

[54] **COMBUSTOR MEANS FOR PRESSURIZED GAS-FIRED SPACE HEATER**

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[51] Int. Cl. **F24h 3/08**

[58] Field of Search **126/90, 91, 91 A, 110, 110 B, 126/116, 116 B; 431/181, 182, 190, 350, 351, 352, 353**

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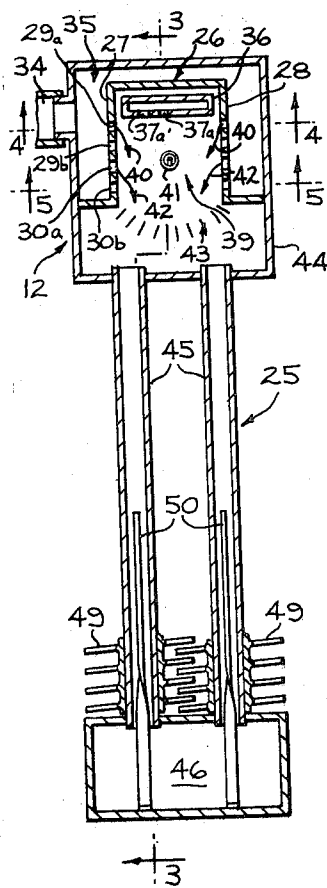
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[57]

ABSTRACT

This invention provides improved combustor means for mixing and burning fuel gas and pressurized air to produce a highly intense heat source for a gas-fired space heater. The combustor means comprises a generally horizontal elongate trough having generally vertical left and right long sidewalls that are pierced by a plurality of combustion air inlet apertures and a fuel gas supply conduit which extends longitudinally through the trough. The gas conduit has a surface that is pierced by a plurality of fuel gas inlet apertures which are arranged such that the gas enters the trough generally parallel to its two apertured sidewalls, and is turbulently mixed with pressurized combustion air in a fuel gas-air mixing area that is defined by the two apertured trough sidewalls and the apertured gas conduit surface. The present invention provides the apertured surface of the gas conduit with at least two offset rows of apertures including a left row of gas inlet apertures aligned with the air inlet apertures in the trough left sidewall and a right row of gas inlet apertures aligned with the air inlet apertures in the trough right sidewall. This offset aperture pattern creates a swirling action within the combustor fuel gas-air mixing area which promotes more turbulent, and hence better, mixing of the pressurized combustion air and the fuel gas and thus promotes more complete combustion thereof and more intense heat production therefrom.

10 Claims, 5 Drawing Figures



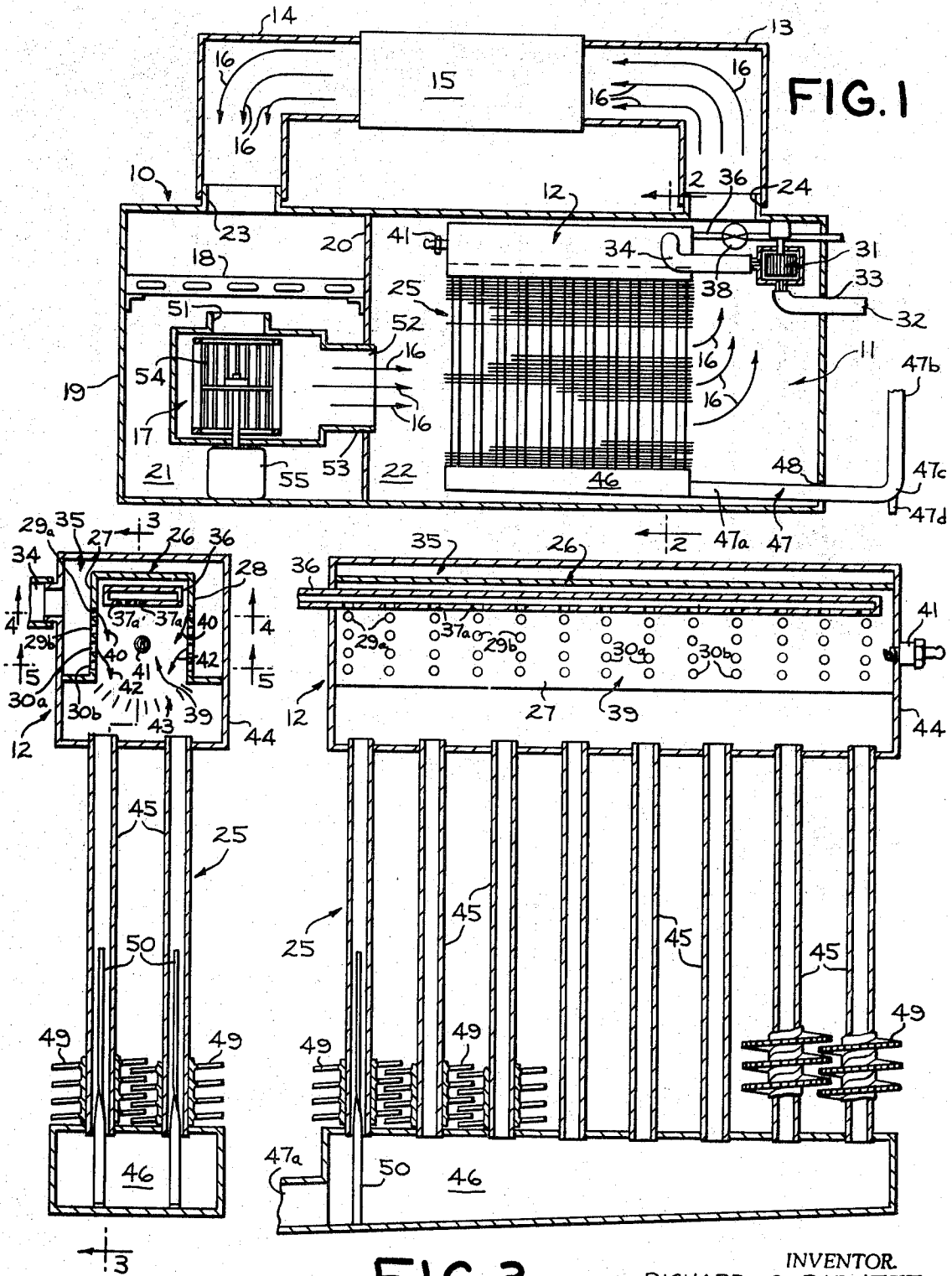


FIG. 2

FIG. 3

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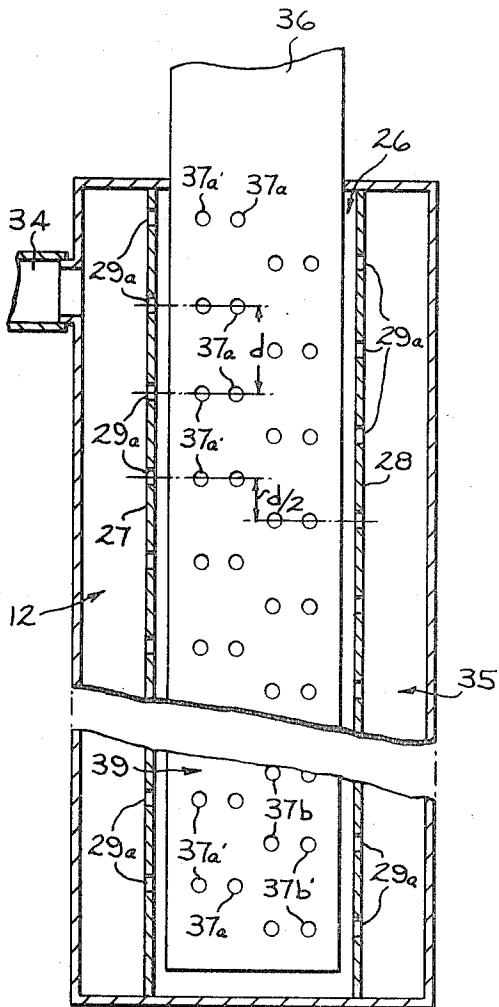


FIG. 4

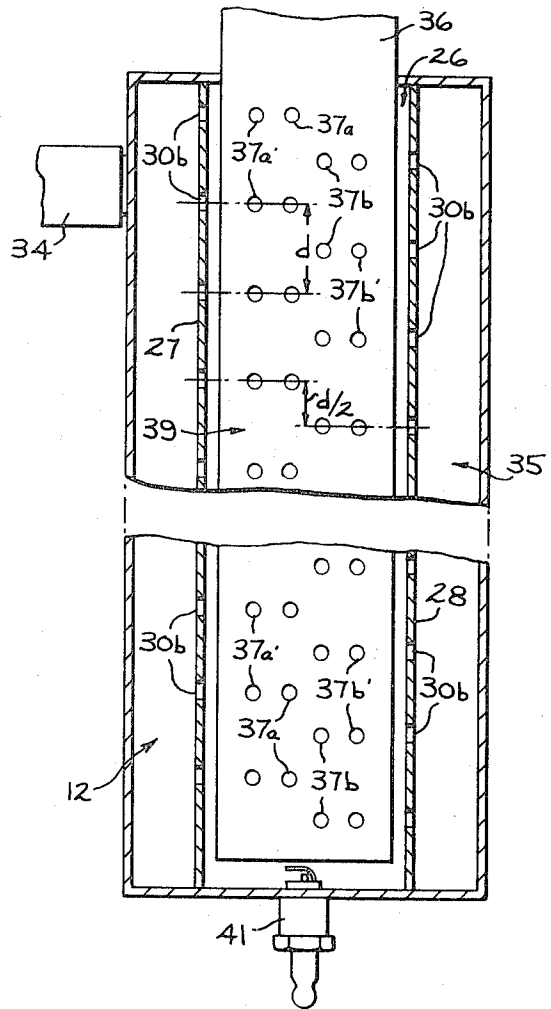


FIG. 5

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COMBUSTOR MEANS FOR PRESSURIZED GAS-FIRED SPACE HEATER

CROSS-REFERENCE TO RELATED APPLICATIONS

The present invention is directed toward improved combustor means that are particularly adapted for use in pressurized gas-fired space heater means, such as those described in detail in a copending, commonly assigned U.S. Pat. applications Ser. No. 47,433, filed June 18, 1970, by Roy W. Abbott and Ser. No. 66,800, filed Aug. 25, 1970, by James D. Boucher.

BACKGROUND OF THE INVENTION

This invention relates to means for supplying heat to a space, such as a room, house, building or the like and more, particularly, to improved pressurized combustor means for gas-fired space heater means for supplying such heat.

Heretofore, conventional gas-fired space heater or furnace means have most frequently employed rather crude cast iron or steel heat exchanger means having the general shape of a hollow box or clam shell to transfer heat generated by the combustion of a combustible gas-air mixture to an airstream circulated between the heat exchanger means and the space to be heated. And, these conventional heat exchanger means have usually been combined with similarly unsophisticated combustor or burner means which have been very much like those used in gas cooking ranges and wherein the combustion air that is mixed with the fuel gas is supplied to the combustor means at atmospheric conditions. In these conventional space heater means, the atmospheric combustor means is located beneath the heat exchanger and the combustion products rise upwardly by natural convection through the heat exchanger and are discharged to the atmosphere via an exhaust vent or flue that is connected to the top of the heat exchanger.

The aforementioned copending, commonly assigned patent applications describe gas-fired space heater means which are superior to the aforescribed conventional heater means in that they permit considerable weight and volume reduction in heat exchanger means material by employing a combination of highly efficient heat exchanger means for transferring heat to an airstream circulated between the heat exchanger means and the space to be heated, and pressurized high intensity combustor means for mixing fuel gas with pressurized combustion air to produce and burn the combustible gas-air mixture.

The pressurized combustor means described in these aforementioned copending, commonly assigned patent applications include a generally horizontal elongate trough having generally vertical left and right long sidewalls that are pierced by a plurality of combustion air inlet apertures and a fuel gas supply conduit which extends generally horizontal and longitudinally through the trough. The fuel gas supply conduit has a generally horizontal long surface that is pierced by a plurality of fuel gas inlet apertures which are arranged such that the fuel gas enters the trough generally parallel to its two apertured sidewalls and is turbulently mixed with the pressurized combustion air in a fuel gas-air mixing area that is defined by the two generally vertical apertured trough sidewalls and the generally horizontal apertured fuel gas supply conduit surface. While the pressurized combustor means that are described in the aforementioned Abbott and Boucher patent applications are superior to the aforescribed conventional atmospheric combustor means, it has been found in accordance with the present invention that they can be still further improved by employing an unique pattern in locating the fuel gas and combustion air inlet apertures relative to one another in the combustor fuel gas-air mixing area.

SUMMARY OF THE INVENTION

This invention provides improved combustor means for mixing and burning fuel gas and pressurized air to produce a more highly intense heat source for a gas-fired space heater. The combustor means comprises a generally horizontally ar-

ranged elongate trough having a pair of opposed, spaced apart, generally vertically arranged left and right long sidewalls that are pierced by a plurality of combustion air inlet apertures and a fuel gas supply conduit which extends generally longitudinally through the trough. The fuel gas supply conduit has a long surface that is pierced by a plurality of fuel gas inlet apertures which are arranged such that the fuel gas enters the trough generally parallel to its two generally vertically arranged apertured sidewalls and is turbulently mixed with the pressurized combustion air in a fuel gas-air mixing area that is defined by the two generally vertical apertured trough sidewalls and the apertured fuel gas supply conduit surface. In particular accordance with the present invention and apertured long surface of the fuel gas supply conduit is provided with at least two rows of fuel gas inlet apertures which are longitudinally offset from one another. The offset rows of apertures in the fuel gas supply conduit include a left row of fuel gas inlet apertures that are aligned with the combustion air inlet apertures in the trough left sidewall and a right row of fuel gas inlet apertures that are aligned with the combustion air inlet apertures in the trough right sidewall. This unique offset aperture pattern provided by the present invention creates a swirling action within the combustor trough fuel gas-air mixing area which promotes more turbulent, and hence better, mixing of a pressurized combustion air and the fuel gas and thus promotes more complete combustion thereof and more intense heat production therefrom than had been achieved previously.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is illustrated in the accompanying drawings, wherein:

FIG. 1 is a somewhat schematic, partly sectioned, front elevational view of a space air-conditioning unit utilizing gas-fired space heater means incorporating a presently preferred form of the improved high-intensity pressurized combustor means of the present invention;

FIG. 2 is an enlarged fragmentary sectional view taken along line 2—2 of FIG. 1;

FIG. 3 is a fragmentary sectional view taken along line 3—3 of FIG. 1; and

FIG. 4 is an enlarged fragmentary sectional view taken along line 4—4 of FIG. 3; and

FIG. 5 is an enlarged fragmentary sectional view taken along line 5—5 of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings and, more particularly, to FIG. 1 thereof, there is illustrated somewhat schematically an air-conditioning unit 10 utilizing gas-fired space heater means 11 incorporating a presently preferred form of the improved pressurized combustor means 12 provided in accordance with the present invention. The air-conditioning unit 10 is fluid-connected by right and left hollow conduit means 13 and 14 to a space 15 (shown in block), such as a room, house, building or the like, so as to condition air contained within the space 15, as by supplying heat to or removing heat from an airstream, indicated by arrows 16, that is circulated between the space 15 and the air-conditioning unit 10 through the conduit means 13 and 14 by space-air blower means 17. As shown, the air-conditioning unit 10 employs the gas-fired space heater means 11 to supply heat to the airstream 16 in combination with cooling means, including an evaporator section 18, to remove heat from the airstream 16.

As illustrated in FIG. 1, the air-conditioning unit 10 includes a generally rectangular hollow boxlike cabinet 19 that is subdivided by a vertically arranged partition 20 into a left compartment 21 and a right compartment 22. The cabinet left compartment 21 has an air inlet opening 23 in its upper wall that is fluid-connected to the space 15 by the left conduit means 14, while the upper wall of the cabinet right compartment 22 has an air outlet opening 24 that is fluid-connected to

the space 15 by the right conduit means 13. The cabinet left compartment 21 houses the cooling means evaporator section 18 and the space air blower means 17, while the cabinet right compartment 22 houses the highly efficient heat exchanger means 25 and the improved pressurized high-intensity combustor means 12 of the present invention that are combined to provide the gas-fired space heater means 11.

The gas-fired space heater means 11 is generally similar to that described in detail in the aforementioned Boucher patent application, except that it substitutes the improved pressurized combustor means 12 of the present invention, which will be described in detail hereinafter, for those described in the aforementioned Boucher patent application.

As shown in FIGS. 1-5, the presently preferred form of the improved combustor means 12 of the present invention includes an inverted, generally horizontally arranged elongate trough 26 having a pair of spaced-apart, opposed, generally vertical, downwardly extending, left and right long sidewalls 27 and 28 that are pierced by a plurality of apertures arranged in four vertically spaced, longitudinally aligned rows along their middle and lower portions to respectively define two rows of primary combustion air inlet apertures 29a and 29b and two rows of secondary combustion air inlet apertures 30a and 30b in each of the walls 27 and 28. Combustion air is introduced into the inverted trough 26 through the primary and secondary combustion air inlet apertures 29a and 29b and 30a and 30b under pressure that is provided by means such as the combustion air supply blower 31. The combustion air supply blower 31 is housed in the upper right hand corner of the cabinet right compartment 22 and has its inlet connected to a combustion air intake conduit 32 which extends outwardly from the cabinet 18 through an opening 33 provided in the right sidewall thereof. The combustion air supply blower 31 has its outlet connected via a combustion air supply blower discharge conduit 34 to a boxlike combustion air supply plenum 35 that is located around the top of the inverted trough 26. A fuel gas supply has conduit 36 extends longitudinally through the inverted trough 26 between its left and right long sidewalls 27 and 28 and has a long, generally horizontal, bottom surface that is pierced by a plurality of fuel gas inlet apertures located above the primary combustion air inlet apertures 29a and 29b provided in the trough long sidewalls 27 and 28.

In particular accordance with the present invention, and as best illustrated in FIGS. 2-5, the fuel gas inlet apertures comprise two longitudinally offset pairs of longitudinally aligned rows of apertures, including two paired left rows of fuel gas inlet apertures 37a and 37a' which are both located on one side of the long central axis of the apertured long bottom surface of the fuel gas supply conduit 36, and two paired right rows of fuel gas inlet apertures 37b and 37b' that are located on the opposite side of the long central axis of the apertured long bottom surface of the fuel gas supply conduit 36. The two paired left rows of fuel gas inlet apertures 37a and 37a' are transversely spaced apart from one another but are longitudinally aligned with one another and are both longitudinally aligned with the combustion air inlet apertures 29a, 29b, 30a and 30b that are arranged in four longitudinally aligned, vertically spaced-apart rows in the left long sidewall 27 of the trough 26. The paired two right rows of fuel gas inlet apertures 37b and 37b' are transversely spaced apart from one another but are longitudinally aligned with one another and are both longitudinally aligned with the combustion air inlet apertures 29a, 29b, 30a and 30b that are arranged in four longitudinally aligned, vertically spaced-apart rows in the right long sidewall 28 of the trough 26. And, as best shown in FIGS. 4 and 5, the apertures forming the paired left two rows of fuel gas inlet apertures 37a and 37a' have their radial centers spaced apart from the radial centers of the apertures forming the paired right two rows of fuel gas inlet apertures 37b and 37b' by an offset spacing distance $d/2$ that is substantially equal to one-half of the longitudinal in-line spacing distance d that is provided between the radial centers of adjacent ones of the aper-

tures forming each of the paired left two rows of fuel gas inlet apertures 37a and 37a'. Hence, the radial centers of the apertures forming the four rows of combustion air inlet apertures 29a, 29b, 30a and 30b in the left sidewall 27 of the inverted trough 26 are also offset from the radial centers of the apertures forming the four rows of combustion air inlet apertures 29a, 29b, 30a and 30b in the opposed, right long sidewall 28 of the trough 26 by the offset spacing distance $d/2$.

As shown in FIG. 1, the inlet of the fuel gas supply conduit 36 is connected via an electric control valve 38 of a well-known type to a source (not shown) of pressurized fuel gas such as natural gas, propane or the like. And, as can be best seen in FIGS. 2-5, fuel gas can enter a fuel gas-air mixing area 39, which is defined by the downwardly extending left and right apertured long sidewalls 27 and 28 of the trough 26 and the generally horizontal, apertured, bottom long surface of the fuel gas supply conduit 36, through the fuel gas inlet apertures 37a, 37a', 37b, and 37b', generally parallel to the apertured long sidewalls 27 and 28 of the trough 26. The fuel gas can be first turbulently mixed as indicated by the arrows 40 (FIG. 3), with the pressurized combustion air that is admitted via the generally horizontally disposed primary combustion air inlet apertures 29a and 29b. The rich combustible mixture which results from the turbulent mixing of pressurized fuel gas admitted to the trough mixing area 39 via the four rows of fuel gas inlet apertures 37a, 37a', 37b and 37b' with the pressurized air that enters through the rows primary combustion air inlet apertures 29a and 29b, moves downwardly through the inverted trough 26 and is ignited by means of an electric spark plug 41 or similar igniter device that is generally horizontally arranged in the left end of the inverted trough 26 at a point vertically spaced between the rows of primary combustion air inlet apertures 29a and 29b and the rows of secondary combustion air inlet apertures 30a and 30b. This ignited mixture of fuel gas and pressurized primary combustion air can then be further turbulently mixed as indicated by the arrows 42 with the pressurized air which enters the inverted trough 26 through the rows of generally horizontal secondary combustion air inlet apertures 30a and 30b provided along the lower portions of the trough long sidewalls 27 and 28 to produce a generally downwardly extending heat source or flame 43 (FIG. 3) of even greater intensity than that produced by the combustor means described in the aforementioned copending, commonly assigned patent applications.

The increased intensity of the heat source or flame 43 that is produced by the improved combustor means 12 of the present invention results from the aforedescribed unique offset pattern that is employed in locating the combustion air inlet apertures 29a, 29b, 30a and 30b and the fuel gas inlet apertures 37a, 37a', 37b and 37b' with respect to one another. As can be best seen in FIGS. 4 and 5, this offset aperture pattern that is provided in accordance with the present invention eliminates or greatly reduces the possibility of head-on collisions between the combustion air streams that are admitted to the fuel gas-air mixing area 39 through the combustion air inlet apertures 29a, 29b, 30a and 30b which pierce the opposed left and right long sidewalls 27 and 28 of the inverted trough 26. Furthermore, this offset aperture pattern of the present invention creates a transverse swirling action within the fuel gas-air mixing area 39 of the inverted trough 26, which promotes more turbulent, and hence better, mixing of the pressurized combustion air and the fuel gas admitted thereto and thus promotes more complete combustion thereof and more intense heat production therefrom.

The highly intense heat from the heat source or flame 43 is discharged downwardly to an inlet at the upper end of the high intensity heat exchanger means 25 via hollow boxlike interconnecting conduit means 44. The intensity of the heat source or flame 43 that is produced by the improved high-intensity combustor means 12 of the present invention is even greater than that produced by the combustor means described in the aforementioned Abbott and Boucher patent applications, and typically is at least 400,000 B.t.u.'s per hour per cubic foot of the

interconnecting conduit means 44, an intensity level far exceeding any previously achieved with the atmospheric combustion air burners which have heretofore been commonly employed in gas-fired space heaters.

As best shown in FIGS. 1-3, the remaining structure comprising the air-conditioning unit 10 is generally similar to that described in the aforementioned, copending, commonly assigned Boucher patent application. The heat exchanger means 25 comprises a plurality of vertically arranged hollow tubes 45. The tubes 45 have their upper ends fluid-connected in parallel to the lower end of the interconnecting conduit means 44 that is provided between the bottom of the inverted trough 26 of the improved combustor means 12 and the top of the heat exchanger means 25, while their lower ends are fluid-connected in parallel to an exhaust plenum 46 which directs waste products of combustion to atmospheric exhaust vent means, including an elbow-shaped vent pipe 47 having an inlet leg 47a and an outlet leg 47b. The vent pipe inlet leg 47a is connected to the exhaust plenum 46 at the bottom of the heat exchanger 25 and extends outwardly from the air-conditioning unit cabinet 19 through an opening 48 provided in the lower end of the cabinet right sidewall, while the vent pipe outlet leg 47b extends upwardly outside the cabinet 29. The outwardly extending vent pipe inlet leg 47a is sloped downwardly towards its intersection or elbow 47c with its upwardly extending outlet leg 47b, and liquid drain means 47d is provided at its lowest point, as in the bottom of the vent pipe elbow 47c.

Preferably, as in the case of the heat exchanger means described in the aforementioned Abbott and Boucher patent application, the outer surfaces of the hollow tubes 45 of the heat exchanger means 25 are provided with a fin means 49 of the so-called "spine fin type" that are generally similar to those described in detail in commonly assigned prior art U.S. Pat. No. 2,983,300, except that the tubes 45 and the fins 49 of the heat exchanger means 25 are preferably formed of a ferrous metal, such as steel, rather than of nonferrous aluminum or copper as in the air-cooling exchanger described in U.S. Pat. No. 2,983,300. As further shown in FIGS. 2 and 3, twisted ribbon like turbulence promoters 50 are provided in the lower exit ends of each of the heat exchanger tubes 45 in order to provide a balance of heat transfer between the finned outer surfaces and the bare inner surfaces of the tubes 45.

As shown in FIG. 1, the space air blower 17 has its inlet 51 aligned with the air inlet opening 23 for the cabinet left compartment 21 and has its discharge 52 fluid connected to the cabinet right compartment 22 via an opening 53 that is provided in the partition 20 and is arranged such that rotation of its impeller 54 by its electric motor 55 will cause the air stream 16 to be circulated between the space 15 and the finned exteriors of the heat exchanger tubes 45. Hence, during operation of the improved combustor means 12 of the gas-fired space heater means 11, the right conduit means 13 serves as means for directing heated air from the air-conditioning unit cabinet 19 to the space 15 or as the so-called warm air conduit means, the left conduit means 14 serve as means of returning air from the space 15 to the air-conditioning unit cabinet 19 for the reception heat, or as the so-called return air conduit means, and the space air blower 17 serves as a means for circulating air between the space 15 and the gas-fired space heater means 11.

Thus, during operation of the improved pressurized combustor means 12 of the gas-fired heater means 11, the combustion products resulting from the ignition and burning of the pressurized fuel gas and combustion air that are mixed in the fuel gas-air mixing area 39 of the inverted trough 26 produce the extremely high-intensity heat source or flame 43 and they and the heat generated thereby are forced downwardly under pressure provided by the combustion air supply blower 31 through the interconnecting conduit means 44 and the tubes 45 of the heat exchanger 25, with the heat therefrom being transferred by conduction, convection, and radiation, first to the interiors of the tubes 45, then to the finned exteriors of the tubes 45 and finally to the space airstream 16 that is circulated

across the finned exterior of the tubes 45 by the space air blower 17. And, the waste products of combustion are forced from the lower end of the heat exchanger tubes 45 and into the exhaust plenum 46 at the bottom of the heat exchanger 25, then outwardly and downwardly through the vent pipe inlet leg 47a and, finally, upwardly to the atmosphere via the vent pipe outlet leg 45b by the pressurized air supplied by the combustion air supply blower 31. The rate of heat transfer to the airstream 16 that can be accomplished by the heat exchanger means 25 is similar to that of the heat exchanger means described in detail in the aforementioned Abbott and Boucher patent applications, and is typically at least 3,500 B.T.U.'s of heat per hour per pound of material that is used in the tubes and the fins, a rate far exceeding any previously achieved with the rather crude prior art boxlike or clamshell-shaped heat exchangers which have heretofore been commonly employed in conventional gas-fired space heaters.

It should be apparent to those skilled in the art that while there has been described what, at present, is considered to be a presently preferred embodiment of this invention in accordance with the Patent Statutes, changes may be made to the disclosed apparatus without actually departing from the true spirit and scope of this invention. It is therefore, intended that the appended claims shall cover such modifications and applications that do not depart from the true spirit and scope of the present invention.

What is claimed is:

1. In a gas-fired space heater employing highly efficient heat exchanger means for transferring heat generated by combustion of a combustible gas-air mixture to an airstream circulated between the heat exchanger means and the space to be heated in combination with high-intensity pressurized combustor means for mixing fuel gas with pressurized combustion air to produce and burn the combustible gas-air mixture, improved combustor means, comprising:
 - a. a generally horizontally arranged trough having a pair of opposed, spaced-apart, generally vertically arranged, left and right long sidewalls pierced by a plurality of combustion air inlet apertures; and
 - b. a fuel gas supply conduit extending generally longitudinally through said trough between said apertured trough long sidewalls and having a long surface pierced by a plurality of inlet apertures,
 - c. said fuel gas inlet apertures being arranged in said apertured conduit surface such that fuel gas can enter said trough generally parallel to said apertured trough sidewalls and be turbulently mixed with pressurized combustion air that can enter a fuel gas-air mixing area defined by said apertured trough sidewalls and said apertured conduit surface, and
 - d. said apertured conduit surface having two longitudinally offset rows of fuel gas inlet apertures therein including a left row of fuel gas inlet apertures that are longitudinally aligned with the combustion air inlet apertures in said trough left long sidewall and a right row of fuel gas inlet apertures that are longitudinally aligned with the combustion air inlet apertures in said trough right long sidewall.
2. The invention of claim 1, wherein said trough is inverted.
3. The invention of claim 1, wherein one of said offset rows of fuel gas inlet apertures is located on one side of the long central axis of said apertured conduit surface and the other of said offset rows of said fuel gas inlet apertures is located on the opposite side of the long central axis of said apertured conduit surface.
4. The invention of claim 3, wherein said trough is inverted.
5. The invention of claim 3, wherein the apertures forming said left row of fuel gas inlet apertures have their radial centers longitudinally spaced apart from the radial centers of the apertures forming said right row of fuel gas inlet apertures by an offset spacing distance that is substantially equal to one-half of the in-line spacing distance that is provided between the radial centers of adjacent ones of the apertures forming said left row of fuel gas inlet apertures.

