United States Patent [19]

Mutchler

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[45] **July 9, 1974**

[54] **GAS-FIRED FURNACE**

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[73] Assignee: **American Air Filter Company, Inc.,** Louisville, Ky.

[22] Filed: **Nov. 8, 1972**

[21] Appl. No.: **304,768**

Related U.S. Application Data

[62] Division of Ser. No. 201,879, Nov. 24, 1971, Pat. No. 3,724,995.

[52] **U.S. Cl.** ..... **126/110 R,** 126/116 R

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

[58] **Field of Search** ..... 122/136 R, 136 C, 149; 126/110 R, 110 B, 116 R

[56] **References Cited**

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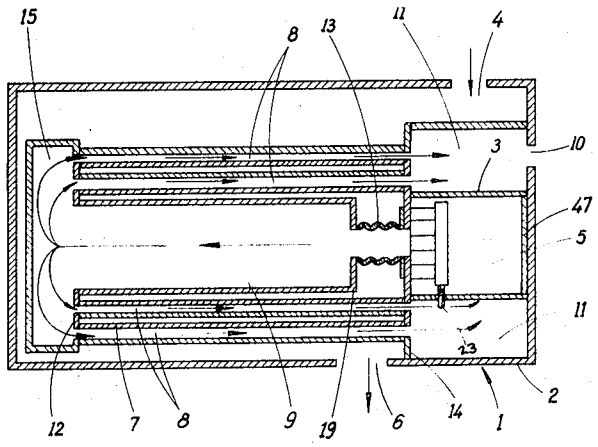
Primary Examiner—William E. Wayner

Assistant Examiner—W. E. Tapolcai, Jr.

[57] **ABSTRACT**

A gas-fired furnace including a heat exchanger mounted in a housing in heat transfer relation with flowing air passing over the heat transfer surface of the heat exchanger and a gas burner assembly; the heat exchanger having a centrally disposed burner tube communicating with a rear tube sheet at one end and the gas burner assembly at the opposite end, and a plurality of return tubes disposed about the burner tube and affixed to the rear tube sheet at one end and a flue gas collector at the opposite end.

9 Claims, 5 Drawing Figures



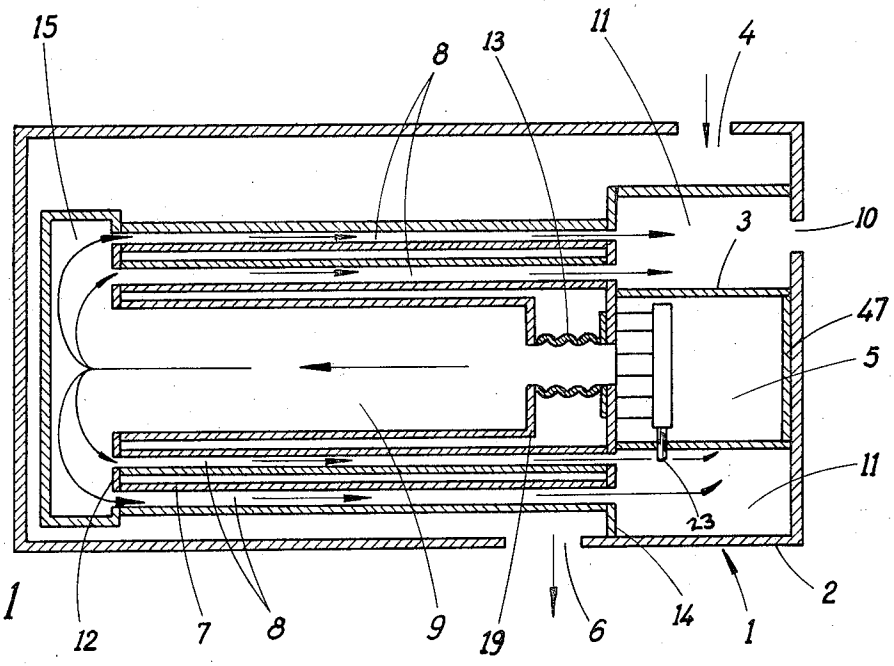

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Fig. 1

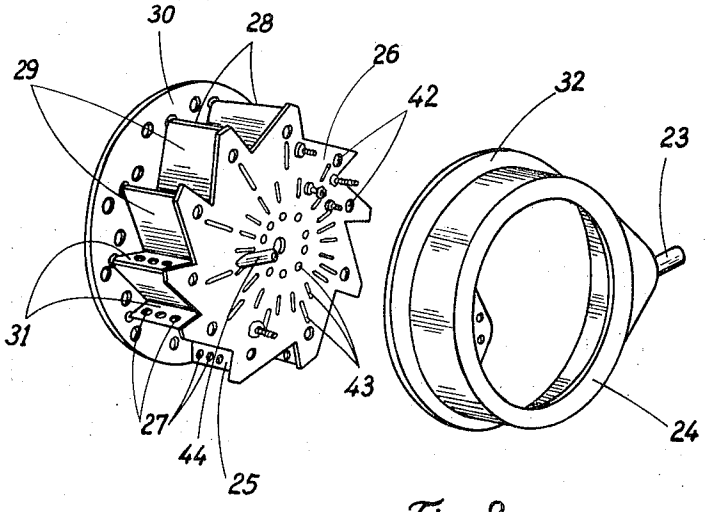

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Fig. 2

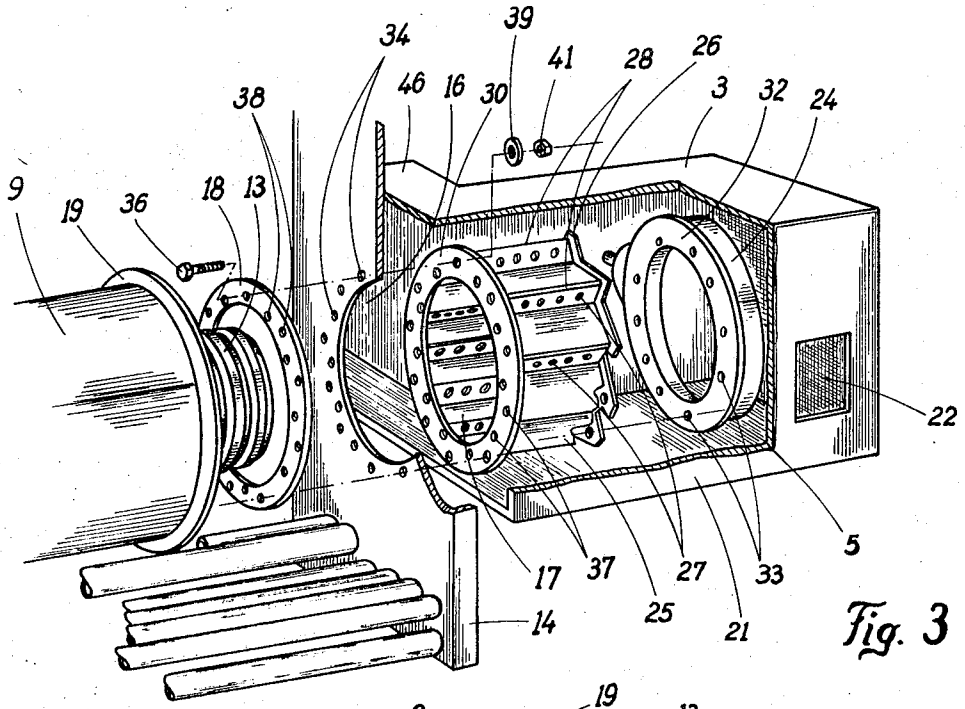

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Fig. 3

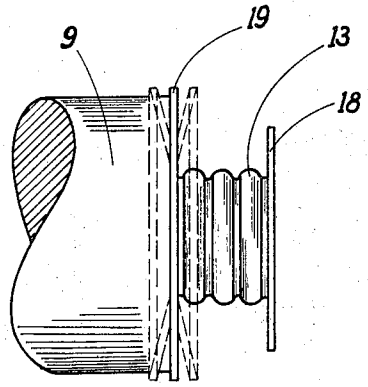

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Fig. 4

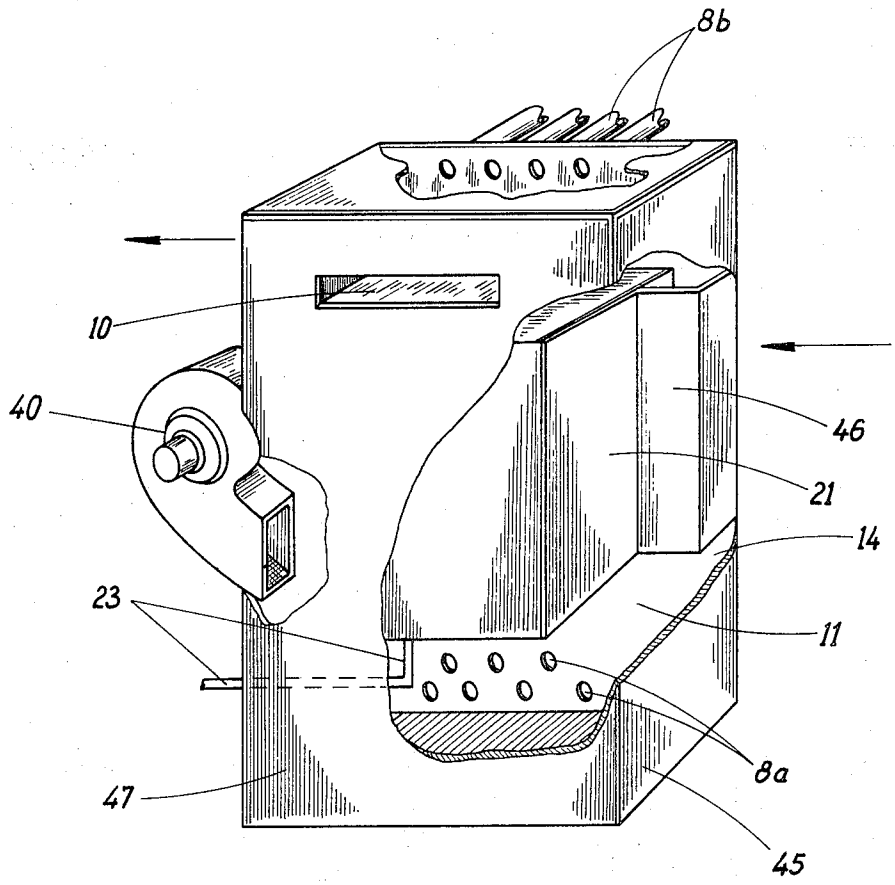


Fig. 5

GAS-FIRED FURNACE

The present invention is a division of copending application Ser. No. 201,879, now U.S. Pat. No. 3,724,995, filed Nov. 24, 1971 by Paul A. Mutchler.

BACKGROUND OF THE INVENTION

This invention relates to a gas-fired furnace and more particularly to a novel tube-type heat exchanger and gas burner assembly, the gas burner assembly being adaptable for cooperating with the novel heat exchanger.

In previous forced draft burner constructions for gas-fired furnaces having horizontal return tubes, high velocity nozzles from small diameter burner blast tubes have been used to fire into rectangular refractory combustion chambers or, unnecessarily large cylindrical furnace tubes. In accordance with the present invention it is recognized that these high velocity flows often have a tendency to cause momentary blowoff of the flame at the burner blast tube end and the gas fires that are late in developing their maximum heat release have tended to make little use of the direct heating surface near the burner or firing end of the furnace. The present invention further recognizes that these late developing gas fires also have led to overworking and overheating of the rear tube sheet which causes for short life and early failure of the rear tube sheet and the horizontal return tube end where the tubes join the rear tube sheet. Moreover, it is recognized that full advantage has not been made of the primary heating surface of the furnace thereby making it necessary to operate a gas burner with minimum excess air in order to keep the stack temperature down to a level necessary to achieve the required furnace efficiency.

SUMMARY OF THE INVENTION

The present invention, recognizing the disadvantages of previous gas-fired furnaces, provides a novel method for burning gaseous fuels with a broad base flame while developing a fire very quickly. Furthermore, the burner of the present invention provides means for establishing a flame having a slow forward velocity while at the same time releasing its heat very quickly.

The present invention advantageously provides a straight-forward arrangement for the preparation of a gas-fired furnace.

The present invention further provides a novel gas burner assembly for use in gas-fired furnaces.

Various other features of the present invention will become obvious to those skilled in the art upon reading the disclosure set forth hereinafter.

More particularly, the present invention provides a gas-fired furnace comprising:

A. a housing having an air inlet and an air outlet;

B. the housing including a heat exchanger and a gas-fired burner assembly, the burner assembly having a central opening therein;

C. the heat exchanger including a burner tube of relatively large cross-sectional area and being adapted to receive heated gas from the burner assembly, the burner tube having an inlet and an outlet and being in axial alignment with and in communication with the opening of the burner assembly at the inlet and a rear tube sheet at the outlet, the rear tube sheet having an opening therein of generally the same cross-sectional area as the inside of the burner tube communicating with the burner tube outlet, at least one second opening in the rear tube sheet communicating with flue gas return means, the flue gas return means being in communication with a flue gas collector, the flue gas return means being adapted to receive heated gas from the burner tube at the rear tube sheet transferring the gas to the flue gas collector;

D. the flue gas collector having a flue gas outlet;

E. a combustion air inlet and a fuel gas inlet, the combustion air inlet and the fuel gas inlet being in communication with the gas burner assembly; and,

F. expansion means in communication with the burner tube whereby upon contraction and expansion of the burner tube the openings in the burner remain generally stationary

Even more particularly, the present invention provides a gas burner assembly comprising: a burner housing having fuel and air inlet means and an outlet, the housing defining a plenum therein; a longitudinally extending chamber of serrated configuration adapted to be received within the housing, the chamber having a plurality of generally V-shaped pockets therein, each pocket being defined by each serration; a gas ring manifold adapted to be received within the housing, the manifold having an inlet in communication with the fuel inlet means in the housing and a plurality of apertures spaced in axial alignment with the pockets of the serrated configured chamber whereby fuel enters the chamber through the pockets parallel to the axis of the chamber; and, each V-shaped pocket includes two flanks, at least one of the flanks having at least one aperture therein whereby air entering the plenum through the air inlet in the housing passes through the aperture in the flank transversely of the fuel passing through the V-shaped pocket.

It is to be understood that the description of the examples of the present invention given hereinafter are not by way of limitation. Various modifications within the scope of the present invention will occur to those skilled in the art upon reading the disclosure set forth hereinafter.

Referring to the drawings:

FIG. 1 is a cross sectional view of a gas-fired furnace of the present invention;

FIG. 2 is an enlarged exploded perspective view of a gas burner assembly of FIG. 1 without a burner housing;

FIG. 3 is another enlarged exploded perspective view of the gas burner assembly of FIG. 1 including expansion means with certain portions thereof cutaway;

FIG. 4 is an enlarged plan view of the expansion means of FIG. 1 with phantom lines indicating the position of the expansion means upon expansion and contraction of the burner tube; and,

FIG. 5 is an enlarged perspective view of the front end of the gas-fired furnace of FIG. 1.

FIG. 1 illustrates a gas furnace 1 including a gas burner assembly 3 of the present invention. The gas furnace 1 includes a housing 2 having an inlet 4 for air which is to be heated in the furnace 1 and an outlet 6 for the discharge of the heated air. Means for introducing air to be heated is not shown but may include any means known in the prior art, such as, for example, a blower,

The gas furnace 1 is further provided with a heat exchanger 7, the heat exchanger 7 including a plurality of elongated tubes 8 of relatively small cross-sectional

area disposed about an enlarged cylinder or burner tube 9 of relatively large cross-sectional area with the tubes 8 being affixed at one end to a flue gas collector 11 and at the other end to a rear tube sheet 12. The burner tube 9 is joined to the rear tube sheet 12 at one end and a flexible expansion flange or head 19 at the other end, the head 19 being attached to a corrugated collar 13, collar 13 being connected to the front tube sheet 14 of the flue gas collector 11. The flexible expansion head 19 being disposed between the burner tube 9 and the corrugated collar 13 is incorporated to relieve the expansion and contraction of the burner tube 9 as the temperature of the burner tube 9 fluctuates over a wide temperature range. It is realized that an expansion means, such as flexible expansion head 19, may be adapted for positioning between the burner tube and the rear tube sheet in addition to or in lieu of the aforementioned exemplified position of the flexible expansion head 19. The front tube sheet 14 of the collector 11 has an aperture 16 therein which is generally of the same diameter as the diameter of the corrugated collar 13 for axial alignment therewith. Further, burner assembly 3 is provided with an aperture 17 (FIG. 3) of generally the same diameter as the corrugated collar 13 and the aperture 17 is also adaptable for axial alignment with collar 13.

In FIGS. 2 and 3 the gas burner assembly 3 of the present invention includes housing 21 defining a combustion air plenum 5 with combustion air inlet 22 and fuel gas inlet 23 disposed therein. The housing 21 is adapted to enclose a longitudinally extending cylindrical shaped chamber 25 having a plurality of serrated sections 28 along the peripheral boundary of the chamber 25 and a fuel gas manifold distribution ring 24 axially aligned with the chamber 25. The longitudinally extending cylindrical shaped chamber 25 is determined by a flange or burner mounting plate 30 fixed at one end thereof and having an aperture 17 therein and a front closure plate 26 fixed at the other end, plate 26 having serrated edges for aligning with the serrated sections 28 of the chamber 25.

The serrated sections or interior pockets 28 of generally V-shaped cross-section are determined by a plurality of flanks 29 and 31 at least such of the flanks 31 having combustion air inlet apertures 27 disposed therein. The front plate 26 is provided with a plurality of apertures 42 therein along the serrated edges for communication with the interior pockets 28, apertures 42 serving to permit the introduction of fuel gas into the pockets 28 of the chamber 25. In operation, fuel gas passes through apertures 42 from the fuel gas distribution ring 24 (in a manner described hereinafter) parallel to the longitudinal axis of the chamber 25 into individual pockets 28 of the chamber 25 and combustion air enters into pockets 28 transversely of the fuel gas through apertures 27 in flanks 31 to develop a flame in each pocket 28. There are generally a plurality of apertures 27 for each flank 31 for uniform distributing of combustion throughout each pocket 28. Front plate 26 is further provided with a plurality of auxiliary combustion air inlets 43 in the form of radially extending slots and a conduit 44 for receiving a pilot gas assembly (not shown), the pilot gas assembly being constructed by any conventional method. The auxiliary air inlets 43 are spaced interiorly of the apertures 42 providing additional combustion air parallel to the longitudinal axis of chamber 25, the additional combustion air being available as the flame being developed in the serrated pockets 28 moves tangentially toward the center of the chamber 25.

The fuel gas manifold distribution ring 24 includes fuel gas inlet conduit 23 and a plurality of fuel gas outlets 33, the fuel gas outlets 33 adapted to be aligned with the fuel gas inlets 42 of the front plate 26. Flange 32 including the fuel gas outlets 33 is adapted for communication with the outer periphery of the front closure plate 26 and is affixed to the plate 26 by any known method, such as bolting, welding, and the like.

In assembling the gas burner assembly 3 to the corrugated collar 13, a flange 18 is provided on the inlet to the corrugated collar 13 with apertures 38 therein. Front tube sheet 14 includes aperture 34 therein for alignment with apertures 38 of the collar 13 and apertures 37 in the burner mounting plate 30 of the gas assembly 3; apertures 37, 34, and 38 being in axial alignment to receive bolts 36 therethrough, bolts 36 being inserted through apertures 38, 34, and 37 with washers 39 and nuts 41 being inserted thereon for holding gas assembly 3 in fluid tight communication with the corrugated collar 13 with the front tube sheet 14 being disposed therebetween. Burner housing 21 encircling the gas burner assembly 3 is then affixed to the front tube sheet 14 by means not shown, such as, welding, bolting, and the like.

FIG. 4 illustrates the operation of the annular flexible head 19 surrounding burner tube 9 and fixed along its inner circumference thereto when the burner tube 9 expands and contracts during heat up and cool down of the furnace. Phantom lines illustrate that as the tube 9 expands and contracts the corrugated collar 13 remains intact, annular flexible head 19 changing its position with movement of the burner tube 9. The collar 13 in the example is of corrugated configuration to improve the strength at the juncture of the burner tube 9 and the flue gas collector 11. It is realized that the corrugated collar 13 may be designed with deeper corrugations to allow for expansion and contraction, thereby relieving stresses in the furnace, alleviating the need for the flexing head 19. However, if the inside diameter of the collar 13 is relatively small in relation to the outside diameter of the tube 9, a thin gauge stainless steel material may be used as the flex head 19 to give sufficient flexibility for relieving stresses caused by the expansion and contraction of the tube 9. For example, it has been found that for a collar 13 of 8 inches ID and a burner tube of 16 inches OD, a flex head 19 of 20 gauge 316 type stainless steel is sufficient for most applications.

FIG. 5 illustrates in detail the front end of the exemplified gas-fired furnace of the present invention showing the flow of air across the unit to best utilize the heat transfer surface of the heat exchanger. As pointed out previously, return tubes 8 are attached to the front tube sheet 14, lower return tubes 8*a* being disposed beneath the burner housing 21 and the upper return tubes 8*b* being disposed above the burner housing 21. The flue gas collector 11 is illustrated as a plenum of generally C-shaped cross-section whereby the flue gas return from the lower return tubes 8*a* being collected in the lower portion of the collector 11 passes upwardly along the side of the housing 21 before mixing with the flue gas from the upper return tubes 8*b*. It is noted that by allowing the hot flue gases to pass upwards along the side of the housing 21 it is advantageous for good heat transfer to introduce the air to be heated in the heat

exchanger at a point so that it will contact the upwardly extending heat surface **45**, surface **45** being disposed between the upwardly moving hot flue gases and the generally horizontally moving relatively cold air.

The front end of the gas fired furnace is further provided with a Z-shaped configured partition **46** as one side of the housing **21** separating the combustion air plenum **5** (FIG. **3**) from the flue gas collector **11**. The Z-shaped partition **46** is attached at one end to the wall **47** of housing **21** and the front tube sheet **14** at the other. The partition **46** is of Z-shaped configuration to allow movement of the tube sheet **14** upon expansion and contraction of return tubes **8** during heat up and cool down of the furnace.

In the operation of the gas-fired furnace **1** of the present invention, pilot fuel gas and pilot combustion air are brought into the gas burner assembly **3** through conductor **44** wherein the pilot gas mixture is ignited by means not shown, such as, for example, electrode means, these means of ignition of a pilot gas-air mixture being any known in the prior art. Combustion air is introduced into the assembly **3** from combustion air blower **40** (FIG. **5**) through inlet **22** in housing **21** and apertures **27** in the cylindrical shaped chamber **25**, the air being directed transversely to the flow of fuel in each pocket **28** of the chamber **25**, the fuel gas being brought in through the ring **24** by way of fuel gas conduit **23** and in turn passes through the ring **24** and out by way of the apertures **33** which are in alignment with the apertures **42** in the cylindrical shaped chamber **25**. The pilot gas-air mixture ignites the fuel gas-air mixture in each pocket **28**, the gas flame being developed in each pocket having tangential direction toward the center of the chamber **25**. Further, additional combustion air is fed interiorally of the chamber **25** through radially slotted apertures **43** for further mixing and ignition of the fuel gas. Ignition of the fuel gas-air mixture in pockets **28** firstly enables the firing of a mixture rich in fuel gas at these locations thereby providing smooth and safe light offs while the gas flame being developed has tangential direction toward the center of the chamber **25**. The gas flame developed in this manner has a broad base and a very slow forward velocity and when entering the burner tube **9** allows for almost maximum heat release early in the cylinder or heat exchanger. It is further realized that because of the initial firing of gas-air mixture rich in fuel gas the burner assembly **3** of the present invention does not require a gas-air premix before the gas is discharged into the individual gas burning pockets **28** so the burner can use raw gas for combustion purposes. The combustion gases upon leaving the burner assembly **3** flow through the corrugated collar **13** and into the burner tube **9**, rear tube sheet **12**, plenum **15**, and then to the flue gas collector collar **11** by way of the elongated tubes **8**. The combustion gases leave the furnace through flue gas outlet **10** in the flue gas collector collar **11**.

The air to be processed or heated by the heat exchanger enters the furnace **1** through inlet **4** being moved therethrough by means not shown, such as a blower, circulating through the housing **2** in heat transfer relationship with the heat exchanger **7**. The heated air then leaves the furnace through the housing air outlet **6**.

It is realized that various changes may be made to the specific embodiment shown as described without departing from the scope and spirit of the present invention.

What is claimed is:

1. A gas-fired furnace comprising:

a. a furnace housing having an air inlet and an air outlet;

b. said furnace housing including a heat exchanger and a gas-fired burner assembly, said burner assembly having a central opening therein and including a burner housing, fuel and air inlet means, and an outlet, said housing defining a plenum therein, a chamber of serrated cross-section configuration adapted to be received within said housing, said chamber having a plurality of generally V-shaped pockets therein, each pocket being defined by each serration, a gas ring manifold adapted to be received within said housing, said manifold having an inlet in communication with said fuel inlet means in said housing and a plurality of apertures spaced in axial alignment with said pockets of said serrated configured chamber whereby fuel enters said chamber through said pockets parallel to the axis of said chamber and, each V-shaped pocket includes two flanks, at least one of said flanks having at least one aperture therein whereby air entering said plenum through said air inlet in said housing passes through said aperture in said flank transversely of said fuel passing through said V-shaped pocket;

c. said heat exchanger including a burner tube or relatively large cross-sectional area and being adapted to receive heated gas from said burner assembly, said burner tube having an inlet and an outlet and being in axial alignment with and in communication with said opening of said burner assembly at said inlet and a rear tube sheet at said outlet, said rear tube sheet having an opening therein of generally the same cross-sectional area as the inside of said burner tube communicating with said burner tube outlet, at least one second opening in the rear tube sheet communicating with flue gas return means being in communication with a flue gas collector, said flue gas return means being adapted to receive heated gas from said burner tube at said rear tube sheet and transferring said flue gas to said flue gas collector;

d. said flue gas collector having a flue gas outlet;

e. a combustion air inlet, and a fuel gas inlet, said combustion air inlet and said fuel gas inlet being in communicative relationship with said gas burner assembly; and,

f. expansion means in communication with said burner tube whereby upon contraction and expansion of said burner tube said openings in said burner tube remain generally stationary.

2. The gas-fired furnace of claim **1** wherein said flue gas return means includes a plurality of elongated tubes fixedly attached to said rear tube sheet at one end and said flue gas collector at the other, said rear tube sheet having a plurality of apertures therein of generally the same cross-sectional area as said elongated tubes with each aperture therein communicating with each elongated tube, said elongated tubes being disposed generally parallel to one another and to the axis of said burner tube, said elongated tubes being disposed about said burner tube.

3. The gas-fired furnace of claim 1 wherein said expansion means in disposed between said burner tube and said gas-fired burner assembly.

4. The gas-fired furnace of claim 3 wherein said expansion means is a flexible flange.

5. The gas-fired furnace of claim 4 wherein the flange is disposed between said burner tube and a stationary collar, said collar being disposed between and in axial alignment with said flange and said burner assembly.

6. The gas-fired furnace of claim 1 wherein said expansion means is disposed between said burner tube and said rear tube sheet.

7. The gas-fired furnace of claim 1, said flue gas collector being a plenum of generally C-shaped cross-section having an upwardly extending heat transfer surface, said heat transfer surface being positioned transversely the flow of the air to be heated.

8. The gas-fired furnace of claim 1, said flue gas collector including a front tube sheet communicating with said return tubes, said burner housing being attached to said tube sheet.

9. The gas-fired furnace of claim 8, said burner housing having one side of Z-shaped configuration attached to said front tube sheet whereby upon contraction and expansion of said return tubes said Z-shaped side relieves the stress on said front tube sheet.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,822,691 Dated July 9, 1974

Inventor(s) Paul A. Mutchler

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 44, "such" should read -- each --; line 59, "air" should follow "combustion". Column 5, line 19, "conductor" should read -- conduit --; line 67, "as" should read -- and --. Column 6, line 31, "or" should read -- of --.

Signed and sealed this 29th day of October 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

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