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Gottschall

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[54] **BURNER PLATE FOR INFRARED RADIATOR**

[75] Inventor: **Herbert Gottschall,** Leichlingen, Germany

[73] Assignee: **Schwank GmbH,** Cologne, Germany

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[52] **U.S. Cl.** **431/328,** 431/329

[51] **Int. Cl.** **B28b 1/48**

[58] **Field of Search** 431/328, 329; 126/92; 432/31, 175

[56] **References Cited**

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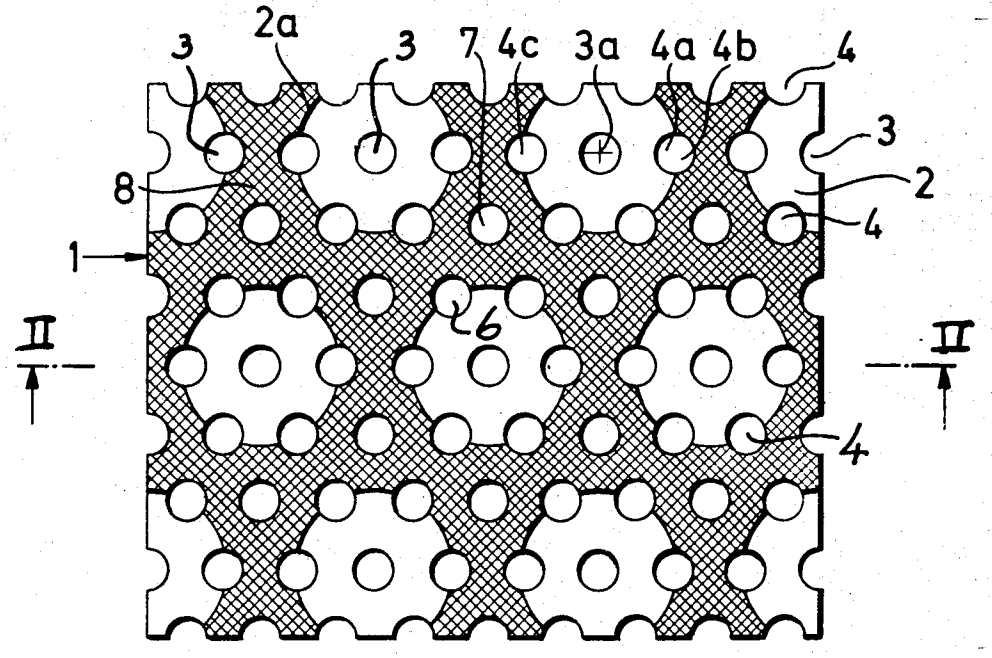
Primary Examiner—John J. Camby
Assistant Examiner—Henry C. Yuen
Attorney, Agent, or Firm—Walter Becker

[57] **ABSTRACT**

A burner plate which comprises depressions on the radiating side and combustion passages arranged parallel to each other for conveying the fuel-air mixture from the mixture side to the radiating side of the plate, in which at least one of the combustion passages is coaxially arranged at the bottom of the respective pertaining depression whereas the other combustion passages are distributed over the sides of the depressions and the plate surface between the sides of the depressions, the combustion passages being distributed over the depressions and the radiating surface in such a way that the flames being generated will so uniformly act upon the lateral surface of the depressions and the radiating surface of the plate therebetween that the temperature being generated in the depressions will substantially equal the temperature generated at the radiating surface between the lateral surfaces of the depressions.

16 Claims, 5 Drawing Figures



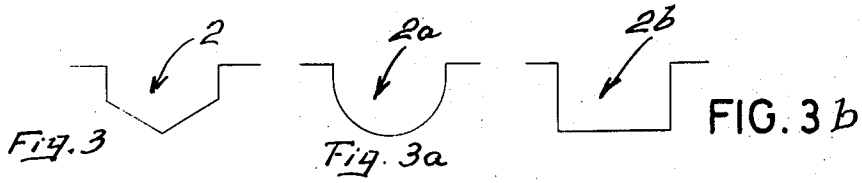


Fig. 3 Fig. 3a FIG. 3b

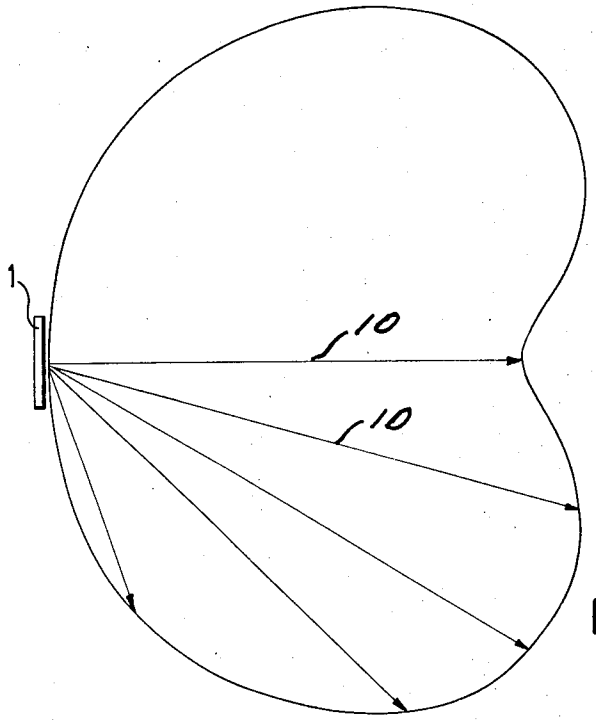


FIG. 4

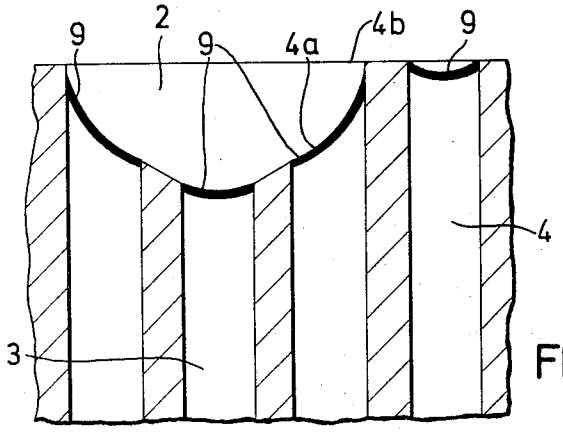


FIG. 5

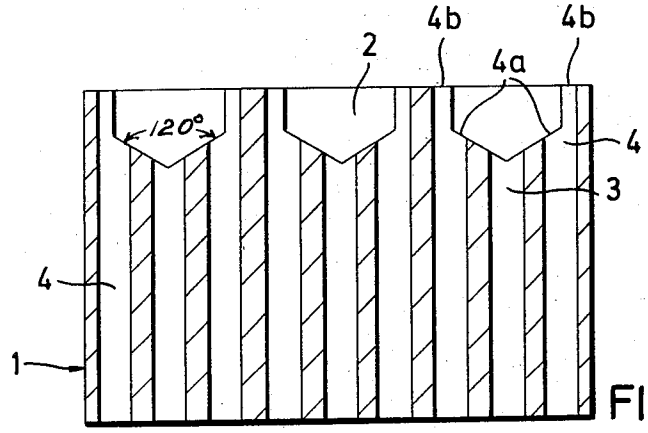


FIG. 2

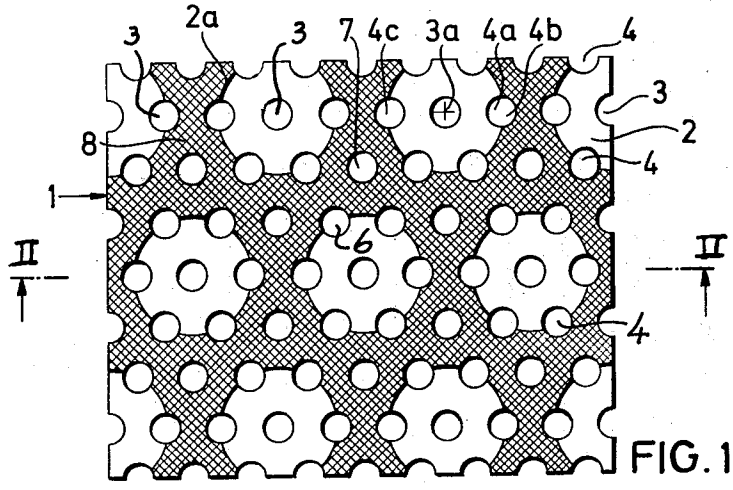


FIG. 1

BURNER PLATE FOR INFRARED RADIATOR

The present invention relates to a burner plate for infrared radiators having depressions on the radiating side and having combustion passages for conveying the fuel-air mixture from the mixing side of the plate to the radiating side, the combustion passages being arranged parallel to each other while at least one of the combustion passages is coaxially arranged at the bottom of a depression whereas the other combustion passages are distributed over the sides of the depressions and over the surfaces between the depressions.

With a heretofore known burner plate of this kind the depressions have an inwardly directed inclination and are deeper than their width, the lateral surfaces being designed with an appropriate curvature and having bevel surfaces inclided toward each other. The combustion passages are arranged in three different planes and, more specifically, one of the combustion passages each is located at the bottom of the depressions while thereabove in the bevel surfaces, i.e., the lateral surfaces within the depressions, there is circularly arranged a plurality of combustion passages. Additional combustion passages are distributed over the surfaces between the depressions.

By an arrangement of this type it is intended to cause the combustion of the gaseous fuel too occur at different levels and at different distances from the general radiation plane whereby a self-control of the inner flames (in the depressions) toward the outer webs of material located between the depressions and vice versa is effected. By the self-control of the flames forming in different planes it is intended to obtain an enrichment of the supply of the primary air to the outflowing fuel-air mixture and thus a complete combustion and possibly to prevent the escape and smaller explosions of non-burned gas particles at the front end of the exit of the combustion passage.

It is an object of the present invention to provide a burner plate with depressions which will have a higher heat radiation at the radiation side than heretofore obtainable.

This object and other objects and advantages of the invention will appear more clearly from the following specification in connection with the accompanying drawings, in which:

FIG. 1 illustrates a top view of a burner plate according to the invention.

FIG. 2 represents a section taken along the line II — II of FIG. 1.

FIG. 3, 3*a* and 3*b* respectively illustrate three different cross sections of depressions in burner plates according to the invention.

FIG. 4 is a diagrammatic illustration of the distribution of the radiation in a semi-body.

FIG. 5 shows a vertical section through a burner plate according to the invention but on a larger scale than that of FIGS. 1 and 2.

The burner plate according to the invention is characterized primarily in that the combustion passages are distributed over the depressions and the webs of material therebetween in such a way that the flames which form will act so uniformly upon the lateral surfaces of the depressions on the one hand and on the webs therebetween on the other hand that the temperature obtained in the depressions will approximately equal the temperature obtained at the surface of the webs.

This has been realized by a device according to the invention in which the depressions are formed by cylinders which may taper to that side which faces away from the radiating side while at the bottom of each cylinder there is provided at least one cylindrical combustion passage. The device is furthermore characterized in that centrally about the center of the bottom of each depression further cylindrical combustion passages are so arranged that their center points are intersected by the circular circumferential line of the cylindrical part of the depressions and that the mouths of each combustion passage is divided into two parts located in different planes. Of these two parts, the inner part is located in the bottom or the conical portion and is confined by that circular intersecting edge of the cylindrical part of the depression which faces away from the radiating side or by the bottom of the depression, whereas the other part is located thereabove on the radiating surface of the burner plate.

According to a particularly advantageous embodiment of the invention, the depression consists of a cylinder which to that side which faces away from the radiating side merges with a hollow cone standing on its tip.

The semicircular mouths of the combustion passages at the upper edge of the depressions and located one adjacent the other together form an extension of the cylindrical depression in the shape of a collar or flange.

In view of the particular arrangement of the combustion passages, which are located around that passage which is provided at the bottom of the depression, and in particular in view of the division of these passages, there is formed above each of the semicircular passages located in the conically reduced portion an upwardly extending semi-cylinder which extends over the entire length of the cylindrical portion of the depression up to the surface of the plate. The heat which is generated in that part of these passages which is located at the reduced portion of the depression is by means of the semi-cylinders located one adjacent the other automatically conveyed upwardly and thus sweeps over the entire lateral wall of the semi-cylinders of the depression, i.e., its entire inner surface with the result that it is strongly heated up.

As a result thereof, the passages located in the webs will be surrounded on all sides by strongly heated walls whereby a further heating up will occur in addition to the heating up due to the combustion taking place therein. The highly heated inner walls of the depressions radiate the absorbed heat back to the oppositely located walls whereby an additional heating up will take place.

In view of the arrangement of the passages according to the present invention, all of the generated heat is taken advantage of for heating up the ceramic surfaces so that an intensely heated up glowing radiating surface is obtained which consists not only of the webs located between the depressions but also comprises the bottoms of the depressions, all of the surfaces of the inner walls formed by the semi-cylinders, and also the webs of material located between the depressions.

Inasmuch as according to the Stefan-Boltzmann Law the radiated energy increases with the fourth power with regard to the absolute temperature when heating ceramic material, it will be appreciated that by means of the design according to the present invention an ex-

tremely high radiation output is obtained which is uniformly distributed over the entire greatly increased radiating surface formed by the semi-cylinders arranged adjacent each other and representing the inner walls of the depressions. In contrast thereto, with heretofore known burner plates, the desired increase in the degree of efficiency is realized by flame radiation which is relatively small as compared to the solid body radiation of the ceramic material.

In view of the design of the side walls of heretofore known burner plates which are provided with a curvature and which are designed as bevel surfaces inclined with regard to each other, the radiation is directed inwardly into the hollow chamber of the depressions and not into the ceramic material. As mentioned above, turbulence is supposed to result which would furnish a more favorable combustion due to an increased intake of air. According to the heretofore known burner plate, the radiating surface consists merely of the webs of material located between the depressions.

Numerous tests have shown that the temperature obtained with the construction of the depressions and the arrangement of the combustion passages according to the present invention is approximately by 100°C higher than is the case with the heretofore known construction with the same dimensions.

According to a particularly advantageous embodiment of the invention, six passages are uniformly distributed around the combustion passage provided in the tip of the cone, whereas between the individual depressions precisely in the center point between each three triangularly arranged depressions there is provided a further passage of the same diameter.

Referring now to the drawings in detail, FIG. **1** shows three rows of depressions **2** at the radiating side of the burner plate **1**, the depressions of one row being offset with regard to the depressions of the adjacent row. Centrally arranged at the bottom of each depression is a combustion passage **3** which according to one specific embodiment of the invention has a diameter of 1.3 mm.

The combustion passages **4** which have the same diameter as the combustion passages **3** are arranged along an imaginary cylinder coaxial with the combustion passages **3** and, more specifically, in such a way that the portions **4***a* of the passages **4** intersect the side walls of the conical bottom or tapering portion of a depression, whereas the other portions **4***b* of the passages **4** intersect the surface of the plate adjacent the depressions. The axes **4***c* of the combustion passages **4** are located along the circumferential line **2***a* of the cylindrical portion of a depression.

The axes **3***a* and **4***c* of the combustion passages **3** and **4** are located in a plane which passes through the axis of the passage **3**. As a result thereof, the connecting lines indicated in dot-dash lines in FIG. **1** and pertaining to the passages **4** of adjacent depressions, which depressions with each other form a triangle, define a hexagon **6**. Precisely through the centerpoint of the hexagon **6** there passes the axis of a further combustion passage **7** which is parallel to the combustion passages **4**. The combustion passage **7** leads to the surface of the burner plate, in other words to the surface of the web portion **8** of the plate.

In the embodiment shown in FIG. **2**, the depressions **2** have the specific shape shown in FIG. **3** according to which the conical portion has an inclination of approximately 120° while the depression itself has a depth of approximately 3 mm. The combustion passages **4** have a diameter of approximately 1.3 mm. FIGS. **3***a* and **3***b* diagrammatically illustrate other possible configurations of depressions **2***a* and **2***b*.

FIG. **4** illustrates the experimentally ascertained distribution of the heat rays **10** emanating from the ceramic plate according to the invention and directed onto an imaginary surface of half a chamber.

The fact that the maximum of the radiation flow does not occur vertically below the ceramic plate but at an angle deviating from the vertical by approximately from 15° – 25° proves that the sidewalls of the depressions **2** which considerably increase the radiating surface furnish the maximum of the emitted radiation.

FIG. **5** illustrates on an enlarged scale a vertical section through a depression **2**. According to this showing, the course of the front of the flame is indicated by heavy lines **9**. As will be evident from FIG. **5**, due to the combustion occurring in the passages shortly ahead of the mouths thereof, there is formed a heating zone which envelops the depression **2** and the web **8** and results in a radiation emanating from the entire inner surfaces of the depressions **2** together with the plate surface.

It is, of course, to be understood that the present invention is, by no means, limited to the specific showing in the drawings but also comprises any modifications within the scope of the appended claims.

What I claim is:

1. A burner plate for infrared radiators, which has a mixture side and an opposite radiating side and parallel passages passing therethrough from the mixture side to the radiating side to convey a fuel-air mixture for combustion on the radiating side of said plate, said radiating side of said plate being substantially flat with cylindrical depressions formed therein, each surrounded by said flat surface and having a peripheral side extending below said surface with the bottom of the depression converging to a central point of greatest depth, each depression having a passage ending in its central point of greatest depth and a plurality of other passages surrounding said central passage and intersecting its side to form semi-cylinders in the depressions, and further a plurality of said passages extending through said flat surface between said depressions, said combustion passages being distributed over said depressions and said flat surface so the flames being generated will uniformly act upon the lateral surfaces of said depressions and the flat surface therebetween that the temperature being generated in said depressions substantially equals the temperature generated at said plate surfaces between said lateral surfaces of said depressions.

2. A burner plate according to claim **1**, in which adjacent depressions are separated by a flat surface of less width than the diameter of a depression, the bottoms and sides with semi-cylinders formed by said depressions with intersecting passages forming layer radiating surfaces at different levels than the radiating surface of the flat surface.

3. A burner plate in combination according to claim **1**, in which said bottom of said cylindrical recess forms a cone tapering in the direction away from said radiating side.

4. A burner plate in combination according to claim **1**, in which said other combustion passages are divided into groups respectively associated with said depres-

sions, the arrangement being such that each of said groups having the axes of its combustion passages located along an imaginary cylinder wall coaxial with the pertaining depression while the mouth of each of said other combustion passages is located in different planes, one of said planes being within the region of the bottom of the respective recess, and the other plane substantially coinciding with said radiating side.

5. A burner plate in combination according to claim **3,** in which said cone cross sectionally defines an obtuse angle.

6. A burner plate in combination according to claim **4,** in which each of said groups of combustion passages comprises six equally spaced combustion passages.

7. A burner plate in combination according to claim **6,** in which the depressions are arranged in a plurality of rows so that the axes of two adjacent depressions of each row define with that respective depression which is adjacent to both of said two depressions and is located in the adjacent row a triangle, and in which in the center of each of the thus defined triangles there is provided an additional combustion passage having the same diameter as said other combustion passages.

8. A burner plate in combination according to claim **1,** in which each depression has a semispherical bottom.

9. A burner plate in combination according to claim **8,** in which each depression is composed of two cylinders of different diameters.

10. A burner plate in combination according to claim **6,** in which that end of said depression which is remote from said radiating side is provided with a conical portion.

11. A burner plate in combination according to claim **3,** in which the tapering portion of said cone cross-sectionwise defines an angle of from 90° to 180° while the depth of the depressions is within the range of from 2 – 5 mm and the diameter of the combustion passages amounts to from 0.5 to 1.5 mm, the number of combustion passages amounting to from four to eight.

12. A burner plate in combination according to claim **1,** in which the ratio of its diameter at the radiating side to the depth of the depressions amounts to approximately 4 : 3.

13. A burner plate in combination according to claim **1,** in which the diameter of the depressions adjacent said radiating side amounts to approximately from 3 to 5 mm.

14. A burner plate in combination according to claim **1,** in which the depressions are arranged in a plurality of rows with the depressions of one row offset relative to the depressions of the adjacent row.

15. A burner plate in combination according to claim **14,** in which the axes of the combustion passages in one and the same row of depressions are located along one and the same line.

16. A burner plate in combination according to claim **1,** in which the depressions define therebetween webs, and in which an additional combustion passage parallel to the other combustion passages is located within the respective web, said additional combustion passage passing through the center of a triangle defined by two depressions located adjacent each other in one row and a depression located in the next adjacent row.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,825,403 Dated July 23, 1974

Inventor(s) Herbert Gottschall

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

[30] Foreign Application Priority Data

Dec. 21, 1971.....Fed. Rep. of Germany 2163498

Signed and Sealed this

Third Day of *April 1979*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

DONALD W. BANNER
Commissioner of Patents and Trademarks