RADIANT GAS BURNER
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This is a continuation-in-part of my application Ser. No. 828,625 filed July 21, 1959, now abandoned, and relates to improvements in gas burner units.

The conventional induction-type gas burner units generally comprise a ganged-opening injector for supplying gas to the inlet of a mixing chamber directly connected with the atmosphere, said chamber being shaped as a venturi formed with a constricted or neck portion at its inlet and widening out at its opposite end terminated by a head member pierced with holes or slits. The gas jet leaving the jet of gas issuing from the venturi partially vacuum carries along by friction combustion air. The widened-out portion, from said neck to the head member, causes the speed to be converted into pressure, whereby the mixture may escape through the outlet openings of the burner.

In most types of burners, a portion only of the combustion air, viz., the so-called "primary air" is carried along by the gas jet in the venturi, the necessary complementary or "secondary" air being derived from the atmosphere adjacent the head member and forming a flame opposite each outlet for the mixture.

In order for the flame to be stable, it is necessary to meet the following conditions:

1. The speed of the mixture leaving the burner should not exceed the propagation speed of the flame at said point, otherwise the flame will "cut off."

2. The speed of the mixture passing inside the burner, particularly through the outlet openings provided on a sufficiently thick wall relative to the cross-section of said openings, should be high enough for a flame to be sustained.

In such burners, the outlet cross-section of the openings is generally between 1.7 and 2.2 times the cross-section of the venturi section, the total thermal output per square centimeter of the outlet section then being between 700 and 800 millih/minute for rich gas mixtures, and about 1300 millih/minute for town gas or gases substitutable thereto. For gases having a high flame propagating velocity, the thickness of the wall formed with the outlet openings is twice as great as their diameter (usually 6 to 8 mm. thick).

The gas burner unit according to the invention generating an infra-red radiation comprises essentially, at the outlet of a mixing chamber supplied with gaseous fuel and air or other combustible gas, a single perforated screen topped by one or a plurality of tubes, exclusive of other piece; the mixture leaves the chamber through the perforated screen, grid or other similar member, providing a passage of a substantially greater cross-section than indicated hereinabove, with respect to the section of the venturi neck, viz., about 10 times the section of said neck, although this may be very much larger; thus, the combustion mixture leaves at a very low velocity, so that combustion is localized at the level of the grid defining the outlet cross-section. On the other hand, due to the large outlet section provided on a thin wall, there is substantially no counter-action to the primary air entrainment, so that the combustion of the mixture is complete, without any secondary air being required. There is moreover no risk of setting fire at the injector on account of the presence of the screen or other similar element, which acts as a flameguard. On account of the large outlet cross-section, the thermal flow per section unit is substantially lower than in flame burners: 50 millih/minute at the most per square centimeter of outlet section.

The screen or grid may consist of a metal-wire netting or lattice with intervening voids, such as a wire gauge for instance. The wire diameter, and the spacing between adjacent wires, vary in accordance with the intended use. In any case, the area of the voids which constitutes the outlet section of the burner is substantially greater than the section of the inlet nozzle. The ratio of these sections may moreover vary within comparatively wide limits, ranging from 25 to 50, although these limiting figures present no absolute character.

The ratio of the "voids" to the total area of the screen is selected as a function of the radiating effect it is desired to impart to the screen or grid. It may vary within substantially wide limits: thus, burner units have been built, whose "void" area is between 18 and 60% of the total surface, although these figures are in no way of an absolute nature.

In any case, the outlet wall having a reduced thickness and being formed with a plurality of adjacent openings offers practically no resistance to the passage of the fluid.

The structure, which is perpendicular to the screen or grid and arranged directly on top thereof, may have various shapes according to the size of the head member, the use desired, etc. It may comprise a plurality of tubes forming a multicellular partition system or grating, or else a single tube forming so to say a monocellular partition system. The one or several of the chimneys or funnels formed above the screen have preferably a height of the same order of magnitude as the transversal dimension thereof.

In the case of a multicellular partition structure, the partitions limiting the cells or chimneys are thin and thus do not affect the escaping of the combustion gases.

The combustion takes place without a flame, on the outer surface of the wall, without the intervention of secondary air and provides a very high temperature. The absence of a flame enables the combustion to be considered as "catalytic," and since no catalytic body—i.e., no catalyst—has to be present, the combustion may be considered as "auto-catalytic."

However, it is also an object of the invention to provide an embodiment according to which the metal constituting the tube possesses catalytic properties. The auto-catalytic combustion mentioned above is then supplemented by an ordinary catalytic combustion, resulting in the burner being practically inextinguishable.

It is another object of the invention to provide an embodiment of a burner wherein the metal constituting the perforated screen presents a catalytic property.

The perforated screen or grid serves also as a reflector for infra-red rays transmitted by the wall of the tube or tubes. Moreover, it performs in itself a radiating function, the importance of which depends on the ratio of the voids to the total surface. In addition, the screen defines the combustion area, thus preventing flare-backs.

Although the mixture of fuel gas and air flows at a very low speed, as proved by the silent operation of the burner, the gases resulting from the combustion, of a volume substantially greater than that of said mixture, are evacuated at high speed, without being restrained in any point, on account of the absence of any piece other than the screen and the tube. This evacuation is accelerated by the presence of one or a plurality of tubes which may function as chimneys when the screen is substantially horizontal.

The height of the tube or tubes may vary within wide limits according to the result desired. The shorter the tube or tubes, the higher the temperature of the burnt gases at the outlet thereof.

According to another feature of the invention, burners are provided having comparatively long tubes, with a high
efficiency of infra-red radiation and a comparatively low convection heating. On the other hand, radiation wave-lengths may be modified by varying the length of the tube or tubes, and consequently the temperature thereof.

The burner unit according to the invention is adapted to deliver natural combustion atmosphere, i.e. neither oxidizing, nor reducing, by simply adjusting the air in the venturi, or by other means.

It is thus possible to use for building the burner, and in particular for making the perforated screen, any currently available material, such as iron. An iron-made burner unit has withstand many thousands of hours of operation, in spite of the high temperatures reached.

The burner unit may also be adjusted to deliver an oxidizing or a reducing atmosphere of burnt gases, over a comparatively wide composition range in either case. The resulting reducing atmosphere may be used, for instance, for a de-oxidizing process, such as the removal of rust from ferrous surfaces, whereas an oxidizing atmosphere is used for room heating.

The burner unit according to the invention may be supplied with a fuel gas naturally containing sulfur compounds, without impairing its operation. The burner will not produce hydrogen sulfide, as proved by testing a perforated screen made of silver which was not attacked during the experiment.

Bummers are known having a cellular partition structure located near a flat outlet diaphragm for the mixture, but in such burner the diaphragm comprises at least two adjacent, substantially parallel wire gauzes between which the combustion takes place. The main function of the partition structure is to avoid the harmful influence of draughts and, although said structure exercises a certain radiating effect on the diaphragm, this effect has no decisive influence on the operation of the burner, which remains satisfactory (in an atmosphere without the presence of draughts) when the partition structure is removed from the burner, in contradistinction with the burner according to the invention, wherein the removal of the structure basically affects the operation thereof.

The invention will be best understood from the following description and appended drawings, wherein:

FIG. 1 is a plan view, with the partition structure and the fastening member removed.

FIG. 2 is a plan view of the partition structure.

FIG. 3 is a cross-sectional view along line 3-3 of FIG. 1.

FIG. 4 is a view, at an enlarged scale, of a portion of FIG. 3.

FIG. 5 is an elevational side view of the device.

FIG. 6 is a cross-sectional view along line 6-6 of FIG. 5.

FIG. 7 is a side view at right angle of FIG. 5.

FIG. 8 is a diagrammatic view of an embodiment, illustrating a single-type burner.

FIG. 9 is a plan view of an alternative embodiment of the device illustrated in FIGS. 1 to 7.

FIG. 10 is an elevational view with parts broken away, to show the arrangement of FIG. 9.

Referring to the drawings, the burner unit as shown in the embodiment illustrated in FIGS. 1 through 7, comprises a body 100, of a material such as cast aluminum, extending along a rectangular plane in the example given, and formed with a peripheral edge 101, the base of which presents a groove portion 102. In said groove portion there is located a gasket 103 supporting a cellular structure 104 comprising a plurality of juxtaposed square-shaped prism elements, opened at their upper and lower sides. At the base of the prism-defining partitions, there are formed semi-circular notches 105. A wire-gauze 106, secured by said structure, rests peripherally on the rim 107 of a U-sectioned frame 108, and formed by said partition framework, the flanged rim 109 of said wire-gauze resting against the upper edge 110 of said frame 108. The partition and wire-gauze assembly forming an unitary structure will thus rest with its rim 107 on a joint 111 located in groove 102. A ring of rectangular contour 112, bearing against edge 101, enables the structure to be fixed in position.

The structure forms the upper perforated wall of a space comprising 113 hoses, by hole 114 into which leads the mixing chamber proper 114. The latter is bounded by an inner wall 115, cast in one piece with body 100 having an extension 116, along the axis of which is an injector 117 having a calibrated opening shown at 118. The supply of fuel gas takes place through conduit 119, the adjustment being effected through pin-scock 120. In this way 117 is located adjacent two windows 121 and 122 through which the primary air is entrained, the flow area of which may be adjusted by means of a slide-ring 122 (shown in broken lines in FIGS. 1 and 5), which may be firmly fixed in position. Starting from opening 118, the cross-section of the mixing chamber first decreases, the increases, the narrow-section area or venturi neck portion thus formed by the convergent-divergent portion being shown at 123. At the outlet of chamber 114, there is provided a zig-zag-shaped deflector 124 (FIG. 1) also cast in one piece with the body 100, with rounded angular portions, a plate 125, secured by means of a screw 126 and preventing direct communication between the partition structure and chamber 114.

The combustion gas supplied by nozzle 119 passing through the injector opening entrains, by induction, the combustion air which enters through the windows or openings 121 and 122. The mixing takes place in chamber 114 and the outflow through the vertically extending (in this figure) ports 127, 128 provided between the end portion of wall 115 and the deflector 124 the shape of which is such as to provide a homogeneous distribution of the mixture. The entire underlapping portion of the wire-gauze 106. The combustion occurs on the upper side of the latter and, immediately after firing, is effected without producing a flame, under the conditions and with the advantages already mentioned.

In a practical embodiment of the burner, the diameter of the body of the inlet nozzle is 13 mm., i.e. a cross-section of 1.33 sq. cm. The area of the head-member is 111.4 sq. cm. The face-gauze is formed of 0.2 mm. diameter wires, with 256 meshes per sq. cm. The area of the "voids" relatively to the overall wire gauze surface is thus equal to 46%; the total area of the voids (outlet section) was equal to 51 cm.2. Thus, the ratio of the outlet section to the section of the venturi constiction is 38.5.

The partition framework on top of the screen of wire-gauze is square-shaped, the partitions being 0.6 mm. thick and each one of the cells having a section of 7 x 7 mm. The partition framework is 7 mm. high. The output of such a burner supplied with butane gas at a pressure of 112 g/sq. cm. was found to be 1891 millitherms/hour, i.e. a thermal output of 17.1 millihk. /hour/sq. cm. of the outlet section. The pressure difference on both sides of the outlet wall was of the order of 0.1 to 0.2 mm. of water. Obviously, the above numerical designations are not to be considered as limiting, and any embodiment of the advantageous features of the burner according to the invention.

Referring now to FIG. 8, the embodiment of the burner shown herein comprises essentially a square, circular, hexagonal etc. cross-sectioned tube 20, closed at the base thereof by means of a flat screen 21, the assembly being mounted over a mixing chamber 22 filled with a combustive substance and fuel, for instance by means of a venturi 23, an inlet injector 24 for the fuel gas and an air-intake 25. The ratio of the height of the tube to the mean size of the perforated screen may vary within wide limits, according to the result to be obtained and the gases used. At 190 bounding lighting the burner, a blue flame occurs above screen 21 and progressively fades out, the combustion proceeding without producing any flame, at a
very high temperature, the combustion area being limited by screen 21.

It is assumed (this applying to the above described embodiment) that the portion of wall 20 which is adjacent screen 21, when heated by the flame occurring at the starting of the lighting, will first transmit infrared rays, then red rays which cause the flame to be irradiated and thereafter to disappear, the screen 21 being rendered incandescent. During the operation of the unit, this catalytic-like phenomenon which activates the combustion is further produced, rendering the latter complete and enabling the burner to evacuate only burnt gases, at high speed, the evacuation taking place without interference at any point, on account of the absence of obstacles above the screen, but, on the contrary, being accelerated by the presence of the tube.

The tube 20 may be solid or perforated. It may be made of refractory material, such as castile, melted cement, clay, porcelain, silica, etc., or of metal, and may be adapted to transmit red and infra-red rays.

The perforated screen 21 may be of the same material to that forming the tube mounted above it, or be of a different material. In many cases, it is built of a wire-gauze or a perforated sheet-iron and its size features correspond to the requirements mentioned herein above.

The screen is lighted and heated at its upper portion by the phenomenon mentioned above, its lower portion being cooled by the supply of fresh, unburnt combustion gases.

The gas burner unit according to the invention operates without requiring any secondary air, thus enabling the unit to be used under very different ambient conditions. It may work in an airless atmosphere, and may therefore be utilized for heating kitchen stoves or industrial ovens, etc., whereas gases derived from a previous combustion may be stagnant. It may function at high altitudes or in a damp or dust-charged atmosphere, or in water or other liquid.

A good operation of the burner may be obtained for various adjustments of the gas mixture, to which corresponds an oxidizing, neutral or reducing atmosphere of burnt gases.

For the emission of infra-red and/or red rays, the adjustment is preferably selected to deliver a neutral atmosphere at the outlet of the burner.

It is for such an adjustment, delivering a neutral atmosphere at the outlet of the burner, that the wall of the tube and the perforated screen are brought to the maximum temperature.

By making use of a constituent material for the tube or for that tube portion adjacent the perforated screen, and/or for the perforated screen, such as thorium, cerium, etc. of great brilliancy, the burner provides a bright light, which may be used for lighting purposes.

In any case, the operation of the burner is completely noiseless and may take place in any desired position: vertical, horizontal, reversed.

The burner unit according to the invention has high versatility. For instance, without modifying the adjustment of the air, the pressure of the fuel gas may be varied within comparatively wide limits. It is also possible, when using butane gas for heating purposes, to vary the pressure of the butane in the range from 15 g./sq. cm. to 100 g./sq. cm. without affecting safety conditions and health regulations.

The unit described with reference to FIGS. 1 to 7 may be considered as formed of an association of several burners—single or mono-burners—as shown in FIG. 8.

FIGS. 9 and 10 illustrate another embodiment of the device, resulting from an association of a plurality of identical single burners supplied with a gas mixture from a common chamber, the perforated screen of the mono-burners being part of the same general screen. On a perforated screen 30, secured tightly at the upper portion of a mixing chamber 31 fitted with an air-intake 32 and a gas inlet 33, are mounted partitions 34 in perpendicular relationship with the screen, which, in the example illustrated, form juxtaposed, hexagonal, cells 35. This apparatus is constituted by juxtaposing a plurality of mono-burners as described hereinabove, each elementary screen of which is topped by a hexagonal-sectioned tube, one wall being common to two adjacent tubes. The partitions are in contact with the perforated screen, and no discontinuities are left therebetween. It is however arranged for a communication between the tubes or chimneys of each burner to be provided, by forming the lower portion of a partition element with a notch, as shown at 36. This will facilitate the propagation of the flame when lighting the apparatus.

The external wall of the partition framework is preferably heat-insulated, in order not to reduce the output of the peripheral burners, as shown at 37.

What I claim is:

A device for the combustion of a gas comprising an enclosure having a narrow inlet end and a widened output end, fuel gas injection means at the narrow inlet end and an opening for the admission of ambient air under the entraining action of the injected gas, a single wire gauze at the outlet end having a total area of voids which ranges from 25 to 50 times that of the narrow inlet end, partition means surmounted on said wire gauze in contact relationship therewith, said partition means being constituted of thin partitions the height of which is substantially of the same order of magnitude as the width of the cells bounded thereby, each partition being provided with a notch on the edge thereof which is in contact with said wire gauze to provide communication between the cells.

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