vergence of brick 80c, being less than the first degree of divergence of brick 80a, permits a lesser degree of flame divergence.

Accordingly, it is apparent that by employing the varying outer bricks 80, in conjunction with inner bricks 84, substantial flame shaping may be accomplished. Thus, in designing a burner throat according to the present embodiment, appropriately shaped outer bricks 80 may be selected to achieve a flame shape to fill the combustion chamber. At regions of the burner throat relatively close to combustion chamber walls, bricks having the third or narrow degree of divergence 80c are installed to minimize the outward divergence of the flame to avoid direct flame impingement on the walls. At regions of the throat relatively remote from the combustion chamber walls, bricks of the type 80b, having the second or wide degree of divergence, are employed to permit the flame to diverge outwardly to a great extent. At regions of the throat where the burner wall is located intermediate the two extremes just described, bricks of the general form indicated at 80a are employed. Obviously, bricks intermediate the three specific forms shown in the drawings can be installed with different degrees of divergence or taper to achieve smooth continuity between various regions in the combustion chamber.

Of course, the specific flame shaping afforded according to the present embodiment also depends, in large part, upon the specific inner bricks 84 employed. Thus bricks 84 are selected in a similar manner to bricks 42 of the previously described embodiment. It is apparent, however, that in accordance with the present embodiment, the degree of flame shaping afforded is maximized, in that the entire burner throat, rather than only the inner portion thereof, is irregularly shaped to afford flame shaping. Of course, since the entire burner throat is formed of a plurality of individual bricks, design and fabrication of the throat are expedited, in that the throat may be formed on the job by placement of the individual bricks at the appropriate positions. Furthermore, it is apparent that burner throats adapted to substantially fill any shape combustion chamber with flame may be provided by appropriately selecting and positioning inner and outer bricks of various shapes and degrees of divergency.

While two embodiments of the present invention have been shown and described in detail, it will be obvious that other adaptations and modifications can be made without departing from the true spirit and scope of the invention.

What is claimed is:

1. In a combustion chamber bounded by refractory walls through one of which extends a throat opening between the outer and inner surfaces of the one wall to admit fuel and air into the combustion chamber, the improvement comprising a plurality of sectorial refractory outer bricks so disposed that the totality of said outer bricks form at least a portion of the throat adjacent the outer surface of the one combustion chamber wall, each said outer brick having a flame shaping surface thereon, the flame shaping surfaces being disposed in circumferentially spaced relation to one another so that the totality of the surfaces form at least the outer portion of the throat opening, said outer brick flame shaping surfaces diverging toward the inner surface of the one wall, the flame shaping surfaces of bricks at dif-

fering circumferential locations about the throat opening diverging at differing degrees.

2. The invention of claim 1, wherein the degree of divergence of each said brick flame shaping surface is proportional to the distance from said brick surface to the boundary of the combustion chamber, said distance being measured radially with respect to said throat.

3. The invention of claim 1, wherein the flame shaping surfaces of bricks adjacent the walls of said combustion chamber diverge to a lesser degree than the flame shaping surfaces of bricks remote from the walls of said combustion chamber.

4. The invention of claim 1 in combination with a plurality of sectorial refractory inner bricks disposed in said throat opening between the inner surface of said one wall and said plurality of outer bricks, the totality of said inner bricks forming the inner portion of said throat and diverging toward the inner surface of the one wall.

5. The invention of claim 6 wherein said inner bricks at differing circumferential locations about the throat opening diverge at differing degrees.

6. In a combustion chamber of the type including a generally vertical front wall that has an outer surface and an inner surface, and side, bottom, and top walls receding generally perpendicularly from the inner surface of said front wall, an improved throat construction forming a throat opening along an axis extending from said outer surface to said inner surface comprising means forming a generally cylindrical opening in said front wall extending between said inner and outer surfaces, said opening being symmetrical with respect to said axis, a plurality of sectorial refractory outer bricks disposed in said cylindrical opening extending from said outer surface to a plane intermediate the outer and inner surfaces of said front wall, said bricks diverging from said outer surface toward said plane, means disposed in said cylindrical opening for defining an outwardly diverging inner portion of said throat, said outer bricks diverging to form a shape at said plane that is generally geometrically similar to the internal shape of the combustion chamber as established by the relative position of said side, bottom, and top walls.

7. The invention of claim 6 wherein said inner portion throat opening defining means includes a plurality of sectorial refractory inner bricks disposed in said cylindrical opening adjacent said inner wall surface.

8. In a combustion chamber bounded by refractory walls through one of which extends a throat opening between the outer and inner surfaces of the one wall to admit fuel and air into the combustion chamber, the improvement comprising a plurality of sectorial refractory outer bricks so disposed that the totality of said outer bricks form the outer portion of said throat defined between the outer surface of said one wall and a plane intermediate the outer and inner surfaces of said one wall, each said outer brick having a flame shaping surface thereon, the flame shaping surfaces being disposed in circumferentially spaced relation to one another so that the totality of the surfaces form the outer portion of said throat opening, said outer brick flame shaping surfaces diverging toward said plane, a plurality of sectorial refractory inner bricks so disposed that the totality of said inner bricks form the inner portion of said throat defined by said plane and the inner surface of said one wall, each said brick having a flame shaping surface thereon, the flame shaping surfaces being disposed in circumferentially spaced relation to one another so that the totality of the surfaces form the inner portion of the throat opening, said inner brick flame shaping surfaces diverging toward the inner surface of the one wall, the flame shaping surfaces of bricks at differing circumferential locations about the throat opening diverging at differing degrees.

9. The invention of claim 8, wherein the degree of divergence of each said brick flame shaping surface is proportional to the distance from said brick surface to the boundary of the combustion chamber, said distance being measured radially with respect to said throat.

10. The invention of claim 8, wherein the flame shaping surfaces of bricks adjacent the walls of said combustion chamber diverge to a lesser degree than the flame shaping surfaces of bricks remote from the walls of said combustion chamber.

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