March 25, 1969 KANEKICHI HAYASHI ET AL 3,434,791

BURNER

Filed Sept. 13, 1965

FIG. 1

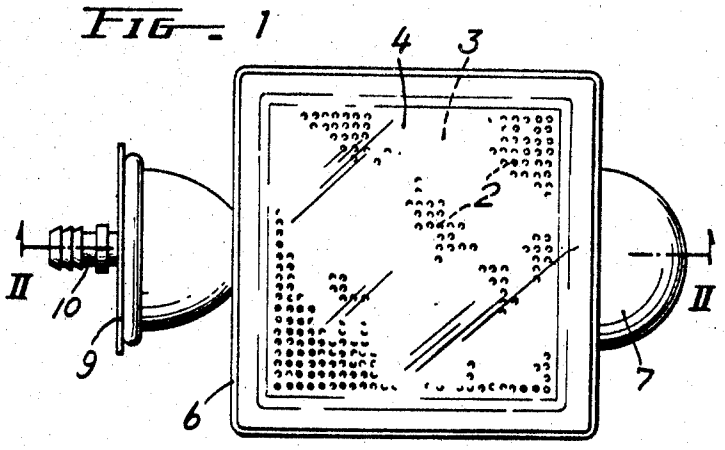
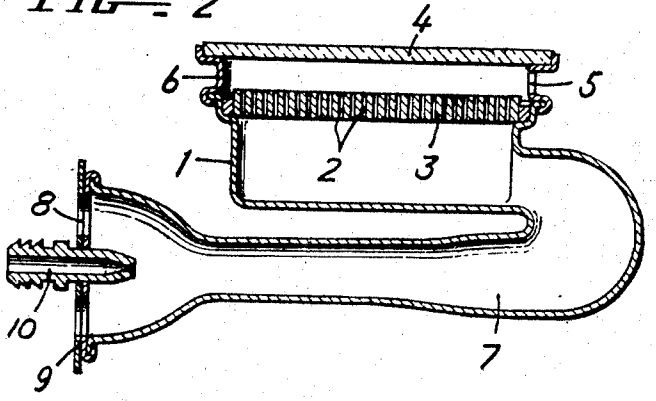


FIG. 2



United States Patent Office 3,434,791
Patented Mar. 25, 1969

3,434,791

BURNER

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Filed Sept. 13, 1965, Ser. No. 486,872
Claims priority, application Japan, Feb. 15, 1965, 40/8,557
Int. Cl. F23d *13/12*; C04b *35/18*
U.S. Cl. 431—328 7 Claims

ABSTRACT OF THE DISCLOSURE

The burner comprises a burner frame having one side closed by an imperforate glass ceramic heating plate of low heat-expansibility, which has a very high heat resistance, a flat body in said frame confronting said plate with a space between said plate and the body and having a multiplicity of passages of small diameter extending between its opposite surfaces, and a chamber for a combustible mixture in communication with said passages for the flow of said mixture into said space where it burns and heats said heating plate.

The present invention relates to burners especially suitable for use in cooking, and which effectively produce a strong radiant heat emitted as a result of the combustion of a gas mixed with air.

Burners are known which emit a strong radiant heat as a result of the combustion of a fuel gas such as town gas, liquefied gas or the like mixed with air. For example, there is known a burner having a fire-resisting material made up as a plate body having a large number of uniformly arranged small holes communicating between the upper and lower surfaces thereof and mounted in an open portion of a burner frame so that mixed gas supplied to the frame is discharged from the small holes and burnt at a position near the surface of the fire-resisting material for heating said surface to a red-hot temperature.

This hitherto known type of burner is suitable where an article to be heated is placed a considerable distance from the surface and receives radiant heat therefrom for being gently heated thereby; however, when an article to be heated is placed above such surface, not only is an additional device necessary for supporting the article but also contamination of the surface is possible. Further, for avoiding such unfavorable influences, a heat-resisting material such as an iron plate is interposed between the surface of the plate body and the article to be heated, the radiant heat emitted from the red-hot surface of the plate body cannot be utilized effectively.

The present invention has as an object the avoiding of those defects as are inherent in the conventional type of burner, and the invention is characterized in that a highly fire-resisting material, made up as a plate body having uniformly arranged small holes communicating between the upper and lower surfaces thereof and mounted in an open portion of a burner frame, is provided at a position near the surface thereof with a transparent or semi-transparent glass or ceramic heating plate having a low thermal coefficient of expansion.

The invention will next be explained in greater detail with reference to the accompanying drawing in which:

FIG. 1 is a plan view of one embodiment of the invention; and

FIG. 2 is a sectional view along line II—II of FIG. 1.

In the drawing, element **1** is a burner frame composed of a heat-resisting material such as an enameled iron plate, an iron casting or the like, and it is provided at its open portion with a fire-resisting flat body **3** having a large number of uniformly distributed small holes or apertures **2** communicating between the upper and lower surfaces thereof.

This flat body **3** is preferably of a fire-resisting material produced such that a properly compounded raw material is molded and fired to have a composition of 62–40% SiO_2, 20–56% Al_2O_3, 1–2% Fe_2O_3, 0–11% MgO, 0.5–1% F_2O_3 and 0–6% Cr_2O_3. The body **3** has a 2.9–3.2 specific gravity, 71.5–67.5% porosity and is fire resistant to about 1300–1500° C. The body material is so highly heat resistant that no change can be observed even when a test piece is rapidly heated until its surface temperature reaches 1000° C. and then it is inserted in water of room temperature for more than ten cycles.

The small holes **2** uniformly distributed in body **3** are preferably about 1–1.3 mm. in diameter and about 900–1300 in number if the body **3** is 11.5 mm. x 46.5 mm. x 66.5 mm. in size.

A body **3** of this size can be so used that in accordance with the size of the burner frame **1** a plurality of sheets can be connected in airtight manner at their adjacent edges to provide a single sheet of larger size.

Element **4** is a heating plate disposed to extend near the surface of the body **3** in parallel therewith, plate **4** is held by a frame member **6** having an exhaust opening **5** and connected to the burner frame **1**. This heating plate **4** comprises a transparent or semi-transparent glass or ceramic material of a low coefficient of expansion. For this ceramic is used a glass of which the essential components are, for example, 1–3% TiO_2, 1–4% ZrO_2, 1–5% P_2O_5, 55–70% SiO_2, 20–35% Al_2O_3, 3–5% Li_2O, and 0.5–4% Na_2O+K_2O (0–4% Na_2O and 0–4% K_2O) and the total of these is at least 95%. This glass is kept at a temperature between its annealing point and its softening point, namely, at about 650–800° C. for starting its crystallization, and is further heated slowly, for example, at an increase of below 5° C./min. for advancing its crystallization, and is finally kept at such a temperature that there is obtained a product that contains substantial crystalline structure but is transparent or semi-transparent. This latter is about 800 to 900° C., this completing the heat treatment, whereby there is obtained a product which is transparent or semi-transparent and is of a low expansibility crystal which is below 10×10^{-7} (including negative) in expansion coefficient at a temperature range of 0–500° C.

One end of the burner frame **1** is connected to a mixing pipe **7** and the base of the pipe **7** is formed to be an air adjusting portion **9** having an adjustable air suction opening **8**. A gas supply nozzle **10** is in communication therewith so that a fuel gas such as town gas, liquefied gas or the like supplied from this nozzle **10** passes through the mixing pipe **7** while drawing in air via the air suction opening **8**. The gas mixed with air in the burner frame **1** gushes through the large number of small holes **3** uniformly provided in the body **3**. If the gas blowing out of these many small holes **3** is lighted, the gas burns near the surface of

the plate body 3 with short flames to make the surface thereof red-hot for giving off strong radiant heat.

As a result thereof, the transparent or semi-transparent plate 4 disposed to extend near the surface of the plate body 3 in parallel therewith receives a strong radiant heat from below and simultaneously is pierced by infrared ray, so that its upper surface can be kept at a high temperature. The exhaust gas caused by the combustion is discharged from the exhaust opening 5 provided in the frame member 6, and when the burner is large and is enclosed in a frame casing, the casing is preferably provided with an exhaust opening.

When the burner is used for the cooking of food, the heated plate 4 whose upper surface is kept at high temperature or through a broiling iron plate or the like supports the food, whereby the food can be easily and properly cooked by the strong radiant heat received from below and and by the infrared rays piercing the plate. This is achieved without influence by the combustion gas exhaust. Even if the plate 4 is rapidly cooled when the food is first placed thereon or if the food gives out juices, the operation is free from any trouble such as injury, cracks or the like because the same is made of low expansibility glass ceramic. Additionally, the plate is not injured even if cleaned immediately after its use by cold water or the like. Furthermore, the body 3 is very resistant to high temperatures and, even though the same is not exposed it is durable for long periods with an ever-unchanged clean appearance below the transparent or semi-transparent plate 4.

As will now be appreciated from the above explanation, the present invention utilizes effectively the radiant heat caused by the combustion of a mixed gas in a skillfully combined construction of a fire-resisting material made into a flat body having uniformly arranged small holes communicating between the upper and lower surfaces thereof and a transparent or simitransparent low expansibility glass ceramic plate suitable as a cooking burner. The apparatus can also be used as a drying furnace or the like where any influence by the combustion exhaust is to be avoided.

In the above text, porosity is expressed in terms of the relationship of pore volume to total volume of the material provided with the pores. Additionally, it will be noted that the distance between elements 3 and 4 is preferably within the range of from about 5 to 15 mm.

Additionally, with more particular reference to the glass process described hereinabove and by way of non-limitative example, the glass may be held at a first temperature of 750° C. for one hour and then raised to a temperature of 850° C. where it is maintained for one hour. Alternatively, the glass can, by way of example, be processed at 720° C. for two hours and then at 820° C. for two hours.

What is claimed is:

1. A method of making a glass for a burner with a composition of 1–3% TiO_2, 1–4% ZrO_2, 1–5% P_2O_5, 55–70% SiO_2, 20–35% Al_2O_3, 3–5% Li_2O, and 0.5–4% Na_2O+K_2O (0–4% Na_2O and 0–4% K_2O), comprising starting crystallization of the glass at 650–800° C., increasing the temperature at less than 5° C./minute to increase crystallization and then maintaining the temperature at 800–900° C. to render the material at least partly transparent.

2. A burner comprising:

a flat body of fire-resistant material provided with a uniform distribution of small holes communicating between the upper and lower surfaces thereof,

a burner frame supporting said body,

a low expansibiliy glass ceramic plate on said frame above said body,

said burner having an upper space between said plate and said body which is closed by said plate, the under surface of said plate being substantially entirely exposed directly to said body,

said material of said body having a composition of 62–40% SiO_2, 20–56% Al_2O_3, 1–2% Fe_2O_3, 0–11% MgO, 0.5–1% F_2O_3 and 0–6% Cr_2O_3.

3. A burner according to claim 2 wherein said body has a specific gravity of 2.9–3.2, a porosity of 71.5–67.5% and a fire resistance to about 1300–1500° C.

4. A burner comprising:

a flat body of fire-resistant material provided with a uniform distribution of small holes communicating between the upper and lower surfaces thereof,

a burner frame supporting said body,

a low expansibility glass ceramic plate on said frame above said body,

said burner having an upper space between said plate and said body which is closed by said plate, the under surface of said plate being substantially entirely exposed directly to said body,

said plate being glass having a composition of 1–3% TiO_2, 1–4% ZrO_2, 1–5% P_2O_5, 55–70% SiO_2, 20–35% Al_2O_3, 3–5% Li_2O, and 0.5–4% Na_2O+K_2O (0–4% Na_2O and 0–4% K_2O) and the total of these is at least 95%.

5. A burner according to claim 4 wherein said plate has less than a 10×10^{-7} expansion coefficient at a temperature range of 0–50° C.

6. A radiant gas burner comprising:

walls forming a plenum chamber,

means for injecting combustible gas into said plenum chamber,

a porous radiating plate in communication with said plenum chamber capable of being heated to a temperature at which it becomes a radiator of infrared energy,

walls forming an additional chamber, one wall of said chamber being formed at least in part by said radiating plate, another wall of said chamber being formed at least in part of a material having a substantial transparency to infrared radiation and which part is substantially opposed to and substantially entirely exposed to said radiating plate,

aperture means provided in a wall of said additional chamber between said wall containing said radiating plate and said wall containing said infrared radiation transparent part, providing a unidirectional flow of gas from said plenum chamber, through said porous radiating plate and out said aperture means to atmosphere,

said radiating plate having a composition of 62–40% SiO_2, 20–56% Al_2O_3, 1–2% Fe_2O_3, 0–11% MgO, 0.5–1% F_2O_3 and 0–6% Cr_2O_3.

7. A radiant gas burner comprising:

walls forming a plenum chamber,

means for injecting combustible gas into said plenum chamber,

a porous radiating plate in communication with said plenum chamber capable of being heated to a temperature at which it becomes a radiator of infrared energy,

walls forming an additional chamber, one wall of said chamber being formed at least in part by said radiating plate, another wall of said chamber being formed at least in part of a material having a substantial transparency to infrared radiation and which part is substantially opposed to and substantially entirely exposed to said radiating plate,

aperture means provided in a wall of said additional chamber between said wall containing said radiating plate and said wall containing said infrared radiation transparent part, providing a unidirectional flow of gas from said plenum chamber, through said porous radiating plate and out said aperture means to atmosphere,

said infrared radiation transparent part being glass having a composition of 1–3% TiO_2, 1–4% ZrO_2, 1–5% P_2O_5, 55–70% SiO_2, 20–35% Al_2O_3, 3–5% Li_2O, and 0.5–4% Na_2O+K_2O (0–4% Na_2O and 0–4% K_2O) and the total of these is at least 95%.

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CHARLES J. MYHRE, *Primary Examiner.*

U.S. Cl. X.R.

106—39

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,434,791 March 25, 1969

Kanekichi Hayashi et al.

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

Column 4, line 53, "o-50° C." should read -- 0-500° C. --.

Signed and sealed this 16th day of February 1971.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR
Commissioner of Patents