March 19, 1968 W. TARNAS 3,373,732

GASEOUS-FUEL JET-FIRED HEATER

Filed Oct. 10, 1966 2 Sheets-Sheet 1

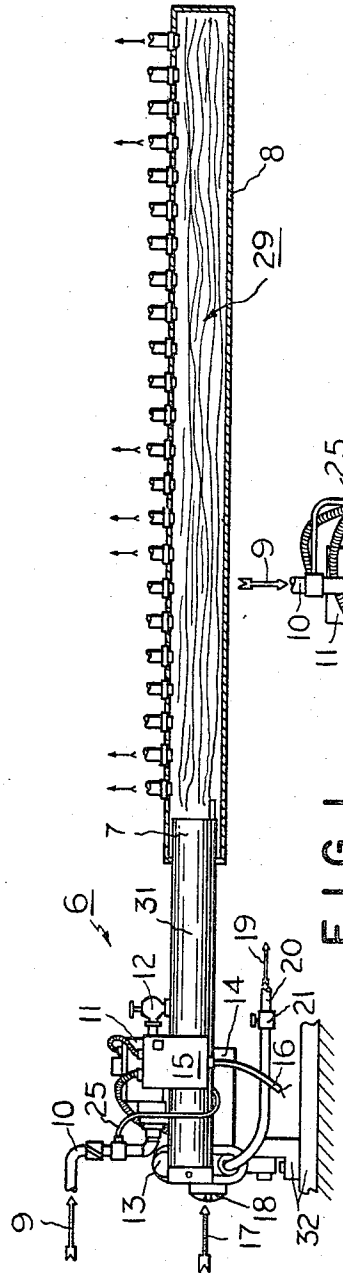

FIG. 1

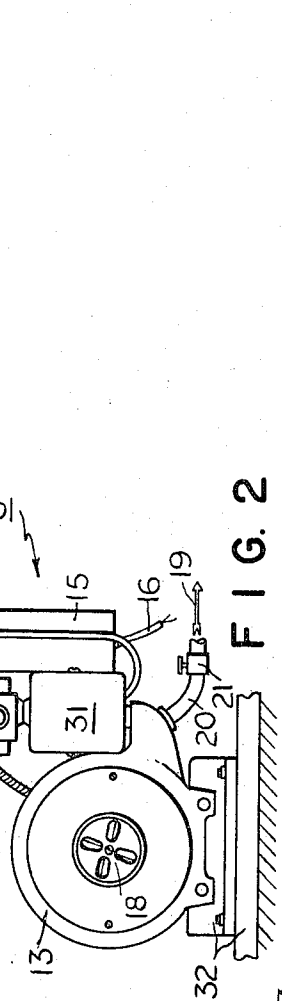

FIG. 2

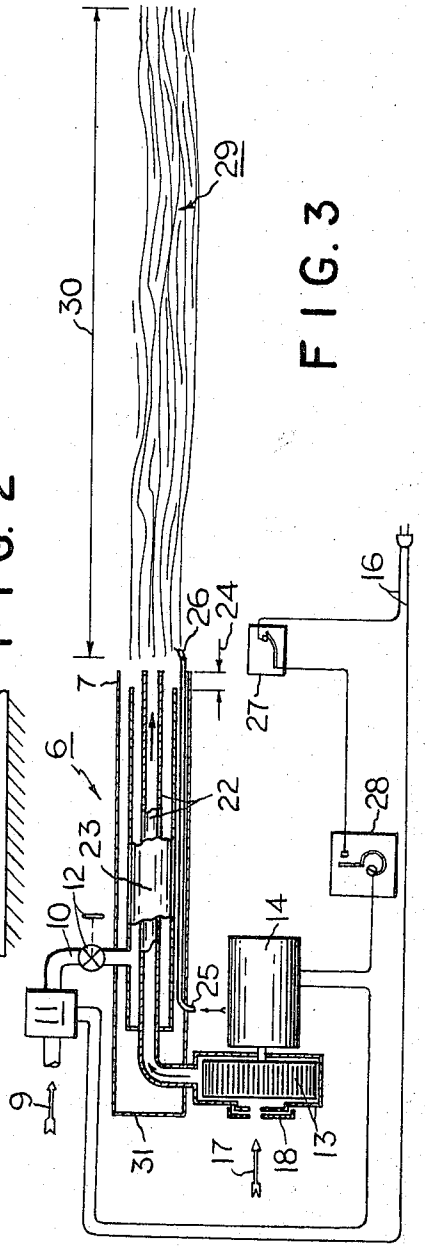

FIG. 3

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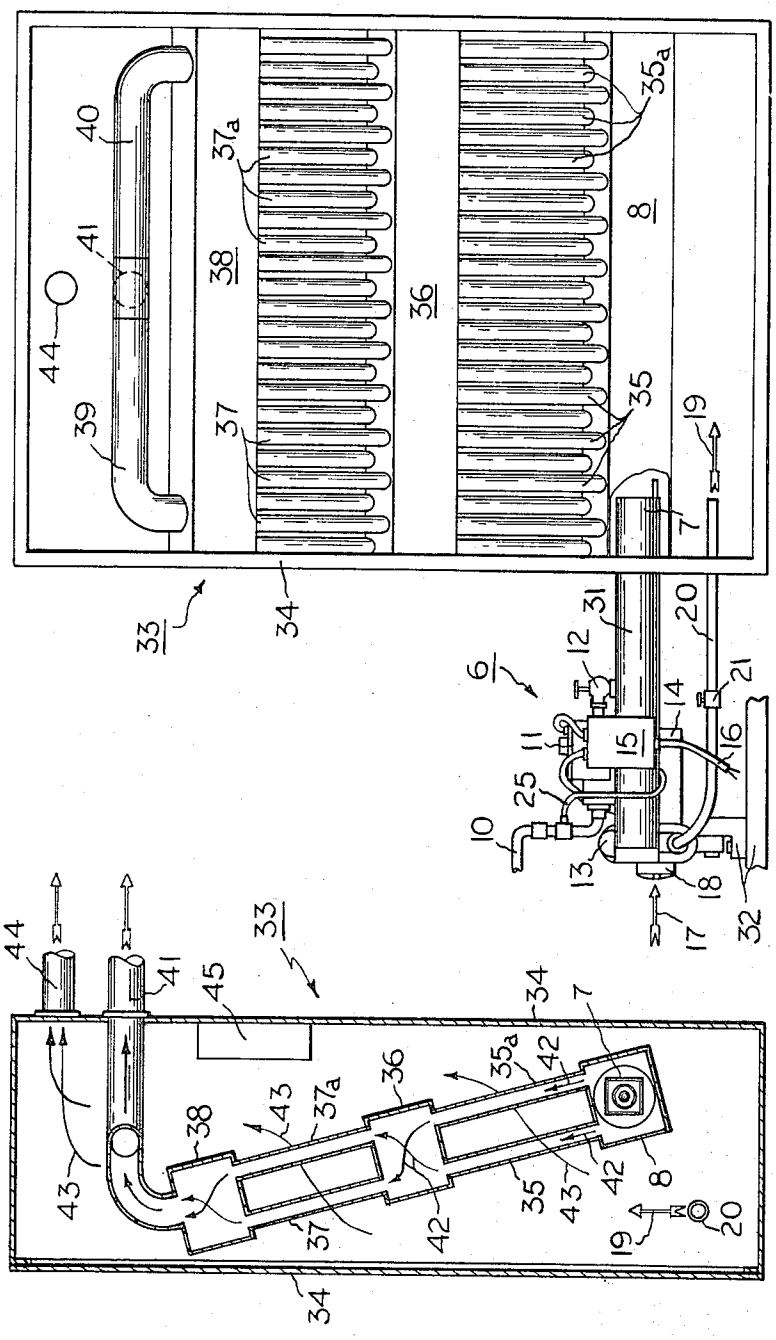

FIG. 5

FIG. 4

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GASEOUS-FUEL JET-FIRED HEATER

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ABSTRACT OF THE DISCLOSURE

In gaseous-fuel burning apparatus, a constant-speed electric motor drives an air blower to force a high-velocity stream of air from the outlet of a straight hollow air barrel while gaseous fuel is being discharged from the outlet of a surrounding concentric hollow barrel slightly upstream of the air-barrel outlet at a position where the gaseous fuel is caused to be entrained with the stream of air, and a pilot igniter near the outlet of the gas barrel but removed from the air stream serves to ignite the fuel when the fuel supply and motor are turned on independently of pre-established settings for the flows of gaseous fuel and air.

The present invention relates to improvements in gaseous-fuel heating apparatus which efficiently and economically fires furnaces for household heating and the like, and, in one particular aspect, to novel and improved gun-type heaters of compact, low-cost and reliable construction wherein ambient air forced by an electrically-motorized blower is caused to entrain and support advantageous uniform combustion of gaseous fuel in an extended path from whence it is circulated into efficient heat-exchange relationship with another medium.

The use of common gaseous fuel for range and furnace heating in homes and industry has a long history and sound reputation; however, in more recent times, other fuels, notably oil and electricity, have become increasingly popular in large measure because of simple, small and easily-regulated equipment involved in their use. Characteristically, gas-burning heaters have been at somewhat of a disadvantage because of relatively bulky cast constructions which were custom-designed for specific installations and provided with numerous relatively small gas-emitting apertures or burners distributed in patterns which impart desired shaping to the resulting composite flames. Optimum combustion requires that predetermined air/gas ratios be preserved, and equipment for automatically regulating the gas and air flows can be complicated and expensive. Although various forms of small torches have also been known, for glass and metal working or the like, where sharp and intense flame jets have been required, these have offered neither the kind of flame distribution nor the constructional features which would best serve the needs of furnace-type heaters. In accordance with the present teachings, however, highly efficient combustion of gaseous fuel for such purposes are achieved uniquely by way of a low-cost integrated gun-type burner incorporating an air blower powered by a small electric motor and having a simple on-off operating mode which renders the use of proportional controllers unnecessary; entrainment of the gaseous fuel by a relatively high-velocity air stream from a relatively simple nozzle results in a highly advantageous elongated unconcentrated flame in which substantially optimum and uniform combustion occurs reliably throughout its length and thus promotes its efficient use with broad-area heat-exchangers of uncomplicated form and various sizes.

It is one of the objects of the present invention, therefore, to provide novel and improved household heating apparatus and the like, of uncomplicated, lightweight and

low-cost construction, in which gaseous fuel is entrained by the air stream from a blower driven by an electric motor and is caused to develop an elongated highly uniform flame advantageously lending itself to efficient heat-exchange purposes.

Another object is to provide a unique gaseous-fuel jet-fired heater in which an inexpensive constant-speed electrified air blower effects a desirable uniform elongation of a heating flame and supports optimum combustion.

A further object is to provide novel and advantageous gas-burner apparatus for the efficient firing of furnace-type heaters in accordance with simple on-off cyclings of supplies of gaseous fuel and air.

Still further, it is an object to provide improved furnace apparatus in which an elongated substantially uniform flame is developed by a simply-controlled gun-type heater and is in efficient heat-exchange relationship with a circulated heat-conveying medium.

By way of a summary account of practice of this invention in one of its aspects, a gun-type gaseous-fuel burner unit is fashioned using a pair of horizontal elongated concentric barrels, the outer of which is supplied near one end with natural or manufactured household gas and the inner of which is supplied at the same end with the relatively high-velocity discharge from a centrifugal air blower driven by a constant-speed electric motor. The resulting substantially laminar horizontally-directed stream of air from the opposite end of the inner barrel entrains gas emanating from the outer barrel near that same site, carrying the gas forward and mixing with it to support substantially uniform and well-diffused combustion throughout a highly elongated horizontal path. A relatively long furnace firebox of relatively small cross-section is in a narrowly-confining enclosing relation to the flame from the burner unit and communicates with a plurality of spaced upstanding heat-exchange tubes through which the hot gases rise to an upper exhaust position, the tubes being heated in the process. Fresh air is circulated past the heat-exchange tubing and is then delivered to areas which are to be heated, either directly or through ducting. A thermostat sensor responds to need for higher temperatures in the heated areas by electrically switching on the normally-off constant-speed blower motor and by electrically valving open the normally-closed supply of gas to the burner unit, the air-gas mixture then being ignited by a pilot flame for the burner unit. The flows of gas and air to the respective burner barrels are under control of manually-set adjustment valves, such that each ignition of the burner results in a heating flame having predetermined optimum characteristics which are pre-established by settings of the adjustment valves.

Although the aspects and features of this invention which are believed to be novel are expressed in the appended claims, additional details as to preferred practices and embodiments, and as to the further advantages, objects and features thereof, may be most readily comprehended through reference to the following description taken in connection with the accompanying drawings, wherein:

FIGURE 1 is a side elevation view of an improved gaseous-fuel burner unit in association with a cross-sectioned heater firebox and with portions of heat-exchanger tubing;

FIGURE 2 illustrates the burner unit of FIGURE 1 in an end view;

FIGURE 3 provides a partly schematic and partly pictorial and cross-sectioned representation of the improved burner unit and associated electrical controls;

FIGURE 4 is a cross-sectioned side view of a household-type arrangement fired by the burner unit; and

FIGURE 5 depicts the same heater arrangement in a view from the front, with a closure panel removed.

The apparatus illustrated in FIGURES 1 and 2 includes a gun-type burner unit **6** having its flame-discharging end **7** inserted a short distance into the end opening of an elongated heater firebox **8** of relatively small cross-section. Unit **6** admits a flow of gaseous fluid, such as common natural or manufactured gas under pressure, designated by arrow **9**, via the gas inlet pipe **10**, the gas supply being either fully opened or closed through coarse controlling actions of a normally-closed electrically-actuated valve **11** (example: solenoid-actuated valve). In addition, a further valve **12**, which is manually adjustable by way of knob, set-screw or the like, finely controls the permissible rate of gas flow to the burner, and is used to maintain optimum combustion conditions whenever the higher-capacity main valve **11** is cycled to the "On" state. Ambient air is forced into the unit at a relatively high velocity by a centrifugal blower **13** rotated at a substantially fixed rate by a constant-speed electric motor **14**. Electrical switching controls **15**, connect the A-C supply line **16** to both the motor and gas valve as dictated by an associated thermostat and other auxiliary sensors which may be used in the system. Inlet of the ambient air to the blower, designated by arrow **17**, is regulated by a common type of rotatable air-shutter **18** and is also set to the adjustment which maintains optimum combustion conditions whenever the burner unit is firing. For purposes of supplying additional amounts of air (arrow **19**) which are to be heated and circulated through a heat-exchanger for delivery in turn to the living areas which are to be heated, the blower **13** is further provided with an air outlet duct **20**; settable valve **21** in that duct controls this additional air output and avoids disturbing the needed constant predetermined supply of high-velocity air to the burner flame.

As is shown in FIGURES 3, air from constant-speed blower **13** is delivered to one end of a central elongated burner barrel **22** and is there converted into a substantially straight horizontal air stream which makes a predetermined relatively high-velocity exit from the downstream end of that barrel. In concentric surrounding relation to inner barrel **22** there is an outer barrel **23** to which the valved gas supply is delivered as shown; the downstream end of the inner barrel projects forwardly of the outer barrel by a short distance, **24**, such that the central air stream does not tend to snuff out the gas flame and such that possibilities of flame blow-back into the outer barrel are also suppressed. A relatively small bleed tube **25**, connected directly to the gas-supply pipe **10** upstream of the aforesaid valving, provides a continuous feed of the gas for a pilot igniting flame **26** disposed ahead of the outer barrel but out of line with the air stream from inner barrel **22**. Alternatively, an electrically-operated igniter may be employed, similarly oriented and arranged to cause the combustible gas to ignite whenever the burner unit is switched on. In the illustrated circuitry, a protective temperature-sensor **27** detects whether or not the pilot flame persists, and interrupts the electrical supply whenever either that flame or the main flame is not present. A common type of thermostat, **28**, determines when the burner unit should be turned on by closure of the electrical supply circuit. Operation of the burner by such controls is thus on a direct On-Off cycling basis, not requiring proportional regulations or like disturbances of the gas and air supplies once their valving has been initially set to values yielding a substantially optimum flame **29**. Gas and air emissions from the open ends of horizontally-disposed concentric barrels **22** and **23** evidently combine in about a substantially optimum uniform ratio, for combustion purposes, throughout a highly elongated distance horizontal **30**, the visible flame cross-section being substantially uniform and exhibiting no core or cone. The relatively high-velocity air stream appears to entrain the relatively low-velocity gas and, surprisingly, to support combustion quite evenly over the length **30**. In one construction, the flame

extended about five feet straight from barrels only about one and a half feet long. Outer barrel **23** need not be fully coextensive with the inner, and may be relatively short or fed with gas at an intermediate position, the latter being shown; the release of gas at the flame end is in substantially concentric relation to the central high-velocity air stream, and the simple open-ended tubes or barrels are preferred constructional embodiments which can be manufactured and kept functioning easily and economically. The entire barrel structure advantageously remains relatively cool, with the heat being largely confined to the flame **29**; however, the site at which gas is fed to the outer barrel is nevertheless disposed sufficiently rearward of the flame to remain well isolated from the heat which is present. In addition, a thin sheet-metal housing **31**, closed at one end, surrounds the barrel structure in spaced relationship and serves, among other things, to isolate them and to prevent heat from the flame from being lost in the rearward direction.

The burner components, including the housed concentric barrel array and the associated constant-speed blower assembly, are mounted as an integrated unit on a base **32** which advantageously permits the unit to have its flame-discharging end aimed directly into an open end of the elongated firebox **8** of a cooperating heat-exchanger and circulation device **33** (FIGURES 4 and 5). This firebox, which is of heat- and flame-resistant metal, has a length about equal to that of the elongated flame produced by the burner unit, and a cross-section which is about the same as or only slightly larger than that of the flame, such that the flame substantially fills (FIGURE 1) the firebox during the "On" cycles of operation. Substantially all of the air supplied to the firebox is that which is forced into it by the constant-speed blower **13** and which is mixed with the gas and supports its combustion. Therefore, the firebox is filled with exceedingly hot combustion products, and a certain amount of forward-acting pressure is produced as the result of the blower action. These gaseous combustion products travel upwardly from the low position of the horizontal firebox in the sheet-metal enclosure **34**, passing through two inclined closely-spaced offset rows of (FIGURE 5) tubes, **35** and 35_a, to a horizontal elongated mixing chamber **36**. In turn, another similar two rows of inclined tubes, **37** and 37_a, carry the combustion products upwardly to a horizontal chamber **38**, from the ends of which two joined pipes **39** and **40** convey the then-cooled gases to an exhaust pipe or stack **41**. Arrows **42** (FIGURE 4) characterize upward gaseous flow, mixture and exhaust. Mixing chamber **36** promotes evenness of heating within enclosure **33**, in that its presence aids in avoiding possible concentrations of hotter gases at localized sites, and, for this purpose, its volume is significantly greater than that of the lower heat-exchange tubes so that the hot gases from them will mingle well before entering the upper set of tubes **37** and 37_a. Chamber **38** functions as an exhaust manifold, and as a further heat-exchange unit. In FIGURE 4, the cross-section is modified from the true construction shown in FIGURE 3, such that the staggered rows of tubes and one of the exhaust pipes appear to be in the same plane, as an aid in illustrating the hot-gas flow paths. The two tiers or stacks of tubes, and also the firebox, mixing chamber, and exhaust chamber, are fabricated of metal having good thermal conductivity, as well as good resistance to corrosive attack by the hot gases. All of the elements carrying these hot gases are narrowly contained within the thin lightweight sheet-metal enclosure, in a vertical stacking with the tubes slightly inclined so that as much as possible of air ascending within the enclosure will come into intimate heat-exchange relationship with them. Preferably, and as shown, all of the tubes are parallel and perpendicular to the firebox, mixing chamber and exhaust chamber, although in an alternative construction the two tiers of tubes may be inclined in opposite directions, for example. Enclosure **34** is sufficiently

air-tight at its lower portions (front cover removed to expose interior details in FIGURE 5) to cause admitted air to rise through and become well heated by the heat-exchange elements. In the illustrated preferred embodiment, the air which is to be heated (arrow **19**) is forced into the enclosure below the firebox, via piping **20**, by the same centrifugal blower **13** which delivers the high-velocity air to the burner unit. Valve **21** regulates this air supply, and is set to insure that adequate quantities of air are heated and forced upwardly (arrows **43**) to the ducting **44** which feeds hot-air registers or the like. A container **45** for a humidifying water supply is conveniently mounted within the same enclosure. The ambient atmosphere may of course be heated directly by leaving the enclosure walls uninsulated, or by providing suitable vents for direct egress of heated air without also so reducing pressure as to prevent effective pumping of the air through such ducting **44** as is used. Through appropriate simple On-Off controls, the pumping of air for heating may be continued for a predetermined period after burner firing has ceased but while the heat-exchange elements remain at a high temperature, and, similarly, the pumping of air may be suspended for a period, after initial firing of the cold elements, until they are raised to a suitable high temperature.

Those skilled in the art will appreciate that various changes may be introduced within the purview of these teachings. By way of example, the fluid medium which is heated and circulated may be in liquid form, and the burner unit may for some purposes include a plurality of the concentric flame-discharging structures, either clustered or arrayed on a single head. Accordingly, the specific embodiments and practices herein described have been presented by way of disclosure rather than limitation, and it should be understood that various modifications, substitutions and combinations may be effected without departure in spirit or scope from this invention in its broader aspects and as set forth in the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. Gaseous-fuel apparatus for household heating and the like, comprising an elongated and substantially straight hollow air barrel, a substantially constant-speed air blower including a rotatable impeller within a housing having an air inlet and an outlet coupled with an inlet of said air barrel and further including a substantially constant-speed electric motor connected in driving relationship to said impeller, settable means including air valving means for adjusting the effective size of said air inlet and supplying said air inlet of said air barrel with a predetermined controlled amount of air from said blower which produces a relatively high-velocity and substantially straight stream of air from the outlet of said barrel, means for discharging gaseous fuel in substantially concentric and substantially surrounding relationship to said outlet of said air barrel at a position slightly upstream of said outlet whence the gaseous fuel is caused to be entrained with the air stream from said air barrel, said discharging means comprising a second hollow barrel in substantially concentric surrounding relationship with said air barrel and having its downstream end at said position, settable means supplying said discharging means with a predetermined controlled amount of gaseous fuel under pressure, said means supplying said gaseous fuel including first gas valving means for setting the amount of flow of said gaseous fuel to said second hollow barrel and second two-state electrically actuated gas valving means for fully opening and fully closing the supply of said gaseous fuel to said discharging means, means for igniting said gaseous fuel, said igniting means comprising means continuously bleeding relatively small amounts of gaseous fuel from said gaseous fuel supplying means in upstream relation to said two-state valving means therefor and delivering the bled gaseous fuel to a pilot flame outlet disposed in proximity with said downstream end of said second barrel and out of alignment with the air stream from said air barrel, and means for switching said gaseous fuel supplying means and said air supplying means on and off independently of the settings thereof, said switching means including means for selectably electrically connecting and disconnecting said electric motor and an electrical supply line therefor and further including means for selectably electrically connecting and disconnecting said second valving means and an electrical supply line therefor, whereby a predetermined elongated and substantially uniform flame is produced downstream of said outlet each time said gaseous fuel and air supplying means together release said predetermined controlled amounts of gaseous fuel and air, respectively.

2. Gaseous-fuel apparatus for household heating and the like, comprising an elongated and substantially straight hollow air barrel, a substantially constant-speed air blower including a rotatable impeller within a housing having an air inlet and an outlet coupled with an inlet of said air barrel and further including a substantially constant-speed electric motor connected in driving relationship to said impeller, settable means supplying said inlet of said air barrel with a predetermined controlled amount of air from said blower which produces a relatively high-velocity and substantially straight stream of air from the outlet of said barrel, means for discharging gaseous fuel in substantially concentric and substantially surrounding relationship to said outlet of said air barrel at a position slightly upstream of said outlet whence the gaseous fuel is caused to be entrained with the air stream from said air barrel, settable means supplying said discharging means with a predetermined controlled amount of gaseous fuel under pressure, means for igniting said gaseous fuel, means for switching said gaseous fuel supplying means and said air supplying means on and off independently of the settings thereof, whereby a predetermined elongated and substantially uniform flame is produced downstream of said outlet each time said gaseous fuel and air supplying means together release said predetermined controlled amounts of gaseous fuel and air, respectively, an elongated and substantially straight, hollow and enclosed firebox having length and interior cross-section proportions comparable to those of the flame, means connecting one end of said firebox in mated aligned relationship with the downstream ends of said air barrel and gaseous fuel discharging means, a plurality of heat-exchange tubes connected with said firebox, means circulating a fluid heat-exchange medium in heat-exchange relationship with the exteriors of said firebox and tubes, a substantially air-tight enclosure for said firebox and heat-exchange tubes, means mounting said air barrel and blower and discharging means externally of said enclosure in position to direct said air stream and flame substantially horizontally into said firebox, and an elongated sheet-metal housing in spaced surrounding relationship to said air barrel and discharging means, said housing being open at a downstream end mated with said firebox and otherwise being substantially closed.

3. Gaseous-fuel apparatus for household heating and the like, comprising an elongated and substantially straight hollow air barrel, a substantially constant-speed air blower including a rotatable impeller within a housing having an air inlet and an outlet coupled with an inlet of said air barrel and further including a substantially constant-speed electric motor connected in driving relationship to said impeller, settable means supplying said inlet of said air barrel with a predetermined controlled amount of air from said blower which produces a relatively high-velocity and substantially straight stream of air from the outlet of said barrel, means for discharging gaseous fuel in substantially concentric and substantially surrounding relationship to said outlet of said air barrel at a position slightly upstream of said

outlet whence the gaseous fuel is caused to be entrained with the air stream from said air barrel, settable means supplying said discharging means with a predetermined controlled amount of gaseous fuel under pressure, means for igniting said gaseous fuel, means for switching said gaseous fuel supplying means and said air supplying means on and off independently of the settings thereof, whereby a predetermined elongated and substantially uniform flame is produced downstream of said outlet each time said gaseous fuel and air supplying means together release said predetermined controlled amounts of gaseous fuel and air, respectively, an elongated and substantially straight, hollow and enclosed firebox having length and interior cross-section proportions comparable to those of the flame, means connecting one end of said firebox in mated aligned relationship with the downstream ends of said air barrel and gaseous fuel discharging means, a plurality of heat-exchange tubes connected with said firebox, means circulating a fluid heat-exchange medium in heat-exchange relationship with the exteriors of said firebox and tubes, a substantially air-tight enclosure for said firebox and heat-exchange tubes, means mounting said air barrel and blower and discharging means externally of said enclosure in position to direct

said air stream and flame substantially horizontally into said firebox, said heat-exchange tubes comprising a first set of a plurality of tubes each connected with said firebox and extending upwardly therefrom in inclined relationship to the vertical to an intermediate-level substantially horizontal elongated mixing chamber and further comprising a second set of a plurality of tubes each connected with said mixing chamber extending upwardly therefrom in inclined relationship to the vertical to a substantially horizontal elongated exhaust manifold chamber, and means sealed with said exhaust chamber conducting gases therefrom to exhaust ducting external to said enclosure.

References Cited

UNITED STATES PATENTS

1,986,675	1/1935	Hobson	126—116
2,632,502	3/1953	Heller et al.	158—109
2,746,404	5/1956	Rottersmann	126—91 X
2,932,347	4/1960	Jaeger	158—109 X
3,044,537	7/1962	Keating et al.	58—109

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