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[15] **3,670,713**

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[54] GAS-FIRED HEATER MEANS

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[73] Assignee: **General Electric Company**

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[52] **U.S. Cl.** .....**126/110 R**, 126/91 A, 126/116 R, 431/190, 431/351

[51] **Int. Cl.**.....**F24h 3/06**

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

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[57] **ABSTRACT**

Improved gas-fired heater means are provided for supplying heat to a space, such as a room, house, building, or the like. Basically, the improved heater means comprises a combination of highly efficient heat exhanger means for transferring heat generated by the combustion of a combustible gas-air mixture to air circulated between the heat exchanger means and the space to be heated at a rate of at least 3,500 BTU of heat per hour per pound of heat exchanger means material and high intensity combustor means for mixing fuel-gas with pressurized air to produce the combustible gas-air mixture and to burn that mixture to provide a source of heat of sufficient intensity to meet the heat transferring ability of the highly efficient heat exchanger means. The improved heater means provided by the present invention permits considerable weight and volume reduction and consequent cost savings in heat exchanger means material over conventional gas-fired heaters of comparable heating capacity.

6 Claims, 7 Drawing Figures

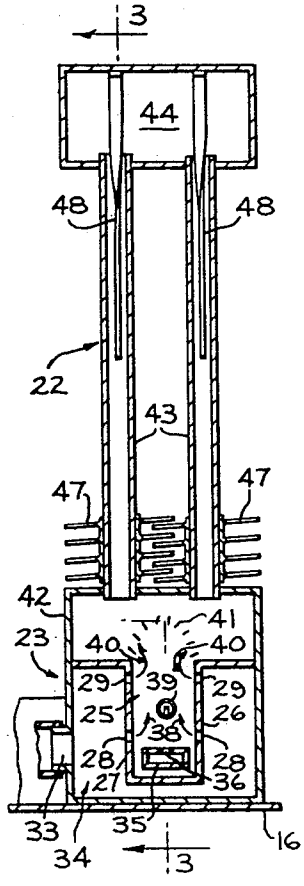
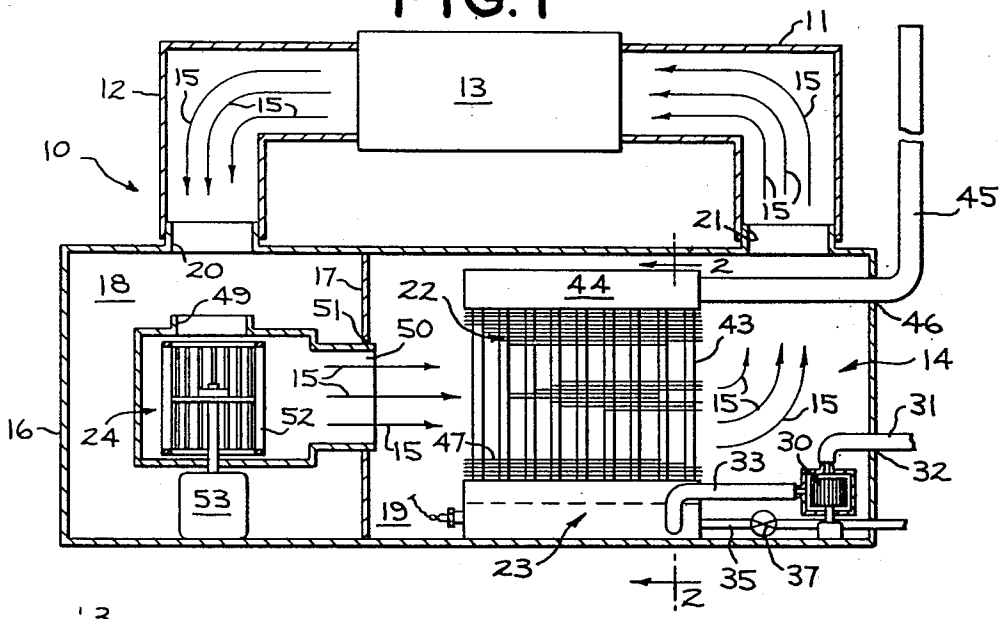


FIG. 1



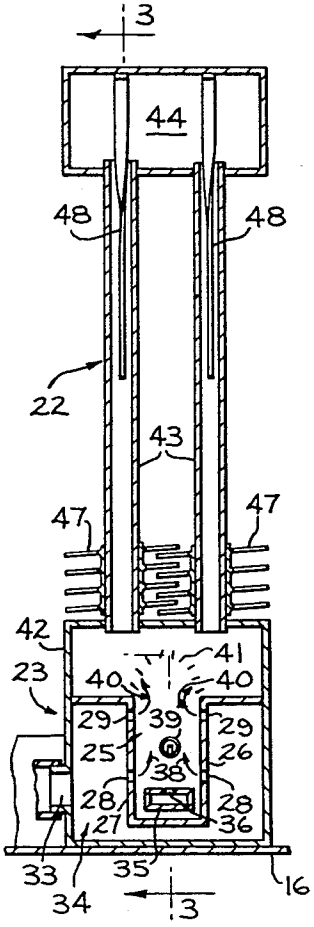


FIG. 2

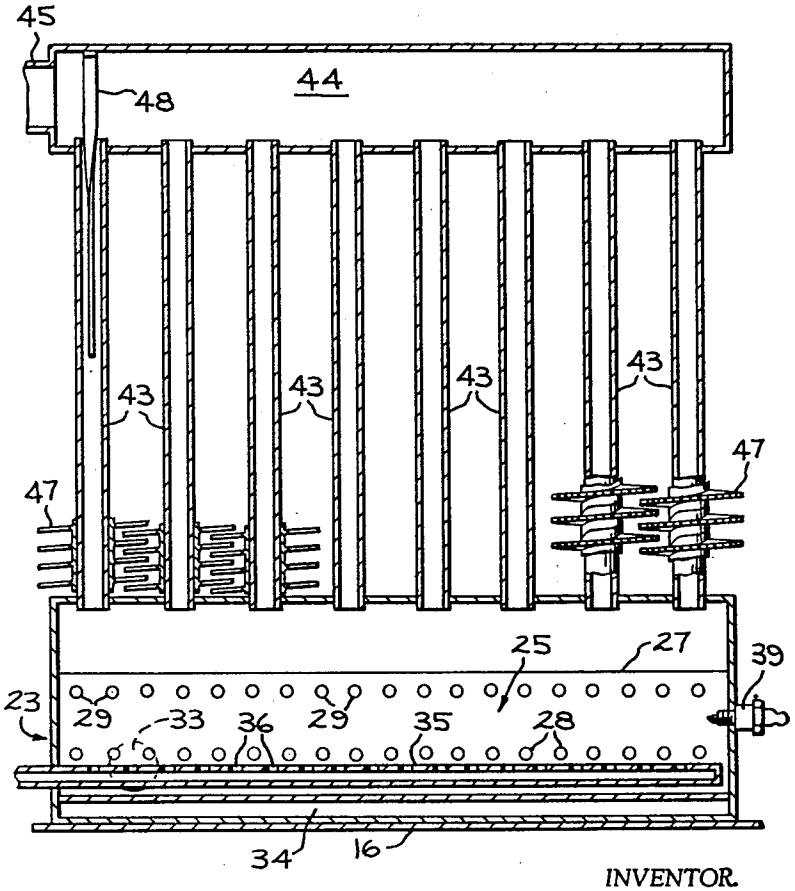


FIG. 3

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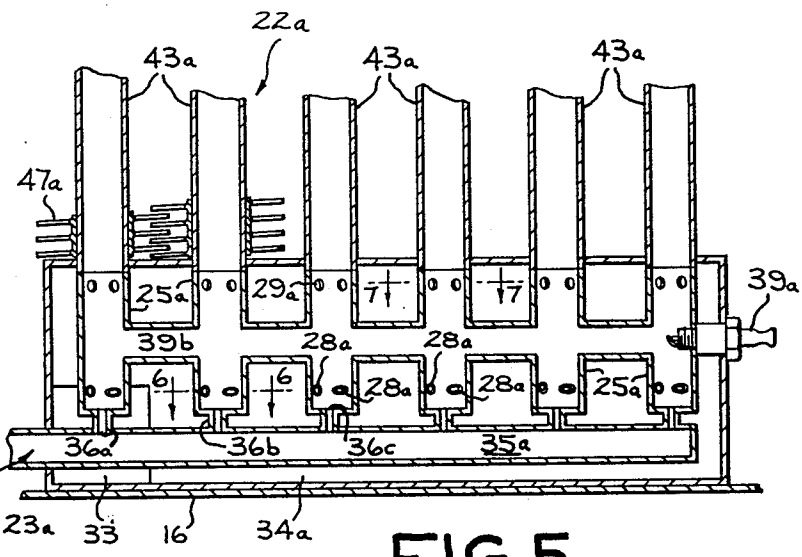

FIG. 5

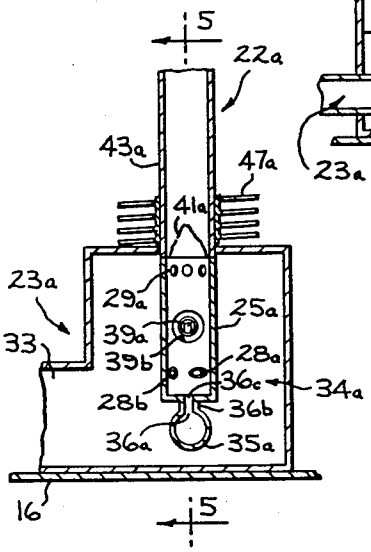

FIG. 4

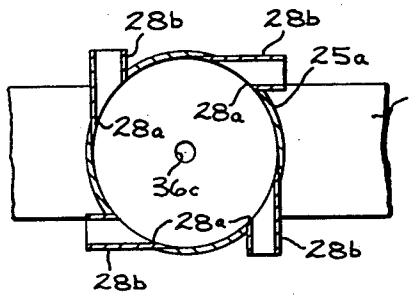

FIG. 6

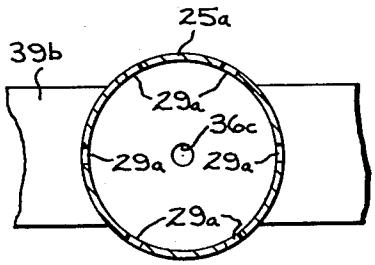

FIG. 7

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GAS-FIRED HEATER MEANS

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 gas-fired heater means for supplying such heat.

Heretofore, conventional gas-fired heater or furnace means of the aforedescribed type have most frequently employed rather crude cast iron or steel heat exchangers 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 air circulated between the heat exchanger and the space to be heated. And, these conventional heat exchangers 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 air that is mixed with the fuel-gas is supplied to the burner at atmospheric conditions. While these prior-art heater means have performed fairly satisfactorily over the years and are widely used to gas-heat rooms, houses, and other buildings, they have been bulky in volume and heavy in the weight (and consequently expensive in the cost) of heat exchanger means material they required, with typical conventional steel heat exchanger means of the clam shell shape being limited in ability to transfer the heat generated by the combustion of the combustible gas-air mixture to the air circulated between the heat exchanger means and the space to be heated to a rate of only around 2,000 BTU of heat per hour per pound of heat exchanger means material.

SUMMARY OF THE INVENTION

The present invention provides improved gas-fired heater means which permit considerable weight and volume reduction, and consequent cost savings, in heat exchanger means material over the aforedescribed conventional gas-fired heaters of comparable heating capacity. Basically, the improved heater means of the present invention comprises a combination of highly efficient heat exchanger means for transferring heat generated by the combustion of a combustible gas-air mixture to air circulated between the heat exchanger means and the space to be heated at a rate of at least 3,000 BTU per hour per pound of heat exchanger means material and high intensity combustor means for mixing fuel-gas with pressurized air to produce the combustible gas-air mixture and to burn that mixture to provide a source of heat of sufficient intensity to meet the heat transferring ability of the highly efficient heat exchanger means.

Typically, the total volume of the combination of the highly efficient heat exchanger means and the high intensity combustor means, which comprises the improved heater means of the present invention, is such that this combination has a heat release rate to the space air stream of at least 45 BTU of heat released per hour per cubic inch of material forming the combination, or around five times greater than the similar heat release rate previously achieved with the conventional heater means. Thus, this combination of far less bulky and lighter weight heat exchanger means and high intensity combustor means, which comprises the improved gas-fired space heater means of the present invention, provides geometry that is much smaller and, hence, far more compatible in size with the compact conventional air-cooling equipment than has heretofore been the case with the aforenoted prior-art heater means.

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 incorporating a presently preferred form of the improved gas-fired heater means of the present invention;

FIG. 2 is a greatly enlarged sectional view taken along line 2—2 of FIG. 1;

FIG. 3 is a sectional view taken along line 3—3 of FIG. 2;

FIG. 4 is a view generally similar to FIG. 2 but illustrating an alternative form of the improved gas-fired heating means of the present invention;

FIG. 5 is a sectional view taken along line 5—5 of FIG. 4;

FIG. 6 is a greatly enlarged sectional view taken along line 6—6 of FIG. 5; and

FIG. 7 is a greatly enlarged sectional view taken along line 7—7 of FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings and, more particularly to FIG. 1 thereof, there is illustrated, somewhat schematically, an air-conditioning unit, generally designated 10. The air-conditioning unit 10 is fluid-connected by right and left hollow conduit means 11 and 12 to a space 13 (shown in block), such as a room, house, building, or the like, so as to condition the air contained within the space 13, as by supplying heat to or removing heat from air that is circulated between the space 13 and the air-conditioning unit 10 through the conduit means 11 and 12. And, as shown in FIGS. 1–3, the air-conditioning unit 10 employs a presently preferred form of the improved gas-fired heater means, generally designated 14, that are provided in accordance with the present invention to supply heat to the air stream, indicated by arrows 15, that is circulated between the air-conditioning unit 10 and the space 13.

As illustrated in FIG. 1, the air-conditioning unit 10 includes a generally rectangular hollow box-like cabinet 16 that is subdivided by a vertically arranged partition 17 into a left compartment 18 and a right compartment 19. The cabinet left compartment 18 has an air inlet opening 20 in its upper wall that is fluid-connected to the space 13 by the left conduit means 12, while the upper wall of the cabinet right compartment 19 has an air outlet opening 21 that is fluid-connected to the space 13 by the right conduit means 11. As still further shown in FIG. 1, the cabinet right compartment 19 houses presently preferred forms of highly efficient heat exchanger means 22 and high intensity combustor means 23 that are provided in accordance with the present invention, while the cabinet left compartment 18 houses space air blower means 24.

As shown in FIGS. 1–3, the presently preferred form of the high intensity combustor means 23 includes a generally horizontally arranged elongate trough 25 of U-shaped cross section having generally vertically arranged interconnected side walls 26 and 27 that are provided with a plurality of apertures along their lower and upper edges to respectively define primary combustion air inlet apertures 28 and secondary combustion air inlet apertures 29. Combustion air is introduced into the trough 25 through the primary and secondary combustion air inlet apertures 28 and 29 under pressure that is provided by combustion air-blower means 30. The combustion air blower means 30 is housed in the lower right hand corner of the cabinet right compartment 19 and has its inlet connected to combustion air intake conduit means 31 which extend outwardly from the cabinet 16 through an opening 32 provided in the right side wall thereof. The combustion air blower means 30 has its outlet connected via combustion air-blower discharge conduit means 33 to box-like combustion air supply plenum 34 that is located around the trough 25. A generally horizontally disposed gas supply conduit 35 extends longitudinally through the trough 25 and is provided with plural gas inlet apertures 36 located below the primary combustion-air inlet apertures 28. The inlet of the gas supply conduit 35 is connected via an electric control valve 37 of a well-known type to a source (not shown) of pressurized fuel-gas, such as natural gas, propane, or the like. The fuel gas inlet apertures 36 are arranged such that gas enters the trough 25 generally parallel to the generally vertically arranged trough side walls 26 and 27 and is turbulently mixed as indicated by arrows 38 with the pressurized air that is admitted via the generally horizontally disposed primary combustion air inlet apertures 28.

The rich combustible gas fuel-air mixture which results from the turbulent mixing of the pressurized gas-fuel that is discharged from the gas inlet apertures **36** with the pressurized air that enters the trough **25** through the primary combustion air inlet apertures **28** moves upwardly through the trough **25** and is ignited by means of a high voltage spark produced in a well-known manner by an electric spark plug **39** or similar igniter device that is generally horizontally arranged at the left end of the trough **25** at a point vertically spaced between the primary combustion air inlet apertures **28** and the secondary combustion air inlet apertures **29**. This ignited mixture of gas fuel and primary combustion air is then further turbulently mixed as indicated by arrows **40** with the pressurized air that enters the trough **25** via the generally horizontal secondary combustion air inlet apertures **29** along the upper edges of the trough side walls **26** and **27** and produces an extremely high intensity heat source or flame **41**. The highly intense heat from this heat source or flame **41** is now transmitted to the lower end of the presently preferred form of the high intensity heat exchanger means **22** via hollow box-like interconnecting conduit means **42**. Typically, the intensity of the heat source or flame **41** that is produced by the high intensity combustor means **23** is at least 300,000 BTU of heat per hour per cubic foot of the interconnecting conduit means **42**, an intensity level far exceeding any previously achieved with the prior-art atmospheric combustion air burners which have heretofore been commonly employed in gas-fired space heaters.

As further shown in FIGS. **1–3**, the presently preferred form of highly efficient heat exchanger means **22** that are provided in accordance with the present invention comprises a plurality of generally vertically arranged hollow tubes **43** having their lower ends fluid-connected in parallel to the upper end of the interconnecting conduit means **42** provided between the top or open side of the trough **25** and the bottom of the heat exchanger means **22**, while their upper ends are fluid-connected in parallel to an exhaust plenum or header **44** which directs the waste products of combustion to an atmospheric vent **45** that extends outwardly from the air-conditioning unit cabinet **16** through an opening **46** provided in the upper end of the cabinet right sidewall.

Preferably, the outer surfaces of the hollow tubes **43** of the heat exchanger means **22** are provided with fin means **47** 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 **43** and fins **47** for the heat exchanger **22** are preferably formed of a ferrous metal, such as steel, rather than of non-ferrous aluminum or copper as in the air-cooling exchanger described in the aforenoted prior-art patent. As further shown in FIGS. **2** and **3**, twisted ribbon-like turbulence promoters **48** are provided in the upper or exit ends of each of the heat exchanger tubes **43** in order to provide a balance of heat transfer between the finned outer surfaces and the bare inner surfaces of the tubes **43**.

As shown in FIG. **1**, the space-air blower means **24** has its inlet **49** arranged beneath the air inlet opening **20** for the cabinet left compartment **18** and has its discharge **50** fluid-connected to the cabinet right compartment **19** via an opening **51** that is provided in the partition **17** and is arranged such that rotation of the space air-blower impeller **52** by its electric motor **53** will cause the air stream **15** to be circulated between the space **13** and the finned exterior of the heat exchanger tubes **43**. Hence, the right space-air conduit means **11** serve as means for directing heated air from the air-conditioning unit **10** to the space **13** or as the so called warm air conduit means, while the left conduit means **12** serve as the means for returning air from the space **13** to the air-conditioning unit **10** for reception of heat or as the so-called return air conduit means, and the space-air blower means **24** serves as the means for circulating air between the space **13** and the improved gas-fired heater means **14** that are provided in accordance with the present invention. Thus, with the novel arrangement illustrated in FIGS. **1–3**, the products resulting from combustion of the gas fuel-primary and secondary combustion air mixture at the highly intense heat source or flame **41** and the heat generated thereby move upwardly through the interiors of the heat exchanger tubes **43**, with the heat being transferred by conduction, convection, and radiation, first to the interiors of the tubes **43**, then to the finned exteriors of the tubes **43**, and finally to the space-air stream **15** that is circulated across the finned exteriors of the tubes **43** by the space-air blower means **24**. Typically, the rate of transfer of this heat to the air stream **15** that can be accomplished with the presently preferred form of the heat exchanger means **22** (FIGS. **1–3**) is at least 3,500 BTU of heat per hour per pound of material that is used in the tubes **43** and fins **47**, a rate far exceeding any previously achieved with the rather crude prior-art box-like or clam shell-shaped heat exchangers which have hereto-fore been commonly employed in gas-fired space heaters.

FIGS. **4–7** illustrate alternative forms of the highly efficient heat exchanger means **22*a*** and high intensity combustor means **23*a*** that are provided in accordance with the present invention, and it should be understood that the relative locations of these alternative forms of highly efficient heat exchanger means **22*a*** and high intensity combustor means **23*a*** within the air-conditioning unit **10** are intended to be generally similar to the locations shown for the presently preferred forms of the highly efficient heat exchanger means **22** and high intensity combustor means **23** in FIG. **1**. The major differences between these alternative forms **22*a*** and **23*a*** and the presently preferred forms **22** and **23** lie in the details of construction of the alternative form of combustor means **23*a*** and the means for interconnecting the alternative form of combustor means **23*a*** to the alternative form of heat exchanger means **22*a***.

As shown in FIGS. **4–7**, the alternative form of high intensity combustor means **23*a*** provided in accordance with the present invention substitutes a plurality of generally vertically arranged flame tubes **25*a*** for the unitary trough **25** that is utilized in the previously described presently preferred form of combustor means **23** (FIGS. **1–3**). As illustrated in FIGS. **4–7**, these flame tubes **25*a*** correspond in number to the total number of the alternate form of heat exchanger tubes **43*a*** that are employed in the alternative form of heat exchanger means **22*a***. Each of these flame tubes **25*a*** comprises a generally vertically arranged hollow cylindrical tube having an open upper end that is joined by welding or other suitable fastening means to the lower end of its associated one of the alternative form of heat exchanger tubes **43*a*** and a bottom end which is provided with a fuel-gas inlet aperture **36*c*** that is connected by conduit means **36*b*** to one of a plurality of gas-fuel apertures **36*a*** provided in the top of a generally horizontally disposed alternate form of gas-fuel supply conduit means **35*a*** which, of course, can be connected via means such as the electric control valve **37** (FIG. **1**) to a source of pressurized fuel-gas, such as natural gas, propane, or the like.

As best shown in FIGS. **4–6**, each of the flame tubes **25*a*** is provided with a plurality of primary combustion air inlet apertures **28*a*** that are tangentially spaced around the lower edge of its cylindrical vertical sidewall, while, as particularly shown in FIGS. **4**, **5** and **7**, the upper edge of the cylindrical sidewall of each of the flame tubes **25*a*** is provided with a plurality of secondary combustion air inlet apertures **29*a*** which extend radially towards the axial center of the tube **25*a***. As particularly shown in FIG. **6**, these alternate form of primary combustion air inlet apertures **28*a*** are provided with intake portions **28*b*** that extend tangentially from the sidewall of the flame tubes **25*a***. And, as further shown in FIGS. **5** and **7**, the plural flame tubes **25*a*** are interconnected by a plurality of generally horizontally arranged cross-over tubes **29*b*** which are axially aligned with one another and with igniter means, such as a spark plug **39*a*** or the like, that is generally horizontally arranged at the left end of the series of flame tubes **25*a*** at a point vertically spaced between the primary combustion air inlet apertures **38*a*** and the secondary combustion air inlet apertures **29*a***.

With this alternative arrangement illustrated in FIGS. 4–7, combustion air is introduced into the flame tubes **25***a* through the primary and secondary air inlet apertures **28***a* and **29***a* under pressure that is provided by means such as the combustion-air blower means **30** shown in FIG. **1**, with the combustion-air blower means **30** having its outlet connected via its discharge conduit means **33** to an alternative form of combustion air supply plenum **34***a* that is located around all of the flame tubes **25***a*. And, the gas fuel is introduced upwardly into each of the flame tubes **25***a* by the gas inlet aperture **36***c* and is turbulently mixed with the pressurized primary combustion air that is tangentially introduced (FIG. **6**) into the flame tube lower end by the primary combustion air inlet apertures **28***a*. This rich combustible mixture of pressurized gas fuel and primary combustion air produces a vortex flow pattern within the lower portion of each flame tube **25***a* which moves upwardly toward the aligned cross-over tubes **39***b*, at which point it is ignited by means of a high voltage spark that is produced in a well-known manner by the igniter **39***a*. This ignited mixture of pressurized gas fuel and primary combustion air is then further turbulently mixed (FIG. **7**) with the pressurized air that enters the flame tube **25***a* via the radially extending secondary combustion air inlet apertures **29***a* around the upper portion of the flame tube **25***a* and produces an extremely high intensity heat source or flame **41***a* that is directly supplied to the lower end of its associated one of the alternative form of the heat exchanger tubes **43***a* that is directly connected by welding or similar fastening means to the upper end of the flame tube **25***a*.

As best shown in FIGS. **4** and **5**, the alternative form of heat exchanger means **22***a* provided in accordance with the present invention comprises a plurality of generally vertically arranged hollow tubes **43***a* which have their lower ends individually fluid-connected to the upper end of an associated one of the plurality of flame tubes **25***a*. Otherwise, the remaining structure of this alternative form of heat exchanger means **22***a* is generally similar to the presently preferred form **22** shown in FIGS. **1–3**, with the upper ends of the alternative form of heat exchanger tubes **43***a* being fluid-connected in parallel to an exhaust plenum or header which directs the waste products of combustion to an atmospheric vent that extends outwardly from the air conditioning unit cabinet through an opening provided in the upper end of the cabinet right sidewall (FIG. **1**). Preferably, as in the case of the preferred form, the outer surfaces of these alternative form of hollow tubes **43** (FIGS. **4** and **5**) are provided within fins **47***a* of the so called "spine-fin type" and are generally similar to those finned tubes described in detail in the aforenoted commonly-assigned prior-art U.S. patent except that the tubes **43***a* and fins **47***a* for the alternative form of heat exchanger **22***a* are preferably formed of a ferrous metal such as steel, rather than of non-ferrous aluminum or copper as in the air-cooling exchanger described in the aforenoted prior-art patent. The alternative form of high efficiency heat exchanger means **22***a* is also similar to the preferred form in that turbulence promoters, not shown but otherwise similar to the turbulence promoters **48** illustrated in FIGS. **2** and **3**, are provided in the upper or exit end of each of the alternative form of heat exchanger tubes **43***a* in order to provide a balance of heat transfer between the finned outer surfaces and bare inner surfaces of the tubes **43***a*.

Typically, the total volume of the combination of the highly efficient heat exhanger means **22** or **22***a* and the high intensity combustor means **23** or **23***a*, which comprises the improved gas-fired heater means **14** of the present invention, is such that this combination has a heat release rate to the air stream **15** of at least 45 BTU of heat released per hour per cubic inch of the material forming the combination, or around five times greater than the similar heat release rate heretofore achieved with the aforenoted conventional heater means. Thus, this combination of the far less bulky and lighter weight heat exchanger means **22** or **22***a* and the high intensity combustor means **23** or **23***a*, which comprises the improved gas-fired space heater means **14** of the present invention, provides geometry that is much smaller and, hence, far more compatible in size and shape with the rather compact conventional air-cooling equipment than has previously been the case with the aforenoted prior-art heater means. Therefore, the improved gas-fired heater means **14** of the present invention are particularly suited for combination within the cabinet **16** (FIG. **1**) with air-cooling means (not shown) to thus provide means for both heating and cooling the air stream **15**, whereby the air-conditioning unit **10** can comprise a combined air heating and cooling unit of far less bulk and weight than has heretofore been possible.

It should be apparent to those skilled in the art that while there have been described what, at present, are considered to be presently preferred embodiments 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. Improved gas-fired space heater means, comprising the combination of:

heat exchanger means for transferring heat generated by the combustion of a combustible gas-air mixture to air circulated between said heat exchanger means and the space to be heated and combustor means for mixing fuel-gas with pressurized air to produce said combustible gas-air mixture and to burn said mixture;

said heat exchanger comprising a plurality of tubes provided with fins on the exterior thereof;

said combustor means comprising burner means including a generally horizontal trough-shaped member forming a primary mixing area and a secondary mixing area spaced apart by an ignition area, means including a plurality of gas inlet apertures adjacent the bottom of said trough-shaped member for supplying pressurized fuel-gas to said primary mixing area; and

means for supplying pressurized air to said mixing areas including primary air inlet apertures adjacent the lower portion of said trough-shaped member and above said gas inlet apertures and secondary air inlet apertures along the upper portion of said trough-shaped member.

2. Improved gas-fired space heater means, comprising the combination of:

heat exchanger means for transferring heat generated by the combustion of a combustible gas-air mixture to air circulated between said heat exchanger means and the space to be heated and combustor means for mixing fuel-gas with pressurized air to produce said combustible gas-air mixture and to burn said mixture;

said combustor means comprising burner means including a horizontal trough having spaced side walls and a bottom wall forming a primary mixing area and a secondary mixing area spaced apart by an ignition area, means for supplying pressurized fuel-gas to said primary mixing area, and means for supplying pressurized air to said mixing areas;

said means for supplying pressurized fuel-gas including a plurality of gas inlet apertures adjacent the bottom wall of said trough; and

said means for supplying pressurized air to said mixing areas includes primary air inlet apertures in the primary mixing area of said trough and above said gas inlet apertures and secondary air inlet apertures along the upper portion of said trough side walls.

3. A gas-fired space heater means comprising the combination of:

burner means including an elongate horizontally extending member of generally U-shaped cross section including opposed walls and an interconnecting wall;

means for supplying pressurized fuel-gas to said burner means including a plurality of gas inlet apertures adjacent said interconnecting wall and extending substantially the length of said member;

said opposed walls having at least one row of primary air apertures extending longitudinally thereof adjacent said gas inlet apertures and at least one row of secondary air apertures spaced from said row of primary air apertures;

means for supplying pressurized air to said apertures;

a heat exchanger comprising a plurality of parallel finned tubes; and

elongate conduit means extending substantially the length of said elongate member connecting the open side of said elongate member to said heat exchanger.

4. A gas-fired heater means according to claim 3 including a pressurized air supply plenum surrounding the side walls of said elongate member.

5. A gas-fired space heater means comprising the combination of:

burner means including an elongate horizontal member of generally U-shaped cross section including opposed walls and an interconnecting wall;

a perforated fuel gas pipe positioned within said member adjacent said interconnecting wall and extending substantially the length of said member;

each of said opposed walls having at least one row of primary air apertures extending longitudinally of said member adjacent said gas pipe and at least one row of secondary air apertures spaced from said gas pipe;

means for supplying pressurized air to said apertures;

a heat exchanger comprising a plurality of finned tubes; and

elongate conduit means extending substantially the length of said elongate member connecting said elongate member to one end of said heat exchanger tubes.

6. A gas-fired space heater means according to claim 5 in which said perforated gas pipe introducing fuel gas generally parallel to said opposed walls and said air apertures introducing air under pressure horizontally into said elongate member.

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