April 21, 1964 G. HÖNGER 3,129,749

RADIATING GAS BURNER

Filed March 1, 1960 2 Sheets-Sheet 1

FIG. 1

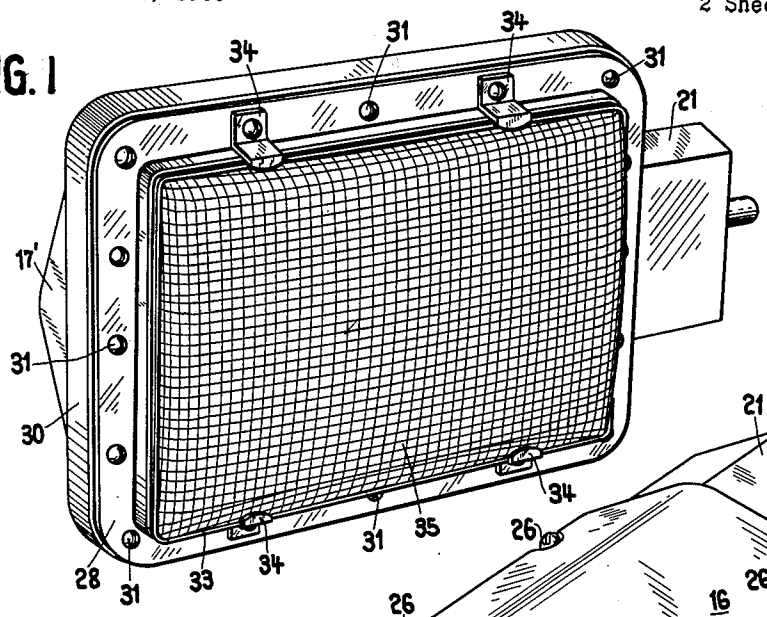


FIG. 2

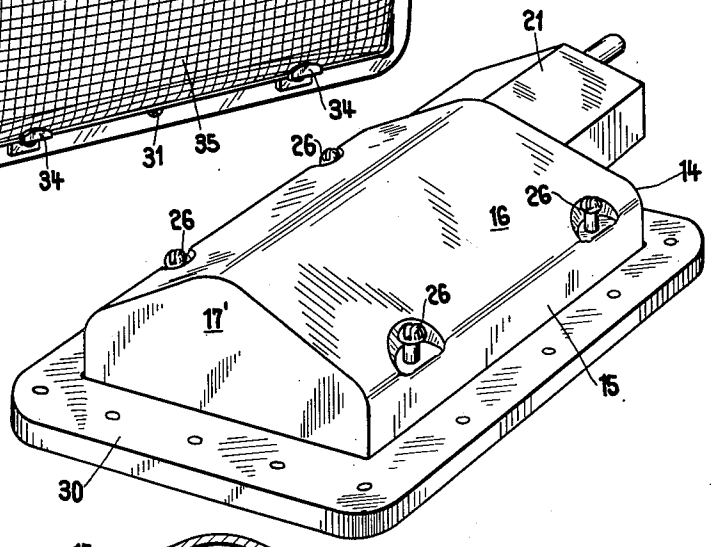
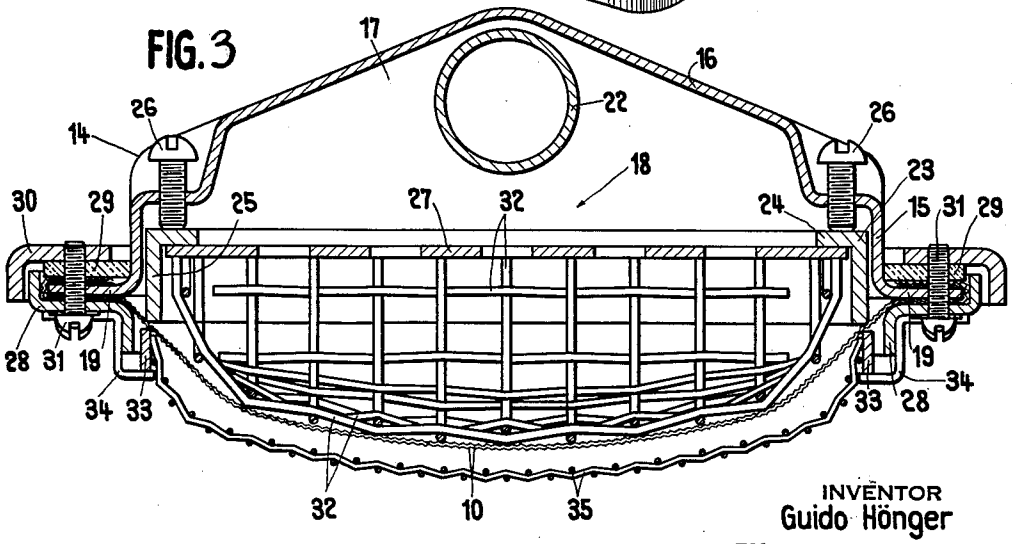


FIG. 3



INVENTOR
Guido Hönger

BY Inirie & Smiley
ATTORNEYS

April 21, 1964 G. HÖNGER 3,129,749

RADIATING GAS BURNER

Filed March 1, 1960 2 Sheets-Sheet 2

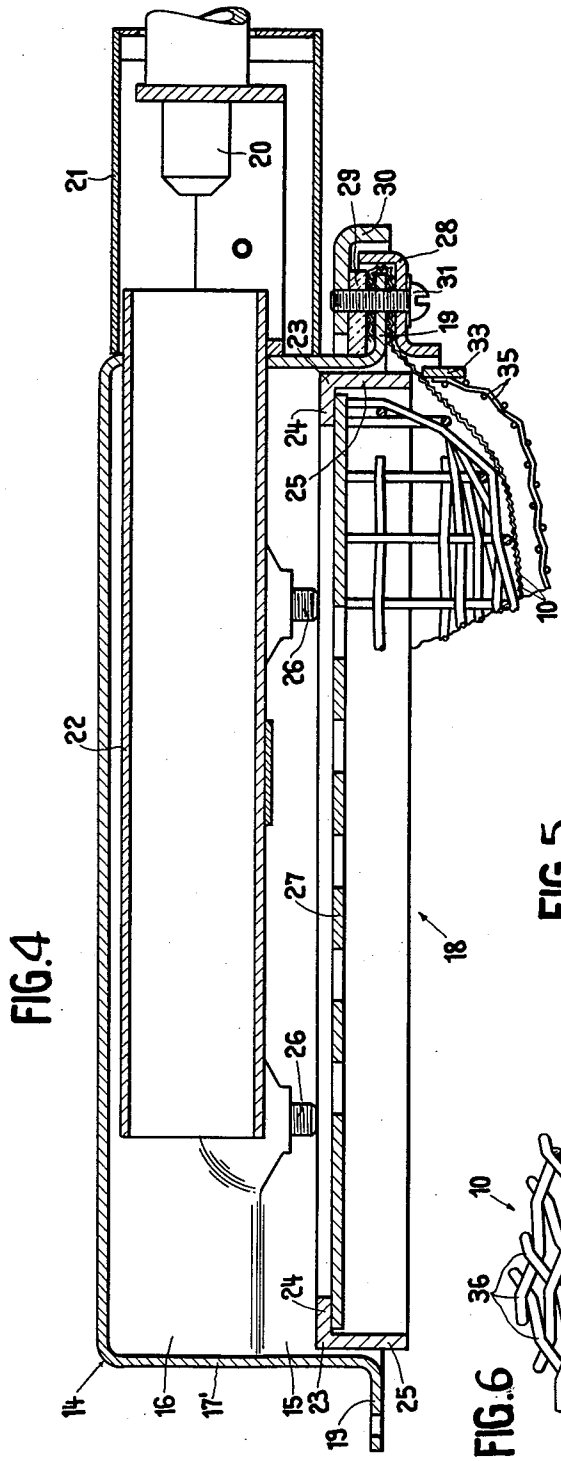


FIG.4

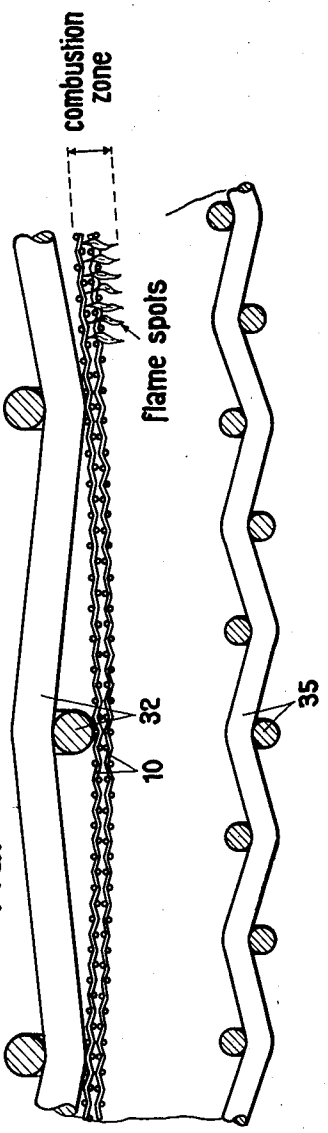


FIG.5

FIG.6

INVENTOR
Guido Hönger
BY Inirii & Smiley
ATTORNEYS

United States Patent Office 3,129,749 Patented Apr. 21, 1964

3,129,749

RADIATING GAS BURNER

Guido Hönger, Zuchwil-Solothurn, Switzerland, assignor to Schweiz. Gasapparatefabrik Solothurn, Solothurn, Switzerland

Filed Mar. 1, 1960, Ser. No. 12,140
Claims priority, application Switzerland Nov. 16, 1953
7 Claims. (Cl. 158—114)

This invention is a continuation-in-part of my U.S. patent application Serial No. 467,525 filed November 8, 1954, now Patent No. 3,021,893.

My invention relates to radiating gas burners and more particularly to fast-starting radiating gas burners wherein the combustion of a gas-air mixture heats an external diaphragm to incandescence within a short time from the ignition of the gas-air mixture.

It is a particular object of this invention to substantially limit the heating effect of the combustion zone to a thin and light outermost portion of the burner diaphragm, preferably to a relatively thin outer wire net having a small heat capacity and allowing therefore rapid heating to incandescence. It is an additional object of the invention to limit heat conduction and heat radiation to the rear portions of the burner diaphragm as far as possible in order to maintain them at a relatively low temperature at which flash-back of the combustion behind the burner diaphragm is prevented.

Further objects and features of the invention will be apparent from the following description and from the attached drawings which show, by way of example, two embodiments of the invention.

FIGS. 1 and 2 are perspective illustrations of an embodiment of the invention,

FIGS. 3 and 4 are a cross section and a partial longitudinal section respectively of the said embodiment.

FIG. 5 is a section of the burner diaphragm of the second embodiment on an enlarged scale for illustration of the burner characteristics and

FIG. 6 is a partial view of a wire net preferably used for building up the burner diaphragm.

The embodiment illustrated in FIGS. 1 to 5 has a burner body 14. A lower portion 15 of this body has a substantially rectangular cross section while an upper, roof-shaped portion of the body has a substantially triangular cross section. The body 14 has flat vertical end walls 17' and 17''. A substantially rectangular burner opening 18 is formed in the burner body and a flat flange 19 surrounds the burner opening. A nozzle 20 is mounted in a casing 21 attached to one end face 17 of the burner body, the nozzle opening being directed into the outer end of a mixing tube 22 projecting through the one end wall 17'' and towards the other end wall 17'. In one practical embodiment of a relatively small burner, the mixing tube diameter is 2.4 cm., the mixing tube length is 16 cm. and the free distance of the inner end of the mixing tube from the end wall 17' is 4.5 cm. The total length of the burner body is 19 cm. and therefore, the mixing tube extends through the greater portion of the length of the burner body. This ϕ is of particular advantage because no further space for the mixing tube is to be provided.

As shown in FIG. 3 a frame 23 is loosely inserted into the burner body, this frame having a flat flange 24 extending in a direction substantially parallel to the burner opening and a flange 25 extending in a direction substantially vertical to the burner opening. Spanning screws 26 are inserted into threaded holes of the burner body, such screws allowing to exert a pressure against frame 23 for spanning the burner diaphragm in a manner set out below. A perforated plate 27 is loosely arranged below the flange 24 of frame 25. In the embodiment set out above, 36 holes having each a diameter of 1.2 cm. are provided in this perforated plate, so that the total flow section of the perforations is in the order of 40 cm.^{2}.

The rim portions of the burner diaphragm, formed by two superposed wire nets of the size indicated above for the first embodiment, are laid round the flat flange 19 of the burner body and are firmly clamped and anchored between this flange and a lower clamping frame 28 and a heat insulating layer 29 respectively which is pressed against the wire nets by means of an upper clamping frame 30. The lower and upper clamping frames 28 and 30 are pulled towards each other by means of screws 31 passing through the lower and upper bend of the diaphragm and assisting absolutely reliable anchoring of the diaphragm on the burner structure.

The burner diaphragm is spanned over a supporting structure or basket 32 made of a very coarse wire grid having wide openings compared with the wire thickness. As an example a wire grid having a wire diameter of 1.7 mm. and a mesh width of 13 to 14 mm. is preferably used. The supporting grid has a substantially rectangular base engaging the rim portion of the perforated plate 27 and is convexly shaped substantially as shown in FIG. 3. When the burner is assembled so far as shown in FIG. 3, the screws 26 are tightened so that the frame 23, the plate 27 and the supporting grid 32 are pressed downwards against the burner diphragm 10 which is thereby tightly spanned over the supporting structure. The inner wire net 10 of the burner diaphragm will thereby be spanned and pressed against the regularly spaced supporting places formed by the wires of the supporting grid, whereas the outer wire net 10 is also spanned and pressed against the inner net 10 at least where the same is supported on the wires of the supporting structure 32. This is shown on a very large scale in FIG. 5. The wire nets 10 of the burner diaphragm contact each other where the inner net is supported on the wires of the supporting structure 32 and the wire nets 10 may be at a little distance in the free spaces between the wires of the supporting structure, where the inner net 10 is not supported. However, since both nets 10 are tightly spanned, they may also contact each other in the free spaces between the wires of the supporting structure in some places distributed at random, but in any case, the free length, whereon the wire nets 10 may be at a little distance from each other is practically limited to the distance between adjacent wires of the supporting structure, that is, for the above practical embodiment to 13 to 14 mm. Under these circumstances the spacing between the wire nets 10 cannot exceed the admissible maximum value of about 0.5 mm. and this spacing will be much less under normal manufacturing and operating conditions. As already mentioned above, keeping this spacing between the wire nets 10 as small as possible over the full burner area is of great importance for proper burner operation, particularly for preventing flash-back of the combustion behind the burner diaphragm.

The mesh size and wire thickness of the nets 10 may depend on the gas quality for which the burner is to be used. For gases having a relatively low calorific value in the order of 3000 to 7000 kcal./m.^{3}, such as methane or sewer gas the mesh size should be in the order of 0.4 to 0.5 mm. whereas the wire thickness should be in the order of 0.15 to 0.2 mm. Additionally the dimensions of the openings between adjacent wires should be 2.5 to 3 times the wire thickness in order to obtain good results. For gases having higher calorific values in the order of 20,000 to 26,000 kcal./m.^{3}, such as butane and propane, a mesh and wire size as mentioned above may be used but a mesh size of up to 0.7 to 0.8 mm. may as well be suitable, the ratio of the mesh width to the wire thickness being as indicated above. For reasons set out later on

it is particularly important to use wire nets wherein all the wires are similarly corrugated as shown in FIG. 6.

A further frame 33 of a flat metal strip is inserted into the outwardly bent flange of the lower clamping frame 28 and is secured between the burner diaphragm 10 and brackets 34 mounted by means of some of the screws 31 (FIGS. 1 and 3). A wire grid 35 of high-refractory material, for instance the material used for the wire nets 10 of the burner diaphragm, is attached to the frame 33 for instance by point welding, this wire grid being convexly shaped similarly to the convex shape of the burner diaphragm, so that the grid 35 is at a substantially constant distance from the burner diaphragm over the full burner area. This distance may preferably be in the order of 0.5 cm. and the wire grid 35 has a wire thickness of 1 mm. and a mesh width in the order of 5 mm. During operation of the burner this outer wire grid has a double function in that it is heated to incandescence and therefore substantially adds to the heat radiation of the burner and this relatively strong wire grid forms a protection of the burner diaphragm against mechanical influences and draught.

The burner opening of the practical embodiment referred to above has a size of 15 x 20 cm., that is 350 $cm.^2$. Considering that the effective flow section of the burner diaphragm is in the order of 40% of the burner area the total flow section of the burner area is in the order of 4.5 $cm.^2$, the flow section of the distributing plate 27 is in the order of 40 $cm.^2$, that is about 10 times the flow section of the mixing tube and the total flow section of the burner diaphragm is in the order of 140 $cm.^2$, that is about three times the flow section of the distributing plate 27 and about 30 times the flow section of the mixing tube. The gas-air mixture is deflected a first time when leaving the mixing tube into the burner body, whereby most of the mixture has to be deflected on the one front wall 17' of the burner body for being distributed to the roof-shaped mixing portion of the burner body through which the mixing tube extends, and the mixture is deflected a second time when flowing from the mixing space above the distributing plate 27 through this plate to the lower burner space covered by the burner diaphragm. As indicated in FIG. 4 the plate 27 is perforated in a middle portion, the outer rows of perforations being at a distance in the order of 4.5 cm. from the end walls 17 of the burner, so that the gas-air mixture cannot directly flow from the inner mixing tube end through such perforations but has to be deflected completely and distributed into the upper roof-shaped mixing space before being allowed to flow down through the perforations of plate 27.

With reference to FIG. 5 which shows a partial section of the supporting structure 32, the burner diaphragm 10 and the wire grid 35, the operating characteristics of the burner will now be explained in detail.

Under the above conditions regarding the wire thickness and mesh width of the wire nets ϕ 10 of the burner diaphragm, the spacing between such wire nets maintained as small as possible, and under the further condition that the exit speed of the gas-air mixture is in the order of 20 to 30 cm./sec., flames will be formed outside the mesh openings of the inner wire net 10. This is schematically shown in FIG. 5. The base of the individual flames is just outside the mesh openings of the inner wire net 10. However, since the distance between the inner and outer wire nets 10 of the burner diaphragm is kept very small and the wire nets are preferably maintained in contacting relationship, only a small portion of the flame is formed between the wire nets 10, whereas the outer flame portions are between the meshes of the outer wire net 10 and outside the outer wire net 10 as shown in FIG. 5. It was found that with the above recited dimensions of the wire nets 10 of the burner diaphragm, with the said dimensions of the flow sections in the burner diaphragm, in the distributing plate and in the mixing tube, and with the above exit velocity of the gas-air mixture through the openings of the inner wire net of the burner diaphragm, combustion substantially as shown in FIG. 5 may be obtained, wherein the flame spots or tips are substantially outside the outer wire net of the burner diaphragm. It is well known in the art that these spots or tips of Bunsen flames are the hottest parts of the flame. This is the reason why in well known radiating burners the outer portion of the burner diaphragm has been arranged at a distance from the inner net in order that this outer portion be directly heated by the flame spots, such spots being thereby located just inside the outer portion of the burner diaphragm. However, it was found that this is not the best way of obtaining maximum efficiency of the burner. With the arrangement as illustrated in FIG. 5, wherein the hottest portion of the flames and of the combustion zone respectively is outside the outer net of the burner diaphragm, it is still possible that this outer net of the burner diaphragm be heated to incandescence at temperatures in the order of 600 to 800° C. substantially due to the heat radiated backwards from the flame spots wherein temperatures in the range of 1500 to 2000° C. are obtained, towards the outer net 10 of the burner diaphragm. While the intensive heat radiation occurring at these high temperatures will heat the outer net 10 of the burner diaphragm to incandescence the outer net 10 constitutes a screening for the inner wire net 10 preventing substantial heat transmission from the flame spots to the inner net 10 by radiation. Therefore, while the outer net 10 is heated to incandescence, the temperature of the inner net 10 is maintained well below radiant temperature, that is below 500° C. at which temperature flash-back of the combustion behind the rear wire net 10 is not possible for normal operating conditions of the burner. In fact it was found that the mean temperature of the inner wire net 10 is about half the temperature of the outer net 10. Therefore, when the outer net is heated to the above higher limit of the admissible operating temperature in the order of 800° C., the inner wire net 10 is heated to a mean temperature in the order of 400° C. whereby flash-back is prevented.

It is true that the outward heat radiation from the flame spots is substantially lost for heating the outer net of the burner diaphragm. It was found however that due to the dimensions of the burner portions as stated above and due to the screening of the inner diaphragm by the outer diaphragm, it is possible to provide high heating power per unit area with only two nets in the burner diaphrgam. Further, due to the relatively low flow resistance in the burner diaphragm having only two wire nets and due to the above further dimensions of the burner opening, the distributing plate and the mixing tube, it is also possible to aspire a high proportion of primary air so that complete combustion will take place in close proximity of the outer net of the burner diaphragm so that this diaphragm is heated at a high heating power produced very close to the outer wire net 10 but in a manner that the inner net 10 is not appreciably heated. This is a particular combination of features allowing operation of the burner at high efficiency and with a simple and inexpensive construction of the burner diaphragm.

Optimum efficiency may be obtained when operating the burner at a rate of 10 kcal./h. $cm.^2$, this heating power resulting in good radiation of the burner diaphragm.

It is well known that the shape and size of the flame depends on the sort of gas and on its exit velocity. As stated above, the exit velocity is in the same order for all gases, but the velocity of propagation of combustion in such gases is different. In gases having a relatively low calorific value such as methane or sewer gas the velocity of propagation of combustion or ignition is higher than in gases having high calorific value such as butane, or propane. Therefore, the flames of butane or propane will be higher and larger than the flame of methane or

sewer gas. In order to obtain somewhat similar characteristics and relative dimensions of the wire nets of the burner diaphragm as compared with the flame size or the height of the combustion zone, coarser and thicker wire nets are used for burners adapted for operation with butane or propane and finer wire nets are used for methane or sewer gas. In any case the thickness and mesh width of the wire nets of the burner diaphragm and the exit velocity of the gas-air mixture are chosen in a manner that the hottest flame spots of the individual flames formed in front of the rear wire net are outside the outer wire net of the burner diaphragm so that only the outer wire net is heated to incandescence.

However, it was found that a temperature of about 800° C. is an upper limit for safely operating the burner with two superposed wire nets in its diaphragm. Higher temperatures are possible but with such higher temperatures a further similar wire net has to be added in the burner diaphragm because the middle wire net is heated to a temperature at which flash-back of the combustion behind it can no longer be avoided. Therefore, this invention is not limited to any distinct number of wire nets **10** but any number may be used. As an example, six wire nets have been used in a burner wherein the outer net of the burner diaphragm is heated to 1000–1200° C.

It was found that for proper burner operation it is important to use wire nets **10** of the type shown in FIG. 6, wherein all the wires are similarly corrugated and have portions or corrugations **36** exposed at the upper side of the wire net and portions or corrugations **37** exposed at the lower side of the wire net. When nets of this kind are mounted in the burner, each wire of each net **10** has alternative portions or corrugations exposed at the inner and outer side of the net. This is of particular importance for the inner net because each wire has portions exposed at the inner side of the inner net where such portions are effieciently cooled by the gas-air mixture admitted to the burner diaphragm. By heat conduction the outer portions or corrugations are cooled from the inner portions or corrugations so that the inner wire net of the burner diaphragm is effectively cooled as a whole. Further due to the structure of the wire nets as shown in FIG. 6 the wire nets will contact each other only in a few places at the tops of the corrugations and therefore heat conduction from the outer incandescent wire net to the inner wire net is reduced to a value for which the inner wire net is not unduly heated. It may be an advantage to superpose the wire nets **10** in such a way that the wires or strands of the inner grid cover with the mesh openings of the outer net **10** so that heat radiation from outside through the mesh openings of the outer wire net is effectively reflected back through such mesh openings.

In the embodiment described in the foregoing a relatively wide rim portion of the wire nets is clamped between relatively cool clamping surfaces of the burner body, so that such rim portions of the wire nets are cooled to substantially the temperature of the burner body. This is very important because the flow of the gas-air mixture is particularly irregular and slow near the walls of the burner body, that is near the rim portions of the burner diaphragm. However, since such rim portions are effectively cooled by clamping them between cool surfaces of the burner body and clamping means respectively, such rim portions wherein the flow of gas-air mixture may be irregular and particularly slow are maintained at a temperature at which flash-back of the combustion is prevented in spite of the comparatively low exit velocity of the gas-air mixture.

With larger burners of a size at least as indicated above for one practical embodiment of the burner shown in FIGS. 1 to 4 it was found that the burner tends to produce relatively loud noises at least during the starting-up periods of the burner. The reason for this noise is not exactly known at this time but in any case an oscillation of the burner diaphragm will certainly accompany this acoustical phenomenon. The characteristics of this oscillation of the burner diaphragm and more precisely of its wire nets **10** greatly depends on the tension set up in such nets and on the free length upon which the nets extend without being supported. It is evident that any oscillation which may occur in the nets is substantially damped where the nets are supported on the wires of the supporting basket **32** but that oscillation of the wire nets is possible between such supporting places where the nets may be at a small distance from each other and are therefore free to oscillate in a direction perpendicular to their flat extension. Since in the embodiment of FIGS. 1 to 4 this free distance between adjacent supporting places is in the order of 1.3–1.4 cm. and the nets are under substantial pull which may be in the order of 0.5 to 1 kg. per centimeter width of the burner diaphragm, each of these free lengths of the burner diaphragm and of its wire nets respectively is capable to oscillate at a natural frequency in the supersonic inaudible range. It may therefore be assumed that portions of the nets **10** which are not supported on the supporting structure will slightly oscillate during burner operation at a high, inaudible frequency. It is a first advantage of this fact that audible noise of the burner is substantially avoided. On the other hand a slight inaudible oscillation of the wire nets of the burner diaphragm may be desirable. As already mentioned above direct contact between the wire nets should be avoided but the wire nets should be maintained at a distance as small as possible in order to prevent heat conduction from the outer wire net to the rear wire net. Of course it is impossible to completely avoid contact between such nets in some places, particularly when the wire nets are spanned over a supporting structure as shown in FIGS. 1 to 4. However, where the wire nets **10** are supported by the wires of the coarse supporting grid **32**, the inner wire net **10** is sufficiently cooled by its contact with the supporting grid **32** so that overheating and flash-back in this supporting place due to direct contact between the inner and outer wire nets **10** is prevented. However, as stated above, some contact between the wire nets **10** is also possible between the supporting places. But the contacting pressure between nets **10** in such contacting places between the supporting places is very small and therefore a slight oscillation of such nets due to the gas flow through them will tend to periodically space the wire nets in the said contacting places by a very little distance so that heat transmission by conduction in such places is appreciably reduced. Thus, while the wire nets **10** of the burner diaphragm may contact each other in many places distributed at random throughout the burner surface when the burner is inoperative, the nets may be slightly spaced from each other even in such places due to the said slight inaudible oscillation of the wire nets occurring during burner operation. Of course cooling of the inner wire net by the gas-air mixture is intensified by the said oscillation, this being another contribution to safe burner operation.

While this invention has been described and illustrated with reference to specific embodiments thereof, it will be understood that other embodiments may be resorted to without departing from the invention. Therefore, the forms of the invention set out above should be considered as illustrative and not as limiting the scope of the following claims.

What I claim is:

1. A radiating gas burner wherein the combustion of a gas-air mixture heats an external diaphragm to incandescence, the said external diaphragm comprising at least two wire nets superposed in substantially parallel position, the mesh width of the said wire nets being in the order of 0.4 to 0.8 mm., a burner body having a burner opening and clamping means round the said burner opening for tightly clamping and securing the said wire nets

along the said burner opening, a supporting structure made of a coarse wire netting having a mesh size in the order of 1 to 1.5 cm. within the said burner body at the inner side of said external diaphragm, the said supporting structure having a slightly convex shape for supporting the said external diaphragm in a slightly convex shape, means for pressing the said supporting structure against the said external diaphragm for stretching it, a pull thereby set up in the external diaphragm being taken up in the said clamping means, the said wire nets of the external diaphragm being supported and in contact with each other along the wires of the said coarse wire netting while they are spanned between such wires on free distances in the order of 1 to 1.5 cm., the wire nets being thereby held in substantially parallel position and at little distance from each other in the said free distances and oscillations set up in such free distances due to the tension set up in the burner diaphragm and due to the passage of the said gas-air mixture through the burner diaphragm and combustion near the said diaphragm are in the range of inaudible, supersonic frequencies.

2. A radiating gas burner wherein the combustion of a gas-air mixture heats an external diaphragm to incandescence, the said external diaphragm comprising at least two wire nets superposed in substantially parallel position, a burner body having a burner opening and clamping means round the said burner opening for tightly clamping and securing the said wire nets along the said burner opening, a latticed supporting structure within the said burner body at the inner side of said external diaphragm, means for pressing the said supporting structure against the said external diaphragm for stretching it, a pull thereby set up in the external diaphragm being taken up in said clamping means, the supporting structure being a coarse wire mesh which is larger than the mesh of said wire nets.

3. A radiating gas burner according to claim 2 wherein the wires of said supporting structure are corrugated whereby to reduce the number of said contact areas of said wire nets with the supporting structure.

4. A radiating gas burner according to claim 3 wherein all the wires of said wire nets are corrugated similar to said supporting structure so that each wire has alternate corrugations situated at the outer surface and at the inner surface of the respective wire net.

5. A radiating gas burner wherein the combustion of a gas-air mixture heats an external diaphragm to incandescence, comprising a burner body having a burner opening lying in a plane covered by the said diaphragm, a cylindrical mixing tube parallel to said plane and open only at its ends, said tube having one end thereof opening into the said burner body and gas nozzle means directed into the other end of the said mixing tube, gas pervious distributing means also lying in a plane parallel to that of the burner opening and positioned in the said burner body between the said mixing tube and the said external diaphragm, openings in the said distributing means, the axes of the openings of the distributing means making a substantial angle to the axis of the said mixing tube, the gas and air being deflected when flowing from the mixing tube into the burner body, the gas being thereby intensively mixed with air, the total cross section of the said openings of the gas pervious distributing means being substantially larger than the cross section of the mixing tube, the said external diaphragm comprising at least two wire gauzes superposed in substantially parallel relation and contacting each other in some places and maintained at a small distance apart in the remaining places, the total exit section of said wire gauzes being substantially larger than the cross section of said mixing tube, clamping means on the burner body round the said burner opening for tightly clamping and securing the said wire gauzes along the said burner opening, a latticed supporting structure having a mesh size greater than the mesh of said wire gauzes within the said buner body at the inner side of said external diaphragm, and means for pressing the said supporting structure against the said external diaphragm for stretching it, a pull thereby set up in the external diaphragm being taken up in the said clamping means.

6. A radiating gas burner according to claim 2 in which is provided an elongate mixing tube open at both ends secured to said body and having one end discharging into the body remote from said diaphragm, means at the other end of said mixing tube for discharging a combustible gas-air mixture into said mixing tube, distributing means fixed within said body and interposed between said one end of the mixing tube and said diaphragm, said distributing means presenting openings to pass combustible gas-air mixture in a direction deflected from the axis of the mixing tube, the size of said burner opening in the body and the wire thickness of said wire nets being such as to define an effective flame discharge area equal to about 25 to 30 times the cross sectional area of said mixing tube, and the openings of said distributing means having a collective area equal to about 10 times the cross sectional area of the mixing tube.

7. A radiating gas burner according to claim 5 wherein the size of said burner opening in the body and the wire thickness of said wire gauzes is such as to define an effective discharge area equal to about 25 to 30 times the cross sectional area of said mixing tube, the openings of said distributing means having a collective area equal to about 10 times the cross sectional area of the mixing tube.

References Cited in the file of this patent

UNITED STATES PATENTS

366,780	Love	July 19, 1887
731,384	Newbold	June 16, 1903
792,356	Shiels	June 13, 1905
824,361	Hudson	June 26, 1906
993,554	Sandford	May 30, 1911
1,677,156	Vaughn	July 17, 1928
1,945,902	Johnson	Feb. 6, 1934
2,021,893	Honger	Feb. 20, 1962
3,029,866	Honger	Apr. 17, 1962

FOREIGN PATENTS

18,150	Great Britain	of 1913
494,087	Great Britain	Oct. 17, 1938
288,442	Germany	Nov. 2, 1915