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Nelson

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[54] **GAS OR OIL FIRED HEAT EXCHANGER FOR FORCED AIR HEATING UNIT**

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[52] **U.S. Cl.** .....**126/110 B,** 126/104 A

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

[58] **Field of Search**.....126/110 R, 110 B, 104 R, 104 A, 126/116 R, 116 B

[56] **References Cited**

UNITED STATES PATENTS

2,250,893	7/1941	McCall	126/110 B
2,800,126	7/1957	Costello et al.	126/110 B
3,028,854	4/1962	Reilly	126/104 A X
3,053,246	9/1962	Kosarin et al.	126/110 B

FOREIGN PATENTS OR APPLICATIONS

929,987	6/1963	Great Britain	126/110 B

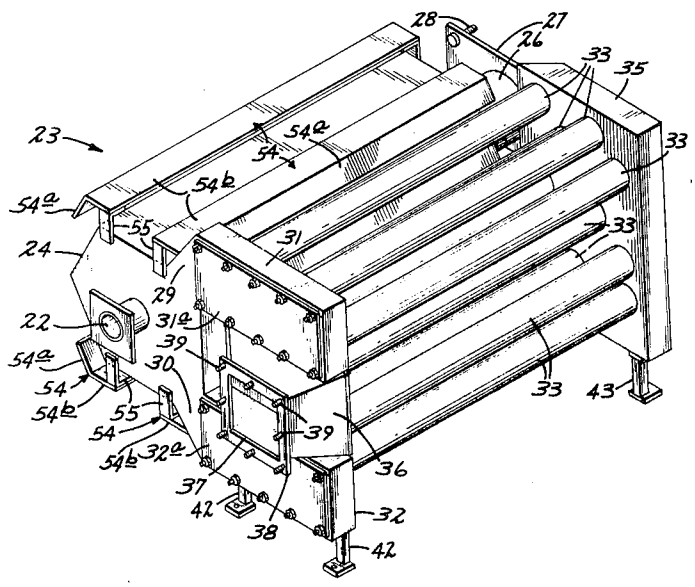
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[57] **ABSTRACT**

A heat exchanger is shown having an elongated combustion chamber with a burner opening in one end thereof and a pair of ducts leading from the other end to a pair of separate headers. Two groups of tubes extend from the two headers along the combustion chamber for connection with a common header, and a third group of tubes extend back from the common header to a combustion gas discharge header positioned between the first two headers, but separate therefrom.

7 Claims, 6 Drawing Figures



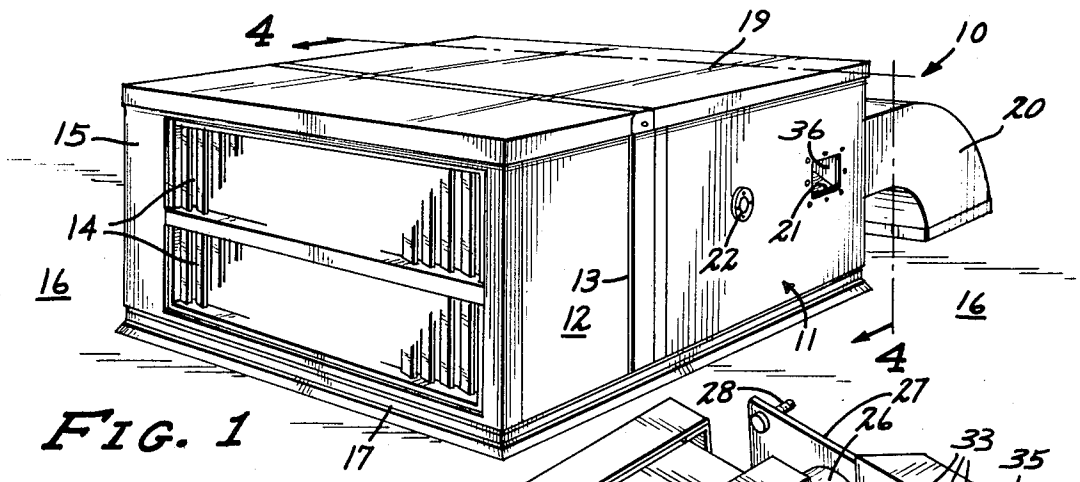


FIG. 1

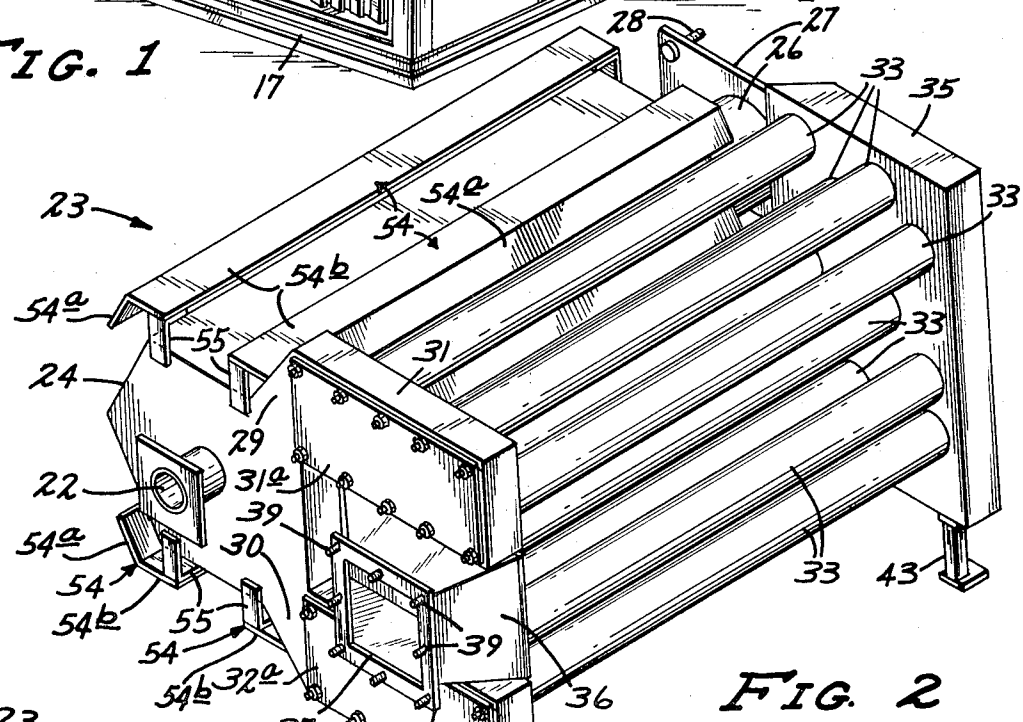


FIG. 2

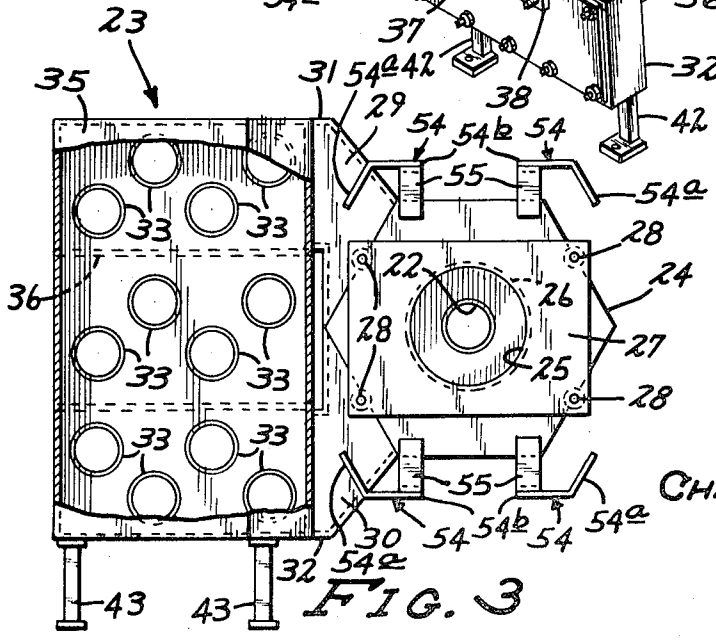


FIG. 3

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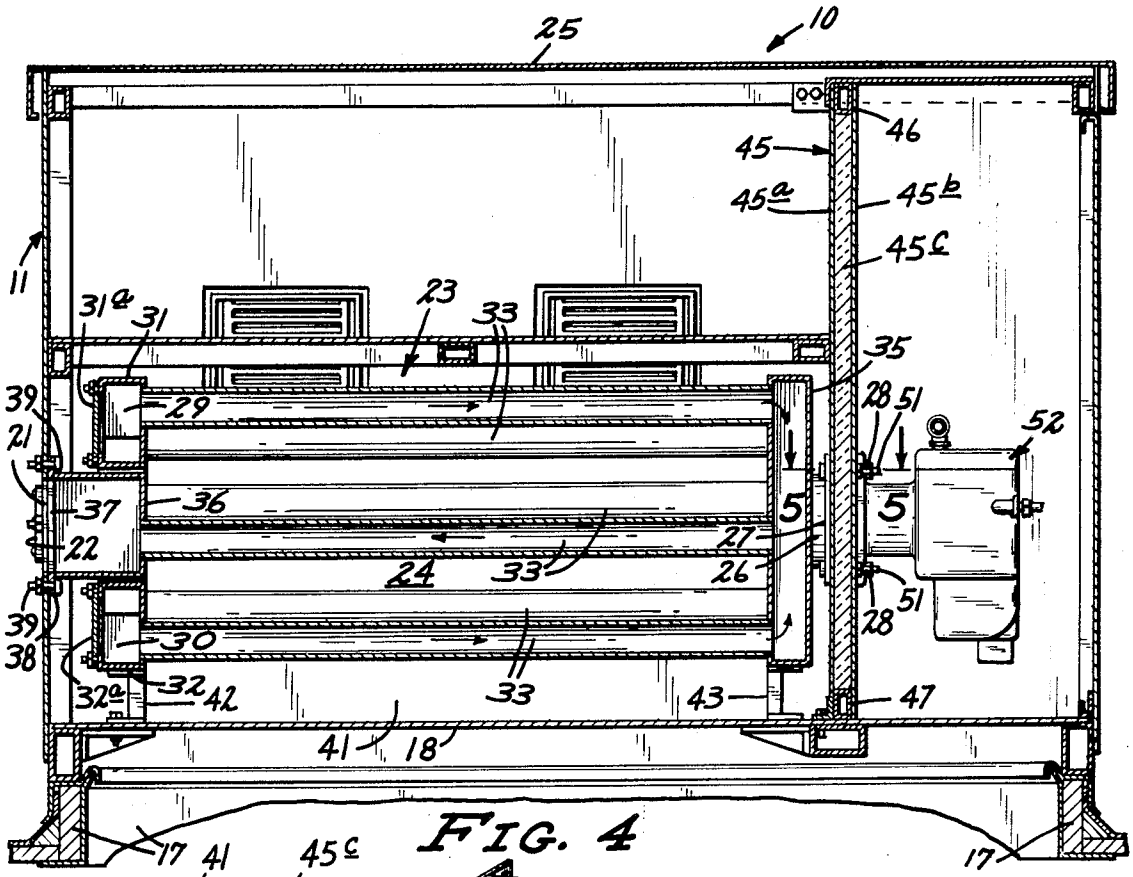


FIG. 4

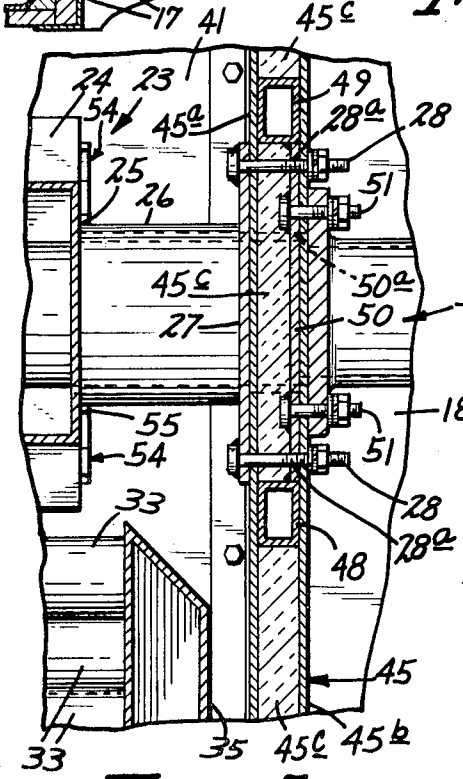


FIG. 5

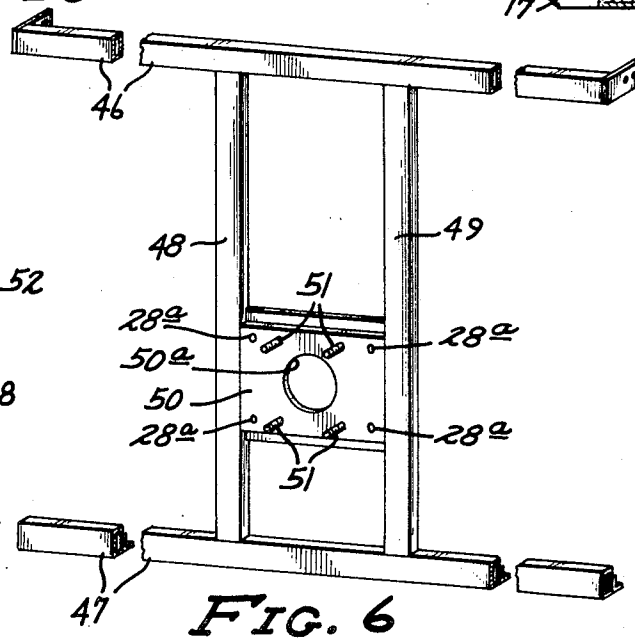


FIG. 6

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GAS OR OIL FIRED HEAT EXCHANGER FOR FORCED AIR HEATING UNIT

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to heat exchangers and more particularly relates to the unique design of a gas or oil fired heat exchanger for a forced air heating unit.

2. Description of the Prior Art

Applicant has the problem of designing a heat exchanger for a rooftop air conditioning unit in which heat is transferred from a gas or oil burner to a stream of air flowing through the unit. For a number of reasons, prior designs did not appear to be satisfactory. The unit had to be capable of utilizing either a gas burner or an oil burner or to be easily converted from one to the other. In many prior art heat exchangers, expansion and contraction caused metal fatigue and premature failure. This also produced noise caused by rapid heating and cooling of the unit. This noise is especially undesirable in a rooftop unit because of the difficulty in dampening the noise. Another problem with many prior art heat exchangers is that they contain various internal baffles, flue restrictors, etc. intended to create certain air flow through the unit and to increase efficiency. However, it has been my experience that these devices tend to wear out and eventually drastically reduce efficiency. Also, prior art heat exchangers of two pass design created excessive heat release at the end opposite the burner causing unequal and stratified heating in downstream ducts.

SUMMARY OF THE INVENTION

The heat exchanger of the present invention provides three passes of the heated combustion gases across the air flow path. Balanced heat released from end to end is thus achieved. Substantially all parts of the heat exchanger are in contact with both the internal flue gases and the external air so that virtually every piece of metal performs a heat exchanging function. The unit has no internal baffles, flue restrictors, swirlers, etc. and as a result, the life expectancy of the unit is much longer than usual. The heat exchanger disclosed herein will accept either a gas or oil burner and can be easily converted from one to the other. The burner assembly and the heat exchanger unit are separately mounted to a common mounting plate such that one can be removed from the unit without disturbing the other. Another important feature of the present invention is that the three groups of heating tubes are connected at one end to a common header but at the other end to separate headers so that different rates of tube expansion and contraction are accommodated. Noise has therefore been significantly reduced, as well as metal fatigue resulting from the expansion and contraction. As a result of these improvements, a more efficient heat exchanger has been provided, that is much quieter and that has a longer life expectancy.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view in perspective of a rooftop air conditioning unit of the type in which the present heat exchanger is mounted;

FIG. 2 is an enlarged view, in perspective, of the heat exchanging unit mounted in the air conditioning unit of FIG. 1;

FIG. 3 is a view of the end of the heat exchanger opposite that shown in FIG. 2, portions thereof being broken away and portions being shown in section;

FIG. 4 is an enlarged sectional view of the air conditioning unit taken along line 4—4 of FIG. 1;

FIG. 5 is an enlarged fragmentary sectional view taken along line 5—5 of FIG. 4; and

FIG. 6 is a view in perspective of the common mounting frame for the heat exchanger unit and burner assembly.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, wherein like reference numerals will be used throughout the several views to indicate like elements of the invention, there is disclosed an air conditioning unit **10** having a side wall **11** with an access door **12** mounted therein by means of a hinge **13**. Outside air enters the unit **10** through a set of dampers **14** in an end wall **15**. Air conditioning unit **10** is mounted on a building roof **16** by means of a curbing **17** connected between the unit and the roof. A return air duct, not shown, enters the unit through the roof. Conditioned air leaves the unit **10** through a duct **20** that also extends downwardly through the roof **16**. The opening **21** in side wall **11** is an outlet for combustion gases from the heat exchanger unit. This may have either a flue gas diffuser or flue pipe attached. The circular device **22** in side wall **11** is a viewing port for the gas or oil fired flame in the heat exchanger. Unit **10** is also provided with a sheet metal top cover **19** having a peripheral lip that overhangs the side and end walls.

FIG. **2** discloses a heat exchanger **23** which, as shown in FIG. **4**, is mounted in air conditioning unit **10**. Heat exchanger **23** includes an elongated combustion chamber **24** that is hexagonal in cross section. One end of chamber **24** is provided with a burner receiving opening **25** having connected to the periphery thereof a tubular extension member **26** having secured to its free end, perpendicular thereto, a rectangular metal mounting flange or plate **27**. Extending outwardly from the face of flange **27**, adjacent the corners thereof, are four threaded studs **28**.

The viewing port **22** is situated in the other end of chamber **24**. Being hexagonal, combustion chamber **25** has six outer and inner wall surfaces extending from end to end thereof. Extending laterally from two of the adjoining wall surfaces adjacent the end having the viewing port **22** are a pair of spaced ducts **29** and **30**. Ducts **29** and **30** provide an outlet for the combustion gases being generated in chamber **24**. Connected to the ends of ducts **29** and **30** are first and second spaced headers **31** and **32**. The headers **31** and **32** are each formed as a rectangular box having access plates **31***a* and **32***a* bolted to the exterior walls thereof. Connected to the opposite walls of headers **31** and **32** are groups of tubes **33** that extend away therefrom generally parallel to combustion chamber **24**. In the preferred embodiment, four tubes are connected to each of headers **31** and **32**. All of the tubes are of the same length and extend parallel to each other.

Connected to the other ends of the tubes **33** is a third common header **35** that is positioned adjacent the burner receiving end of the chamber **24**. As best shown in FIG. **3**, there are three groups of the tubes **33** and four tubes in each group. The number of tubes will obviously vary depending upon the capacity of the unit. However, in the preferred embodiment, there are four tubes extending between first header **31** and third header **35**, and another four tubes extending between second header **32** and third header **35**. A third group of four tubes **33** is connected to common header **35** between the first two groups, in parallel therewith. The other end of this third group of tubes **33** is connected to a fourth header **36** having a flue gas outlet **37** formed in the outer wall thereof. A mounting flange **38** is mounted around outlet **37** and is provided with a plurality of outwardly extending mounting studs **39**. Fourth header **36** is connected only to the side wall **11** by studs **39** and to the ends of the associated tubes **33**. It is not otherwise connected to headers **31** or **32**, or to combustion chamber **24**.

It can be seen that the gases being formed from combustion in chamber **24** leave the chamber through the two ducts **29** and **30** so that generally equal amounts of combustion gases are received by headers **31** and **32**. The combustion gases leave the headers **31** and **32** through the associated tubes **33** and are discharged thereby into common header **35**. The gases leave common header **35** through the four tubes **33** leading to fourth header **36** and are discharged from the unit through the outlet **37**.

As best shown in FIG. **4**, heat exchanger **23** is mounted in a plenum chamber **41** of the forced air heating unit or air conditioning unit **10** such that air is forced over substantially the entire surface thereof. The heat exchanger **23** is positioned as shown in FIG. **3** so that air first passes over the combustion chamber **24** and then over the headers and tubes **33**. A pair of legs **42** are connected between header **32** and a floor **18** of the air conditioning unit. Another pair of legs **43** are connected between common header **35** and the floor **18**. As best shown in FIG. **4**, the threaded studs on flange **37** extend through side wall **11** and suitable nuts are threadedly secured thereto, to provide support for fourth header **36**.

Air conditioning unit **10** is provided with a common support wall **45** positioned at one side of plenum chamber **41** opposite from side wall **11**, and parallel thereto. As shown in FIG. **6**, support wall **45** includes upper and lower horizontally extending frame members **46** and **47** and a pair of vertical, spaced frame members **48** and **49** connected therebetween. As shown in FIG. **4**, inner and outer walls **45*a*** and **45*b*** are connected to this frame and an insulation material **45*c*** is positioned in the voids between the two wall surfaces and frame members **46–47**. Welded between the two vertical frame members **48** and **49** is a metal mounting plate **50** having openings **28*a*** therein to receive the first group of studs **28** and a large, central burner receiving opening **50*a***. A group of threaded studs **51** extend outwardly therefrom, and are spaced closer to the burner receiving opening **50*a*** than the stud receiving openings **28*a***. As best shown in FIGS. **4** and **5**, a burner assembly **52** is bolted to the outwardly extending studs **51** so that the burner extends into extension member **26** and chamber **24**. The studs **28** on mounting flange **27** extend through the openings **28*a*** of mounting plate **50** and are secured thereto as shown in FIG. **5**. The burner receiving end of combustion chamber **24** is thus supported by common support wall **45**. Because the mounting studs **28** and **51** are offset from each other, the heat exchanger unit **23** and the burner assembly **52** are separately demountable from support wall **45**.

As best shown in FIG. **3**, combustion chamber **24** is mounted so that its upper and lower wall surfaces are horizontal. Four elongated air deflecting vanes **54** are secured to chamber **24** by means of mounting brackets **55** welded thereto. The vanes **54** are mounted along and spaced from the entire length of the heat exchanger **24** at the opposite edges of the upper and lower horizontal wall surfaces thereof. Each of the vanes **54** comprise two flat portions **54*a*** and **54*b*** that form an obtuse angle with respect to each other, the angle corresponding generally to the angle between adjacent wall surfaces of the combustion chamber **24**. Thus, one flat portion **54*b*** is generally parallel to the horizontal wall surface of chamber **24**, and the other flat portion **54*a*** is generally parallel with the adjoining wall surface. The vanes **54** are designed to force a portion of the air entering the plenum chamber **41** to pass directly over the entire outer surface of combustion chamber **24** so that it is exposed to the entire heating surface thereof.

After the air passes over combustion chamber **24**, as guided by the vanes **54**, it passes among the tubes **33** and around the headers **31**, **32**, **35** and **36**. All of these units transfer heat from the interior combustion gases to the air passing thereover. As previously mentioned, there are no interior baffles etc. within the combustion chamber, headers or tubes. A suitable back pressure is built up within the heat exchanger by virtue of the fact that only four tubes **33** are connected to the discharger header **36**. This back pressure ensures that the gases are not discharged until they have surrendered a major portion of their heat.

Because various portions of the heat exchanger unit **23** are heated to different temperatures at different times, they expand and contract at different rates. The unit is designed to accommodate these expansions and contractions without undue stresses or noise occurring. For one thing, only one end of the combustion chamber **24** is connected to the header and tube assembly. Further, only one end of the combustion chamber **24** is directly connected to the walls of the air conditioning unit. Thus, combustion chamber **24** can freely expand with respect to the walls of the air conditioning unit and also with respect to the tube and header assembly. The headers at the discharge end of the unit are an especially critical area for expansion and contraction because the two outer groups of tubes operate at a different temperature from the inner group of tubes. To accommodate the different rates of expansion and contraction of these groups of tubes, discharge header **36** is not connected to the other headers **31** and **32**. This separate mounting of the discharge header **36** eliminates a major problem area with respect to both stresses and noise. It is noted that discharge header **36** is connected to side wall **11** but that header **35** is not connected to support wall **45**. Although common header **35** is supported by legs **43** on floor **18**, the legs

are not connected to the floor, thereby permitting lateral movements of header **35** relative to floor **18**, resulting from expansion and contraction of the tubes.

What is claimed is:

1. A heat exchanger for a forced air heating unit comprising:

a. an elongated combustion chamber having a burner receiving opening in one end thereof and a pair of spaced ducts leading from the other end thereof;

b. first and second spaced headers connected to said ducts;

c. a third header positioned adjacent said one end of said combustion chamber;

d. a fourth header having a flue gas outlet therein positioned between said first and second headers;

e. a plurality of tubes connected between said third header and said other headers to provide a combustion gas flow path from said chamber through said ducts into said first and second headers, then through certain of said tubes to said third header, and then through the remaining tubes to said fourth header for discharge therefrom; and

f. said heat exchanger being mounted in a plenum chamber of a forced air heating unit for passage of air thereover, the mounting means including a first plurality of mounting legs connected between a support surface of said unit and said second header, and a second plurality of mounting legs supporting said third header on said support surface so as to permit relative lateral movement therebetween, and further including said fourth header and said one end of said combustion chamber being connected to said unit.

2. A heat exchanger for a forced air heating unit comprising:

a. an elongated combustion chamber having a burner receiving opening in one end thereof and a pair of spaced ducts leading from the other end thereof;

b. first and second spaced headers connected to said ducts;

c. a third header positioned adjacent said one end of said combustion chamber;

d. a fourth header having a flue gas outlet therein positioned between said first and second headers;

e. a plurality of tubes connected between said third header and said other headers to provide a combustion gas flow path from said chamber through said ducts into said first and second headers, then through certain of said tubes to said third header, and then through the remaining tubes to said fourth header for discharge therefrom;

f. said heat exchanger being mounted in a plenum chamber of a forced air heating unit for passage of air thereover, with the air first passing over said combustion chamber and then over said headers and tubes; and

g. elongated air deflecting vanes being mounted to the outer surface of said combustion chamber to direct the flow of air thereover.

3. The apparatus of claim **2** wherein said combustion chamber is hexagonal in cross section and is mounted to have horizontal, parallel upper and lower wall surfaces.

4. The apparatus of claim **3** wherein said vanes are mounted along and spaced from the length of said heat exchanger at edges of said upper and lower surfaces, each of said vanes comprising two flat portions forming an obtuse angle with respect to each other, corresponding generally to the angle between adjacent wall surfaces of said combustion chamber.

5. A heat exchanger for a forced air heating unit comprising:

a. an elongated combustion chamber having a burner receiving opening in one end thereof and a pair of spaced ducts leading from the other end thereof;

b. first and second spaced headers connected to said ducts;

c. a third header positioned adjacent said one end of said combustion chamber;

d. a fourth header having a flue gas outlet therein positioned between said first and second headers;

e. a plurality of tubes connected between said third header and said other headers to provide a combustion gas flow path from said chamber through said ducts into said first and second headers, then through certain of said tubes to said third header, and then through the remaining tubes to said fourth header for discharge therefrom;

f. said heat exchanger being mounted in a plenum chamber of a forced air heating unit for passage of air thereover, with the air first passing over said combustion chamber and then over said headers and tubes;

g. a metal mounting flange connected to the periphery of said burner receiving opening having a first group of threaded studs extending outwardly therefrom, a mounting plate supported by said unit having openings therein to receive said first group of studs, a central burner receiving opening and a second group of threaded studs extending outwardly therefrom spaced closer to said burner receiving opening than said first group, and a burner assembly mounted on said second group of studs opposite said mounting plate from said heat exchanger, said heat exchanger and said burner assembly thereby being separately demountable from said mounting plate.

6. A heat exchanger for a forced air heating unit comprising:

a. an elongated combustion chamber having a burner receiving opening in one end thereof and duct means leading from the other end thereof;

b. first and second spaced headers connected to said duct means;

c. a common header positioned adjacent said one end of said combustion chamber;

d. a discharge header having a flue gas outlet therein positioned between said first and second headers;

e. a plurality of tubes connected between said common header and said other headers to provide a combustion gas flow path; and

f. said common header and one of said first and second headers being supported by a support surface of said unit, said burner receiving opening end of said chamber being connected to a support wall of said unit, and said discharge header being secured to a side wall of said unit, to provide the entire support of said heat exchanger in a plenum chamber of said unit.

7. A heat exchanger for a forced air heating unit comprising:

a. an elongated combustion chamber having a burner receiving opening in one end thereof and a pair of spaced ducts leading from the other end thereof; and

b. a header and tube assembly comprising:

i. first and second spaced headers connected to said ducts, providing the sole connection between said combustion chamber and said header and tube assembly to permit different rates of expansion and contraction thereof;

ii. a third header positioned adjacent said one end of said combustion chamber;

iii. a fourth header having a flue gas outlet therein positioned between said first and second headers; and

iv. a plurality of tubes connected between said third header and said other headers to provide a combustion gas flow path from said chamber through said ducts into said first and second headers, then through certain of said tubes to said third header and then through the remaining tubes to said fourth header for discharge therefrom, said fourth header being connected to said header and tube assembly solely by said remaining tubes to thereby permit a different rate of expansion and contraction thereof with respect to said certain of said tubes and said first and second headers.

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