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G. SCHWANK

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RADIATION BURNERS

Filed March 8, 1951

2 Sheets-Sheet 1

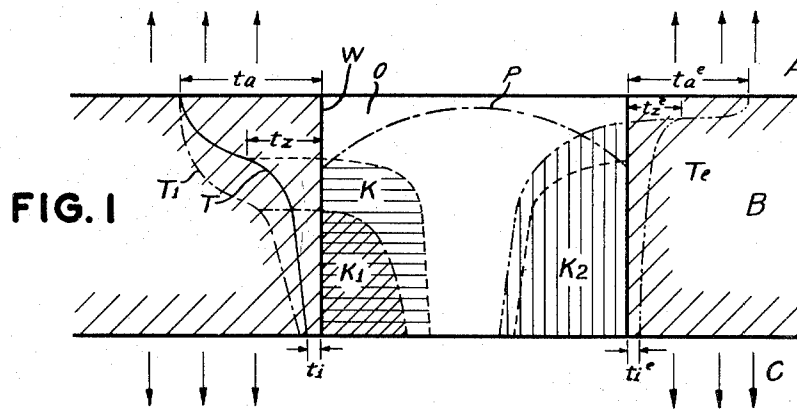


FIG. 3

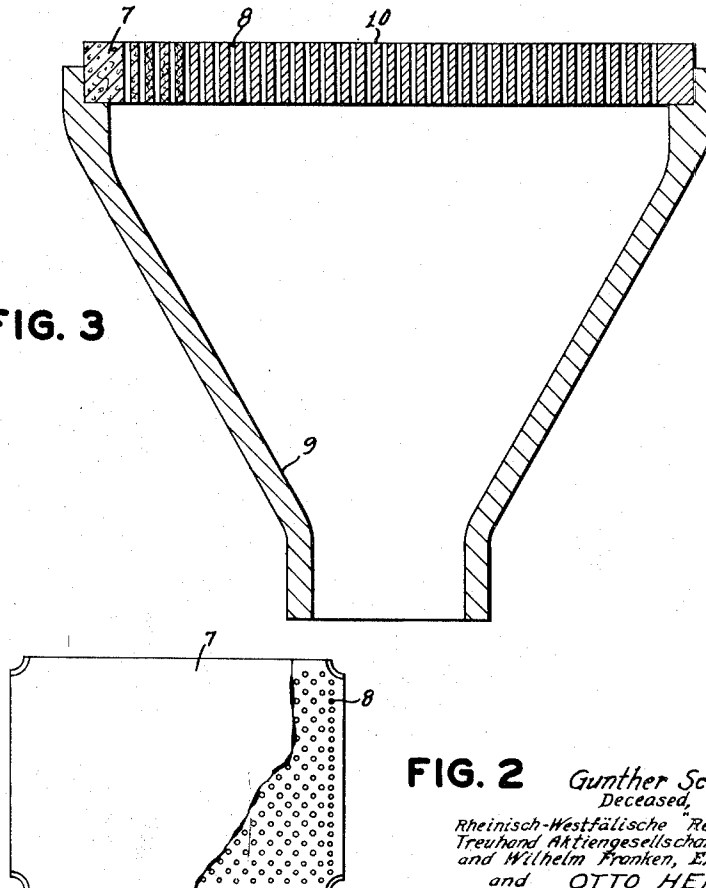


FIG. 2 *Gunther Schwank*
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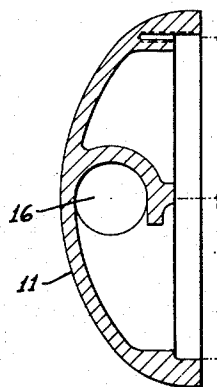
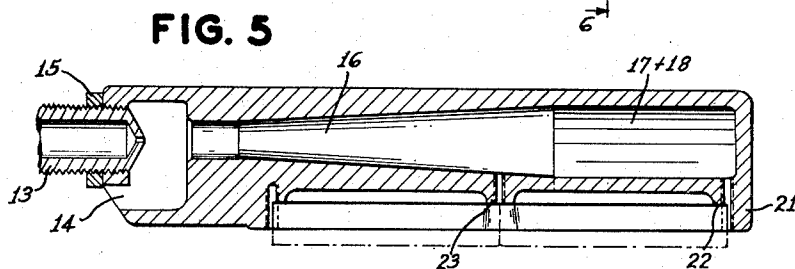
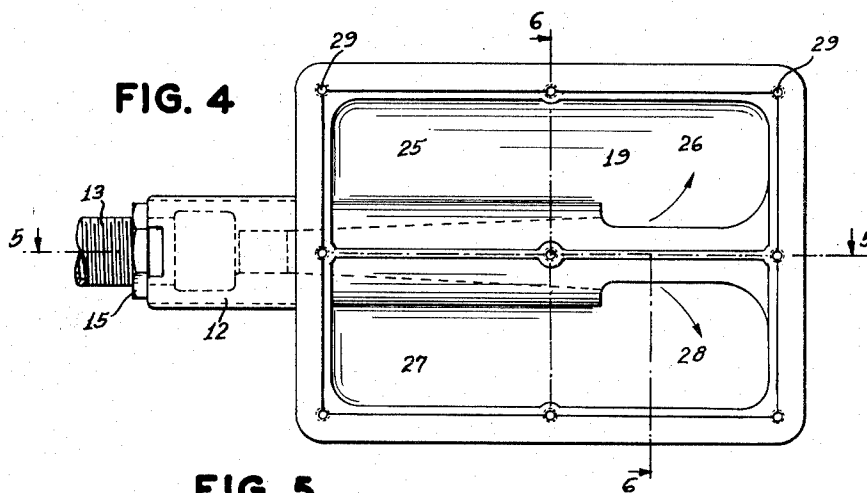
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RADIATION BURNERS

Günther Schwank, Glucksburg (Ostsee), Germany; Rheinisch-Westfälische "Revision" Treuhand Aktiengesellschaft (Treuhand Aktiengesellschaft) and Wilhelm Franken, executors of said Günther Schwank, deceased, assignor to American Infra Red Radiant Co., Inc., New York, N. Y., a corporation of Delaware

Application March 8, 1951, Serial No. 214,468

Claims priority, application Germany March 11, 1950

5 Claims. (Cl. 158—116)

This invention relates to radiation burners, more particularly for gaseous fuels, in which an incandescent surface is formed by the combustion of a mixture of air and a fuel.

A known burner of this nature comprises a body portion consisting of fireclay, steatite or another refractory material, to which a homogeneous or coarse granular structure has been imparted by a sintering process and which is furnished with a plurality of closely disposed fine apertures or passages in which combustion takes place of a mixture of air with a fuel. In burners of this nature, particularly in the operative condition when thermal equilibrium of the burner has been reached, there is danger of a backfiring effect when the average rate of flow of the mixture of air and fuel is considerably smaller than the ignition speed of the mixture. It has already been attempted to avoid this drawback by suitable selection of the average cross-sectional size of the individual passages, and the danger of a backfiring effect has thus been reduced, although it has not been eliminated, particularly if, after thermal equilibrium has been reached, the rate of flow of the mixture is substantially smaller than its speed of ignition, or the temperature of the incandescent surface exceeds a certain level.

It is a main object of the present invention in the case of burner elements, more particularly in the form of cover plates, which consist of a refractory substance and comprise a multiplicity of fine passages, to preclude the danger of a rearwardly extending combustion and thus of a backfiring effect.

A further object of the invention is to provide burners having burner elements comprising a refractory substance for radiating, heating and like purposes, wherein the use of a special pressure source, such as compressed air or a high gas pressure, can be dispensed with, and in which a rearwardly extending combustion, and in consequence a backfiring effect, is avoided even when the rate of flow of the mixture is substantially lower than the speed of ignition.

The invention also has for its object to provide burner elements which effect radiation within desired and predetermined wave length ranges which can be varied in accordance with the requirements.

The possibility of a rearwardly extending combustion in the passages of the burner element in opposition to the direction of flow of the fuel mixture is, apart from other causes, brought about substantially by the thermal conductivity of the refractory material of the burner element.

In carrying these objects into effect, the thermal conductivity of a burner element composed of refractory material is reduced so that conduction of heat towards the inlets of the passages is diminished. This is the fundamental idea on which the solution according to the invention is based.

According to the invention a burner element having a surface to be rendered incandescent by the combustion of a mixture of fuel and air comprises the combination

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of heat-resisting material furnished with a multiplicity of fine passages, with heat restraining means to reduce the thermal conductivity of the element.

In order that the invention may be clearly understood some embodiments thereof will now be described, by way of example, with references to the accompanying drawings in which:

Figure 1 shows to an enlarged scale, a single passage formed in a burner and illustrates the principle on which the present invention is based,

Figure 2 is a top plan, partly in section, of a burner element according to the invention and shows the multiplicity of fine passages therein,

Figure 3 is a section through a simple embodiment of burner having an element according to the invention,

Figure 4 is a top plan of a burner having a plurality of burner elements in accordance with the invention,

Figure 5 is a longitudinal section through Figure 4 taken along the line 5—5, and

Figure 6 is a section taken along the broken line 6—6, Figure 4.

Before referring to the embodiments of the invention illustrated in the drawings it will be convenient to describe the manner of construction of burners according to the invention.

As has been stated above the basic idea on which the present invention is based consists in reducing the thermal conductivity of the refractory material from which the burner element is made so that conduction of heat towards the inlets of the passages in the element is reduced.

The reduction of the thermal conductivity of the refractory material can be accomplished in particular by providing in the burner element finely distributed heat-restraining means, which may be formed by suitable materials or by spaces.

For example, according to one embodiment of the invention, particularly when employing ceramic substances, it is possible to carry out the sintering of the ceramic substance of the burner element in incomplete fashion, or to omit the same entirely. It is possible, for example, to perform a simple air drying of the ceramic substance, or the crystalline-bound water can be expelled at approximately 500° C., and beyond this a firing of the element can be effected, sintering of the material, however, not being carried out in complete fashion. The method of air-drying or of incomplete sintering of the burner element is particularly suitable for burner elements which consist of metal silicates.

By the use of one of the methods aforesaid the shrinkage of the ceramic substance is not completed, so that between the particles of material there remain extremely finely distributed air spaces which cause a reduction in the heat conductivity of the burner element.

According to a further embodiment of the invention, the production of hollow spaces for reducing the thermal conductivity of the material is effected by the addition of gas-forming substances to the raw material, by means of which finely distributed hollow spaces are formed within the body of the material during the heating process.

According to a still further embodiment of the invention, the finely distributed hollow spaces in the burner element can also be produced by the addition of substances which are eliminated by burning, these substances being added to the raw material in suitable amount and after completion of the sintering process or the like leaving hollow spaces in the body of the burner.

A burner of the invention cannot be compared with a known ceramic body being of a porous structure. With this known body the fuel and air mixture is pressed through the porous body itself. Contrary to this, in accordance with the present invention the small cells in-

volved in the body of the burner are not interconnected and contrary to the known burner body of porous structure with a burner of the invention the mixture of fuel and air is passing through the multilicity of passages.

Instead of employing air or another gas in the finely distributed pores within the burner element as a means for reducing the thermal conductivity, it is also possible in accordance with the invention to employ other suitable substances as desired. Thus, for example, according to a still further embodiment of the invention, it is possible to admix with the raw material heat-restraining solid materials in suitable quantity, which materials are disposed in extremely fine distribution within the burner element and reduce the thermal conductivity thereof. As heat-restraining materials of this nature there can be employed heat-resisting heat-protective agents, such as kieselguhr or asbestos powder. The specific weight with inclusion of the pores should if possible be less than 1.2 kg./dm.³, and the thermal conductivity less than 0.5 k. cal./hr. m.[°] C.

As additional and auxiliary means for preventing a rearwardly extending combustion in the fine passages of the burner element the latter, according to a practical embodiment of the invention, can be furnished in small quantity with means for increasing its radiation, so that by increase of the radiation, the quantity of heat supplied being the same, the temperature of the incandescent surface is reduced.

As a possible means of accomplishing this object of the invention the front surface of the burner element can be furnished in the manner known per se with irregularities, roughened portions or the like additional to the small irregularities already existing as a result of the means employed for reducing the thermal conductivity. For the purpose of increasing the radiation from the burner element, and thus of reducing the temperature of the incandescent surface, there can be employed, for example, an addition of iron oxide, manganese oxide, cobalt oxide or chromium oxide.

Further, it is also possible, by the selection of suitable additions, such for example as the combination of zirconium or cerium, to dispose the maximum radiated heat energy in a certain wave ranges, which do not coincide with those of the basic material at equal temperature. This possibility is of particular value in those cases in which, dependent on the use of the burner for certain materials, for example colored lacquers or cellular tissues, heat radiations of a certain wavelength are particularly effective. The selection of the substances by means of which the heat energy is disposed within certain wave ranges depends upon the particular purpose for which the burner element according to the invention is to be employed. For example, it is possible by concentration on certain wave ranges to employ a burner element according to the invention for therapeutic purposes, or in the case of other wave ranges for drying purposes of a desired kind, which may be of a widely different nature.

The employment of such additions also has a catalytic effect on the mixture of air and fuel insofar as by reason of the same the rate of combustion of the mixture is increased.

According to a further embodiment of the invention, the possibility is provided of furnishing the radiation surface of the burner element with substances having different radiating properties, whereby markings or signs of a desired nature can be produced, which are rendered visible by their varying light intensity or their color. Substances of this nature, for example sodium or magnesium compounds, are preferably sprayed or painted on to the surface of the burner element and plate in a non-heat-resisting binding agent by means of stencils. Such signs may be employed, for example, for advertising purposes.

In carrying the invention into effect it is desirable to maintain a certain ratio between the size of apertures and the remaining cross-section of the material, the thickness

of the burner element also being taken into consideration. According to one form of the invention it is preferred to provide as many apertures or passages as possible through the burner element, the individual cross-sections preferably not exceeding a size of 4 mm.² and being disposed so closely together that altogether they occupy as far as possible more than 20% of the total area of the burner element. It is desirable to select the thickness of the burner element, and accordingly the length of the passages, in excess of 5 mm. in order to ensure a sufficient restraint on the heat.

Burner elements according to the invention can be employed for many purposes. Certain of their uses are quoted below but it will be understood that these uses are by no means exhaustive. Thus a burner element according to the invention has an intense infra-red radiation, for which reason it can be employed for medicinal purposes, for example for rheumatic ailments, the infra-red radiation being capable of exercising a subcutaneous effect. A burner element can be employed for all methods of heating confined spaces, in the form of ovens, plates or the like, in which connection the burner can be used either vertically or obliquely or also horizontally in the form of overhead radiating means. Owing to their intense and even radiation of heat, burner elements according to the invention are also capable of being employed with advantage for all possible drying processes; their usefulness, however, also extends to the entire field of use in association with the preparation of foods, for example, roasting, grilling, baking and the like. Owing to the practically flameless combustion the foods or commodities being treated can be placed in the immediate vicinity of the radiating surface, and thus an intense roasting, baking or like operation can be carried out in a minimum of time.

In the following there is quoted an example relative to the production of a burner element according to the invention, to which example, however, the invention is not limited. The figures quoted relate to parts by weight:

	Parts
Clay	35
Substances eliminated by burning.....	40
Filling substances.....	15

The substance eliminated by burning may be, for example, pulverised coal or wood dust.

If to a burner element according to the invention it is desired also to add in small amount agents for the purpose of increasing the radiation of the heat, the following addition is made to the above:

Metal oxide, such as cobalt oxide or chromium oxide—between approximately 0.5 and 2 parts by weight.

The production of a sintered element according to the invention may be carried out in the following manner:

The dry material of the above composition is admixed with oil and water to form a plastic paste or dough and is pressed into the desired form, on which occasion there are formed the numerous fine passages, and following thereon the element thus produced is either merely dried, partially sintered or completely sintered, dependent on the fact as to which of the stated means is employed in carrying the invention into effect.

By way of explanation of the fundamental idea according to the invention reference is made to Figure 1 of the drawing, on the basis of which the principle of the invention is described in detail.

In Figure 1 there is shown a passage through a burner element B to greatly enlarged scale. The passageway itself is designated O, the wall of the passage being shown at W.

It is well known that the speed of a combustible mixture of gas and air is disposed according to a parabola, which is indicated in Figure 1 by the dash-dotted line P.

The parabolic form arises from the fact that friction occurs along the walls of the passage, whereby the rate of flow is reduced. It will be understood that the combustion occurs in the forward zones of the passages O and adjacent to the front of the block (area A), the inner, relatively cold layer being designated C. The temperatures resulting from the combustion are indicated by the curve designated T, the temperature at the inlet end being designated t_i and at the outlet end t_a . At the point t_z , owing to the combustion of the mixture, there is a considerable rise in temperature, and from the projection of this point on to the wall of the passage O there then results on both sides within the passage a cooling zone which is designated K and on the left is provided with horizontal hatching. If an ordinary ceramic element is employed, there arises the danger, following establishment of the thermal equilibrium, that the temperature curve T will assume a form such as indicated by the dash-dotted line T^1 on the left of Figure 1. In accordance with this temperature curve there is then formed within the passage O about the inner wall thereof a cooling zone, which is designated K_1 and is cross-hatched horizontally and obliquely. It will be apparent that with a disposal of this nature of the temperature curve T^1 the danger arises that the zone of combustion of the fuel will tend to be displaced towards the rear portions of the passage O, with the consequent danger of backfiring.

If on the other hand a burner element is constructed in accordance with the invention, the disposal of the temperature curve will be approximately as indicated in Figure 1 by the dash-and-double-dotted line T^e . In this connection the inlet temperature is equal to t_i^e , whilst the zone of higher temperature is shown at t_z^e and the temperature at the outlet end is designated t_a^e . It will be apparent that the critical point at which the projection of t_z^e intersects the curve of the speed is situated higher than t_z . In consequence there is formed about the inner wall of the passage O an annular cooling zone K_2 , which is indicated by a dash-and-double-dotted line and is represented on the right by vertical hatching.

It is thus accomplished in accordance with the invention that also in the case of burners in which the speed of ignition is considerably higher than the rate of flow of the fuel the combustion preferably takes place in the forward zone of the passage O, there also being formed at the same time an effective cooling zone K_2 and any back-firing effect being avoided. The matter illustrated in Figure 1 is purely diagrammatical and is not intended as an exact reproduction of the size or cross-section of the passage O. Such illustration serves merely to explain the principle on which the invention is based.

The burner according to Figure 3 possesses a closure plate 7 composed of ceramic material and having a large number of fine passages 8, which are disposed parallel to one another and in which fuel is combusted which is supplied from the rear through a burner 9, the front surface 10 of the burner element, or in other words the closure plate 7, thereby being raised to incandescence.

The passages or apertures 8 are preferably disposed at equal distances apart and all furnished with the same circular or polygonal, for example hexagonal, cross-section. By the omission of certain passages it is possible to produce on the burner element a desired design or lettering.

In Figures 4 to 6 the burner element is generally designated 11 and is furnished at one end with an inlet socket 12 for a gas and for air. Within this socket there terminates a gas supply pipe 13 in the form of an injector, which sucks in air through apertures 14 preferably disposed about the same. The gas supply pipe can be secured to the burner casing by means of a nut 15.

From the socket the mixture of fuel and air is conducted through a pipe 16, which extends in the longitudinal direction of the burner casing and opens out into

two large lateral outlet apertures 17, 18, through which the mixture is able to enter a space 19 which is disposed behind the actual burner element. The front side 20 of the burner casing is furnished with a peripherally disposed flange 21 and peripherally disposed bearings 22 and a central bearing 23, within which there are provided, for example, four burner elements according to the invention, which elements are designated 25, 26, 27 and 28 respectively and are indicated in outline in dash-dotted lines in Figure 4. The burner elements can be furnished at their corners with partial recesses, so that they can be secured to the burner casing by means of headed screws or the like engaging in corresponding threaded apertures 29 in the burner casing. The heads of the screws, which may be countersunk, can be covered by a suitable material not affected by heat.

A burner according to the invention can be furnished with a suitable ignition device of the known kind (not shown) arranged laterally of the actual burners. It is also possible to provide on the burner casing suitable safety means of a known kind, for example a bi-metallic element, by means of which, below a certain temperature, for example when the flow of gas fails or the ignition flame is extinguished, the supply of gas is stopped, in order to preclude with safety the escape of unburnt gas. There may be employed any desired gaseous or vaporised fuel, such as town gas, propane gas, petrol or a gas stored in cylinders. In the latter case suitable pressure-reducing means for the gas are provided. A description of these, however, is unnecessary, as they do not form part of the actual invention.

A jet burner having burner elements in accordance with the invention possesses in face of known constructions the definite advantage that, in addition to avoiding an undesirable backfiring of the mixture, additional apparatus, for example compressed air generating means or auxiliary means for increasing the gas pressure, are unnecessary. By reason of the invention it is possible for the first time to operate radiation burners by using, for example, the usual pressure of town gas, whilst sucking up the air necessary for combustion, so that the burner does not require any additional compressor. This is distinct from the constructions hitherto known, in which it has been necessary to employ either compressed air or a gas under increased pressure in order to ensure that the rate of flow of the mixture of gas and air is not appreciably below the average ignition speed of the mixture. Naturally, the invention is not limited to those burners which operate without additional pressure sources.

Further, it will be understood that burner elements according to the invention can be used in a radiation burner operated by means of air and a finely atomized liquid fuel, for example combustible oils or the like instead of a mixture of air and gas as described above.

I claim:

1. A burner member, comprising a block of refractory material provided with passages therethrough for a combustible fuel mixture, said passages being substantially uniformly distributed throughout a portion of the area of said block and each having a cross sectional area of not more than about four square millimeters and a length not less than about five millimeters and each extending substantially in the same direction throughout its length from one side of the block to the outer side thereof, said passages collectively occupying not less than about 20 percent of the total radiation area at said outer side of the block, said block of refractory material having a heat-retarding medium of substantially lower thermal-conductivity than said refractory material distributed therein to reduce the thermal-conductivity of the block, the latter having a thermal-conductivity of less than 0.5 kilocal./hr. m. °C., said passages being defined by integral internal wall surfaces of said block and said

heat-retarding medium being disposed adjacent to said passage-defining surfaces, said passage arrangement and dimensions and said heat-retarding medium in said block and adjacent to said internal wall surfaces of said passages being jointly operable to confine the combustion of the fuel mixture to the outer zone of said passages and to inhibit said combustion from traveling in said passages inwardly of said zone and producing a backfiring effect.

2. A burner member, comprising a block of refractory material provided with passages therethrough for a combustible fuel mixture, said passages being substantially uniformly distributed throughout a portion of the area of said block and each having a cross sectional area of not more than about four square millimeters and a length not less than about five millimeters and each extending substantially in the same direction throughout its length from one side of the block to the outer side thereof, said passages collectively occupying not less than about 20 percent of the total radiation area at said outer side of the block, said block of refractory material having a heat-retarding medium of substantially lower thermal-conductivity than said refractory material distributed therein to reduce the thermal-conductivity of the block, the latter having a thermal-conductivity of less than 0.5 kilocal./hr. m. °C., said passages being defined by integral internal wall surfaces of said block and said heat-retarding medium being disposed adjacent to said passage-defining surfaces, said passage arrangement and dimensions and said heat-retarding medium in said block and adjacent to said internal wall surfaces of said passages being jointly operable to confine the combustion of the fuel mixture to the outer zone of said passages and to inhibit said combustion from traveling in said passages inwardly of said zone and producing a backfiring effect and a metal oxide incorporated in said refractory material to increase the heat radiation properties thereof.

3. A burner member, comprising a block of refractory material provided with passages therethrough for a combustible fuel mixture, said passages being substantially uniformly distributed throughout a portion of the area of said block and each having a cross sectional area of not more than about four square millimeters and a length not less than about five millimeters and each extending substantially in the same direction throughout its length from one side of the block to the outer side thereof, said passages collectively occupying not less than about 20 percent of the total radiation area at said outer side of the block, said block of refractory material comprising essentially a clay material having a heat-retarding medium of substantially lower thermal-conductivity than said clay material distributed therein to reduce the thermal-conductivity of the block, said passages being defined by integral internal wall surfaces of said block and said heat-retarding medium being disposed adjacent to said passage-defining surfaces, said passage arrangement and dimensions and said heat-retarding medium in said clay material block and adjacent to said internal wall surfaces of said passages being jointly operable to confine the combustion of the fuel mixture to the outer zone of said passages and to inhibit said combustion from traveling in said passages inwardly of said zone and producing a backfiring effect.

4. A burner member, comprising a block of refractory material provided with passages therethrough for a combustible fuel mixture, said passages being substantially uniformly distributed throughout a portion of the area of said block and each having a cross sectional area of not more than about four square millimeters and a length not less than about five millimeters and each extending substantially in the same direction throughout its length from one side of the block to the outer side thereof, said passages collectively occupying not less than about 20 percent of the total radiation area at said outer side of the block,

said block of refractory material comprising essentially a clay material having a heat-retarding medium of substantially lower thermal-conductivity than said clay material distributed therein to reduce the thermal-conductivity of the block, said heat-retarding medium comprising a multiplicity of minute isolated gas filled cavities distributed throughout said clay material block, said passages being defined by integral internal wall surfaces of said block and said heat-retarding medium being disposed adjacent to said passage defining surfaces, said passage arrangement and dimensions and said heat-retarding medium in said clay material block and adjacent to said internal wall surfaces of said passages being jointly operable to confine the combustion of the fuel mixture to the outer zone of said passages and to inhibit said combustion from traveling in said passages inwardly of said zone and producing a backfiring effect.

5. A gas burner device, comprising a burner casing defining a chamber having an open part and fuel and air inlet means to said chamber, a burner member disposed at said open part and forming a closure thereat, said burner member comprising a block of refractory material having a multiplicity of passages therethrough for a combustible fuel and air mixture, said passages being substantially uniformly distributed throughout an area of said block and each having a cross sectional area of not more than about four square millimeters and a length not less than about five millimeters and each extending substantially in the same direction throughout its length from the inner face of the block to the outer face thereof, said passages collectively occupying not less than about 20 percent of the total radiation area at said outer face of the block, said block of refractory material having a heat-retarding medium of substantially lower thermal-conductivity than said refractory material distributed therein to reduce the thermal-conductivity of the block with the latter having a thermal conductivity of less than 0.5 kilocal./hr. m. °C. and defining a radiant surface on the outer face thereof to be rendered incandescent by the combustion of fuel and air supplied to the inner face thereof, said passages being defined by integral internal wall surfaces of said block and said heat-retarding medium being disposed adjacent to said passage-defining surfaces, said passage arrangement and dimensions and said heat-retarding medium in said block and adjacent to said internal wall surfaces of said passages being jointly operable to confine the combustion of fuel and air to the outer zone of said passages and to inhibit said combustion from traveling in said passages inwardly of said zone and producing a backfiring effect.

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