March 16, 1965 J. S. WRIGHT 3,173,470

GAS-FUELED RADIANT HEATER

Filed Nov. 17, 1961 2 Sheets-Sheet 1

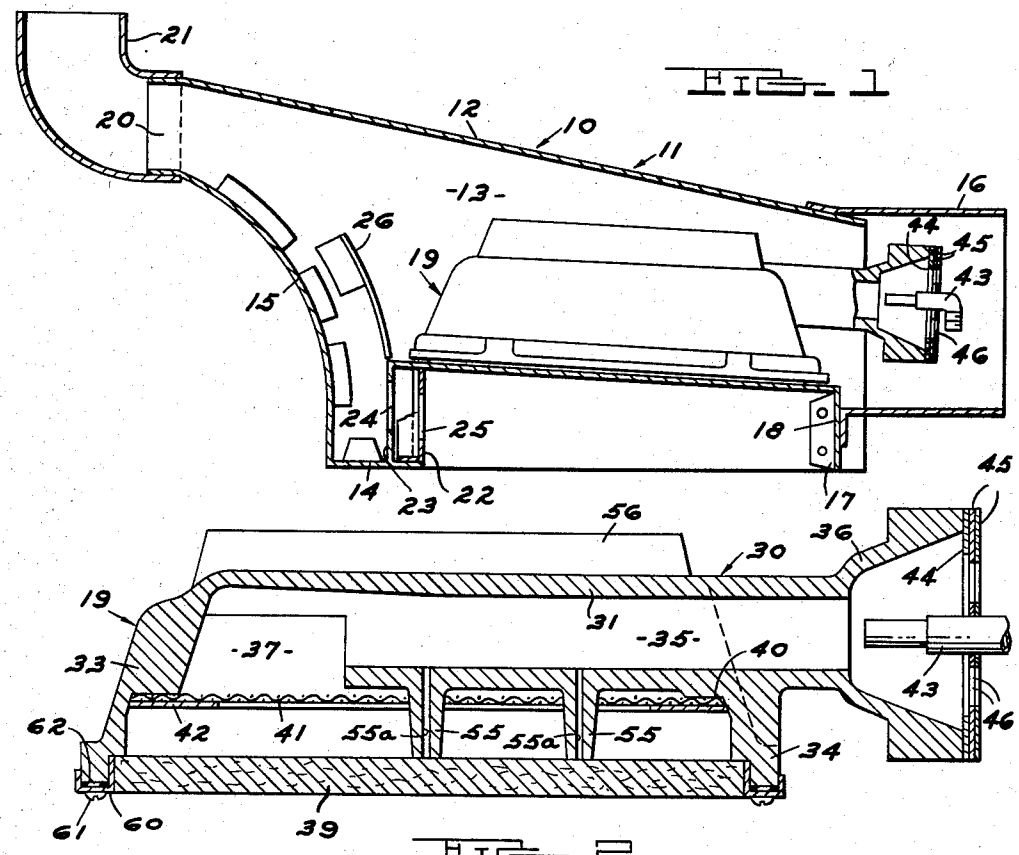



FIG. 1

FIG. 2

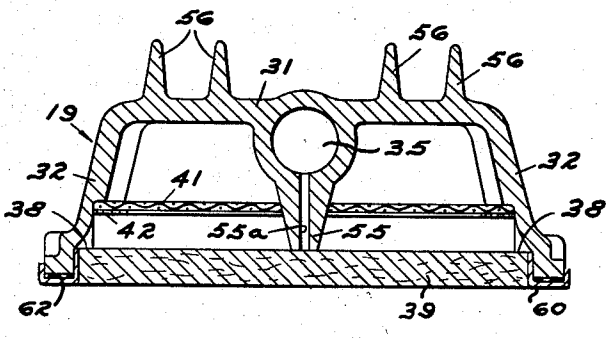



FIG. 3

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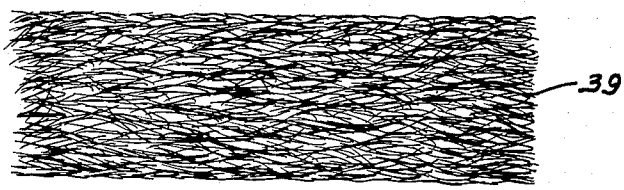



FIG. 4

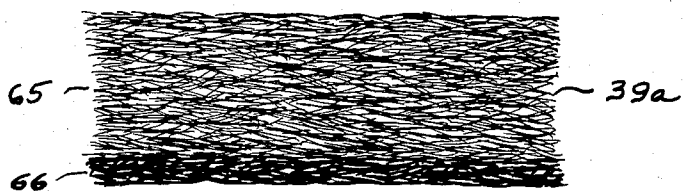



FIG. 5

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3,173,470

# GAS-FUELED RADIANT HEATER

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Filed Nov. 17, 1961, Ser. No. 153,110
5 Claims. (Cl. 158—99)

This application is a continuation-in-part of my application Serial Number 72,435, titled Infrared Gas Heating, filed November 29, 1960.

This invention relates to gas burner apparatus and particularly to gas burner apparatus of the type which is utilized to produce highly intense flames including infrared rays.

It has been known in the art that when a mixture of combustible gases and air is caused to flow through a perforated ceramic plate and is ignited on the outer surface of the plate, the burning gases, in addition to producing heat by combustion, also produce heat in the form of infrared rays. As indicated in said copending application, one of the major problems in such a combustion is the tendency for the ceramic plate and the associated casing to heat up raising the temperature of the interior of the casing and causing the burner to backfire and burn within the interior of the casing on the opposite side of the ceramic plate. This, in turn, causes a rapid deterioration of the plate. Another major problem is that the combustion gases tend to collect in the area of the ceramic plate and thereby adversely affect combustion. A further problem is that the proximity of the article being heated affects the temperature of the ceramic plate so that a combustion arrangement which is satisfactory for one type of heating is unsatisfactory for another type of heating.

According to the aforementioned patent application Serial No. 72,435, a more efficient burning of combustible gases is obtained by providing a housing around the burner casing in such a manner that a natural draft is caused by the flow of gases of combustion from the area of the surface of the burner or ceramic plate, drawing cool air across the outer surface of the casing of the burner and into the inlet of the casing for combustion.

Although the above described arrangement which is disclosed and claimed in the aforementioned application Serial No. 72,435 produces a more efficient burning than has heretofore been obtained, the degree of temperature obtained is limited by the nature of the burner element such as the ceramic plate. Another difficulty with ceramic plates is that they are fragile and easily broken.

It is an object of this invention to provide an improved gas burner apparatus wherein higher temperatures are achieved than have been heretofore possible.

It is a further object of the invention to provide a novel burner element for use in prior art gas burner apparatus.

It is a further object of the invention to provide gas burner apparatus having a much more effective and longer life than burner elements which have heretofore been used.

Basically, the invention comprises utilizing a novel burner element in the apparatus shown in the aforementioned application Serial No. 72,435. The burner element comprises a mat of sintered metal fibers, the mat having substantially uniform thickness throughout and preferably having fibers of particular size and shape distributed in such a fashion that a predetermined porosity is obtained. The novel burner element is also useful in apparatus of prior art design as fully described below.

In the drawings:

FIG. 1 is a part sectional elevation of an apparatus embodying the invention.

FIG. 2 is a sectional view of the radiant gas burner.



FIG. 3 is a further sectional view of the radiant gas burner.

FIG. 4 is a fragmentary partly diagrammatic view on an enlarged scale of the burner element embodying the invention.

FIG. 5 is a fragmentary partly diagrammatic view on an enlarged scale of a modified form of burner element.

Referring to FIG. 1, the apparatus **10** comprises a housing **11** that can be made of sheet metal and includes a top wall **12**, side walls **13**, a bottom wall **14** and an end wall **15**. Housing **11** also includes a rectangular inlet **16** that has a width substantially equal to the distance between the side walls **13**. Bottom wall **14** is provided with an opening **17** in which a rectangular support **18** is provided for a burner or rayhead **19**. As shown, the rayhead **19** is positioned within the housing **11** in spaced relation to the top and bottom walls **12**, **14**.

The upper wall **12** is inclined upwardly away from the inlet **16** and the end wall **15** is curved upwardly and outwardly to form an outlet **20**. A curved conduit **21** extends from the outlet **20** to provide a vertical stack. Support **18** includes spaced vertical walls **22**, **23** adjacent and spaced from end wall **15**. Walls **22**, **23** have vertically staggered openings **24**, **25** therein through which the gases of combustion from adjacent the rayhead **19** pass and are directed upwardly toward the stack **21**. Housing **12** includes a curved deflector **26** which is generally parallel to the end wall **15** and extends between the side walls **13** to guide the gases of combustion upwardly toward the stack **21**. The movement of the gases toward the outlet **20** and stack **21** causes relatively cool air to be drawn through inlet **16** and across the exterior surface of the rayhead **19** to cool the casing, as presently described. At the same time, the cool air passes to the interior of the rayhead **19** where it is mixed with combustible gases and caused to burn on the surface of the rayhead as presently described.

Referring to FIGS. 2 and 3, the rayhead **19** comprises a generally rectangular dish-shaped casing **30**, preferably a casting of light-weight heat dissipating material such as gray iron. Casing **30** includes a substantially flat bottom wall **31** and inclined side walls **32** and end walls **33**, **34**. The housing **30** also includes an integral passage **35** that is formed in part by the bottom wall **31**. Passage **35** communicates with an extension **36** exteriorly of the casing **30** which forms an inlet that is flared and diverges outwardly. The passage **35** terminates within the chamber **37** of the casing **30** nearer the end wall **33** than the end wall **34**. The inner edges of the side walls **32** and end walls **33**, **34** are formed with projections **38** for supporting a burner element **39** which is in the form of a flat uniformly thick porous mat of sintered fibers, as presently described. Bosses **55** extending from the wall which forms passage **35** support plates **39** intermediate their edges. Passages **55***a* in bosses **55** vent passage **35** and tend to prevent vapor lock in the passage **35**.

The casing **30** also includes a secondary shoulder **40** on side wall **32** and end walls **33**, **34**, intermediate the bottom wall and the burner elements **39** and in parallel spaced relation thereto, which supports a foraminous element **41** such as a screen. In addition, a flange or frame member **42** rests on the screen and surrounds the interior of the chamber **37**.

A nozzle **43** is supported within the inlet **36** by a suitable plate **44** having openings therein through which air can pass to the interior area **37** of the casing **30**. Damper members **45** having openings therein are mounted adjacent the member **44** and is adapted to be moved relative thereto to restrict or enlarge the openings **46** and thereby control, in part, the air passing to the interior of the casing **30**.

Top wall **31** of casing **30** is formed with integral longi-

tudinally extending fins 56 which increase the surface area thereof and facilitate the cooling of the casing 30.

The pressure of combustible gases through the nozzle 43 aspirates air from the exterior through inlet 16 of housing 11 and into the converging inlet 36 of the casing 30. The mixture of air and gases passes thereafter through passage 35 to the area 37 of the casing 30. The screen 41 serves to distribute the gases throughout the chamber 37 and cause them to flow toward the burner element 39 and threafter pass through the burner element 39 to the exterior thereof where they are burned. The flange member 42 serves to prevent the concentration of the gas and air mixture adjacent the periphery of the casing 30 and thereby further facilitates the even combustion of the gases on the surface of the burner elements 39.

The aforementioned apparatus, except for the particular burner element 39, is identical to that disclosed and claimed in the aforementioned application Serial No. 72,435.

Burner element 39 comprises a porous mat of generally uniform thickness and consisting of sintered metal fibers.

The mat is formed integrally with a frame 60 that has a J cross section (FIG. 3) and is held in position on the lower end of the casing by screws 61. A gasket 62 of insulating material is provided between the flange 60 and the casing to provide an air-tight seal and prevent gases from escaping thereby insuring that the gases will pass through the mat 39.

The fiber mat is made from metal fibers which have a high temperature resistance, high coefficient of heat transfer, and a length, size and distribution such that the mat has a porosity permitting the proper flow of mixture of air and gases therethrough and combustion thereof on the surface of the mat.

Metal fibers of stainless steel produce satisfactory results. Other metal fibers which can be used are tungsten, titanium diboride, platinum, and rhodium-platinum. Higher temperature resistance is obtained by making the layer adjacent the combustion area of a fiber having a higher temperature resistance than the fibers of the remainder of the mat. Thus, tungsten fibers can be used adjacent the combustion area while stainless steel fibers comprise the remainder of the mat. Alternatively, the fibers can be plated adjacent the combustion surface with a material that is more resistant to high temperatures such as nickel, platinum or tungsten. In addition, the fibers adjacent the combustion surface can be oxidized to obtain a greater resistance to oxidation.

It is also desirable to provide a reflective surface that minimizes the heat flow to the mat. Such a surface may be obtained by coating the fibers with the nickel and platinum.

The thickness of the mat can vary but preferably ranges from ⅜ to ¾ of an inch depending on the temperature required. If the temperature is higher, a thicker mat is required whereas if the operating temperature is lower, a thinner mat can be used.

The size of the fibers both in cross section and length are very important in determining the density and porosity of the mat. It is preferred that the fibers be of substantially uniform cross section and length such as may be obtained by cutting up extruded wire, drawing wire or turning wire from metal stock. The length of the fibers is preferably ⅜ to ¾ of an inch.

In the form of mat shown in FIG. 4, the porosity of the mat is substantially uniform throughout. In order to achieve this, the mat is made with substantially uniform thickness throughout and contains fibers of substantially uniform dimensions. A porosity of 20 to 36 percent is preferred.

I have found that if the porosity of the mat is such that upon aspirating gas and air, a pressure differential of 0.1 inch of water exists between one side and the other of the mat excellent results are achieved.

Although the manner of forming the sintered fiber mat does not form any part of this invention, one method that can be used is to distribute the previously sized fibers in a uniform layer onto a pallet on which frame 60 is supported and then move the pallet into a furnace which is at a temperature just below the melting temperature of the metal fiber and has an atmosphere of an inert gas such as hydrogen. The pallet is maintained at that temperature and in that atmosphere for a time sufficient to produce the sintered mat. For example, it has been found that a mat ⅜ inch thick can be produced from T430 stainless steel wherein the fibers have a diameter of 0.002–0.003 inch if a layer of fibers is sintered for 26 minutes at 2300 degrees Fahrenheit in an electric furnace wherein hydrogen is moved at the rate of 1100 cubic feet per hour. The finished mat is relatively rigid and bonded to the frame 60.

I have found that an apparatus such as shown in the drawings and embodying a metal fiber mat in accordance with the invention produces a flame of high temperature not heretofore obtainable by the use of the commercially available ceramic plates. The following examples are typical of the results that have been achieved from fiber mats made from T430 stainless steel having a diameter of 0.002–0.003 inch, the length of the fibers being ⅜ of an inch and using natural gas:

| Example | Density, percent | Thickness, inches | Pressure, Inches of Water | Orifice Diameter, inches | Venturi Diameter, inches | Temperature, ° F. |
|---|---|---|---|---|---|---|
| 1 | 4.48 | ⅜ | 14 | .041 | .875 | 1,450 |
| 2 | 4.725 | .350 | 14 | .041 | .875 | 1,400 |
| 3 | 4.60 | .360 | 14 | .041 | .875 | 1,430 |
| 4 | 4.48 | .250 | 14 | .041 | .875 | 1,430 |

The porosity of the fiber mat should be such that a balance is created between incoming air and gas and the open area of the mat to insure total combustion. Inasmuch as the apparatus operates upon the aspirating principle, the porosity should not be such as to restrict the flow so that insufficient air will be aspirated to create total combustion. The porosity should not be too great so that the mixture of gas and air will escape too readily and result in combustion at an area spaced from the outer face of the mat. The porosity should thus be associated with the gas pressure and air pressure.

The thickness of the mat should not be so small that insufficient cooling will result. The thickness must be such that the heat is dissipated before passing entirely through the mat resulting in possible combustion within the casing rather than on the outer surface of the mat.

In the modified form of mat shown in FIG. 5, the mat 39*a* comprises a substantially uniform overall thickness comprising a relatively thick layer 65 of one porosity and a thin layer 66 of material having a greater porosity. The layer 65 comprises fibers of substantially uniform dimensions that are shorter and have a lesser cross section than the fibers in the layer 66. The thickness of the layer 66 is a fraction of the layer 65. For example, if the overall thickness is ⅜ of an inch, the layer 66 has a thickness of 1/16 of an inch.

In use, the mat 39*a* is positioned such that the layer 66 is adjacent and forms the flame-producing surface.

The mat 39*a* is made by applying the layers of fibers and then sintering simultaneously the overall mat so that the layers are simultaneously sintered.

Mat 39*a* can be made of two types of fibers with the fibers constituting the layer 66 being made of a material that is less susceptible to oxidation and is more highly reflective than the fibers constituting the layer 65.

It can thus be seen that I have provided a combustion apparatus which results in higher temperatures, longer life and a novel burner element which can be operated at

higher temperatures and is not fragile or easily broken.

I claim:

1. In a high temperature burner apparatus, the combination comprising a casing defining an enclosed chamber, said casing having an opening in a wall thereof, a burner element closing said wall, said element being of substantially uniform thickness and comprising a gas-permeable block of randomly-oriented sintered machined metal fibers, said casing having an inlet through which a mixture of air and combustible gasses may pass to said chamber and through said burner element for combustion on the exterior surface of said burner element, a nozzle at the inlet of said casing through which gas is introduced to said inlet and caused to aspirate air from the vicinity of said nozzle into said inlet, a housing surrounding said casing and having an opening in a wall thereof into which said casing is positioned and extends, the exterior surface of said burner element being exposed to the exterior of said housing, said housing having an inlet through which air may be supplied to the casing and to the interior of the housing, said housing having an outlet, and means within said housing for directing gases from adjacent the burner element to said outlet to draw air from the exterior of said housing into said casing and across the exterior surface of said casing to cool said casing and to said outlet of said housing and to cause a portion of said air to mix with the combustion gases and pass to the interior of said casing.

2. In a high temperature burner apparatus, the combination comprising a casing defining an enclosed chamber, said casing having an opening in a wall thereof, a burner element closing said wall, said element being of substantially uniform thickness and comprising a gas-permeable block of randomly-oriented sintered machined metal fibers, said casing having an inlet through which a mixture of air and combustible gases may pass to said chamber and through said burner element for combustion on the exterior surface of said burner element, a nozzle at the inlet of said casing through which gas is introduced to said inlet and caused to aspirate air from the vicinity of said nozzle into said inlet, the porosity of said burner element being such that the difference in pressure between one side of the burner element and the other is less than 0.1 of an inch of water under operating conditions and rates of flow of said air-gas mixture, a housing surrounding said casing and having an opening in a wall thereof into which said casing is positioned and extends, the exterior surface of said burner element being exposed to the exterior of said housing, said housing having an inlet through which air may be supplied to the casing and to the interior of the housing, said housing having an outlet, and means within said housing for directing gases from adjacent the burner element to said outlet to draw air from the exterior of said housing into said casing and across the exterior surface of said casing to thereby cool said casing and pass to the outlet of said housing and to cause a portion of said air to mix with the combustion gases and pass to the interior of said casing.

3. In a high temperature burner apparatus, the combination comprising a casing defining an enclosed chamber, said casing having an opening in a wall thereof, a burner element closing said wall, said element being of substantially uniform thickness and comprising a gas-permeable block of randomly-oriented sintered machined metal fibers, said block having a porosity of 20 to 36 per cent, said casing having an inlet through which a mixture of air and combustible gases may pass to said chamber and through said burner element for combustion on the exterior surface of said burner element, a nozzle at the inlet of said casing through which gas is introduced to said inlet and caused to aspirate air from the vicinity of said nozzle into said inlet, a housing surrounding said casing and having an opening in a wall thereof into which said casing is positioned and extends, the external surface of said burner element being exposed to the exterior of said housing, said housing having an inlet through which air may be supplied to the casing and to the interior of the housing, said housing having an outlet, and means within said housing for directing gases from adjacent the burner element to said outlet to draw air from the exterior of said housing into said casing and across the exterior surface of said casing to thereby cool said casing and pass to the outlet of said housing and to cause a portion of said air to mix with the combustion gases and pass to the interior of said casing.

4. In a high temperature burner apparatus, the combination comprising a casing defining an enclosed chamber, said casing having an opening in a wall thereof, a burner element closing said wall, said element being a gas-permeable, rigid block of substantially uniform thickness formed of randomly-oriented sintered machined metal fibers, said block including a layer adjacent the external surface thereof of a material having a greater thermal resistance than the remainder of the mat, said casing having an inlet through which a mixture of air and combustible gases may pass to said chamber and through said burner element for combustion on the exterior surface of said burner element, a nozzle at the inlet of said casing through which gas is introduced to said inlet and caused to aspirate air from the vicinity of said nozzle into said inlet, a housing surrounding said casing and having an opening in a wall thereof into which said casing is positioned and extends, the external surface of said burner element being exposed to the exterior of said housing, said housing having an inlet through which air may be supplied to the casing and to the interior of the housing, said housing having an outlet, and means within said housing for directing gases from adjacent the burner element to said outlet to draw air from the exterior of said housing into said casing and across the exterior surface of said casing to thereby cool said casing and pass to the outlet of said housing and to cause a portion of said air to mix with the combustion gases and pass to the interior of said casing.

5. In combination with an air inspirating type gas burner having a wall with an outlet opening therein, a burner element mounted on said burner over the opening in the wall thereof comprising a rigid gas permeable mat of sintered machined metal fibers randomly oriented and of a size, length and distribution to provide a predetermined pressure differential between one side of the mat and the other under operation conditions and rates of flow when a mixture of air and gas introduced into the gas burner is inspirated through the mat, a metal rim positioned about the periphery of said sintered metal fiber burner mat, said fibers being sintered to said metal rim, and means for removably mounting said metal rim on said gas burner for retaining the burner mat in position thereon.

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