

[54] MULTI-PASS HEATING APPARATUS WITH
EXPANDABLE AIR COOLED JACKET[75] Inventors: John F. Finger; Merle E. Pochop,
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[58] Field of Search... 122/248, 249, 250 R, DIG. 1,
122/494

[56]

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Primary Examiner—Kenneth W. Sprague

[57]

ABSTRACT

A multi-pass heating apparatus having an air-cooled, expandable jacket through which a portion of the air from the burner blower is circulated. The air flowing through the jacket passageway cools the jacket and is thereafter ported into the discharge end of the burner combustion chamber, increasing the efficiency of the apparatus. The heating coils form three concentric spirals or helices. A baffle mounted at the discharge end of the burner deflects the hot gases after a first pass through the heating coils for a second pass. A third pass is made after another deflection. At least the outermost heating coil, adjacent the jacket, is tightly wound to prevent the burner flame from penetrating to the jacket.

5 Claims, 7 Drawing Figures

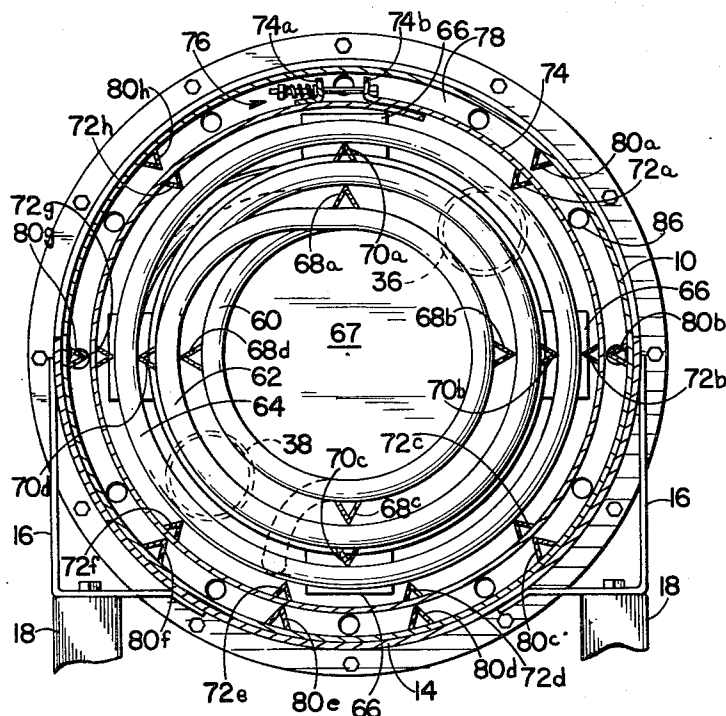


FIG. 1

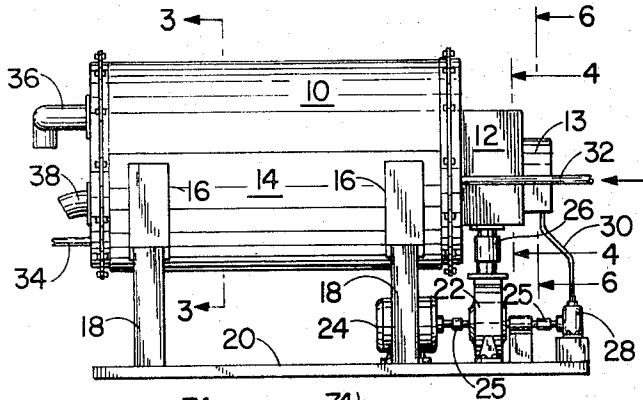


FIG. 2

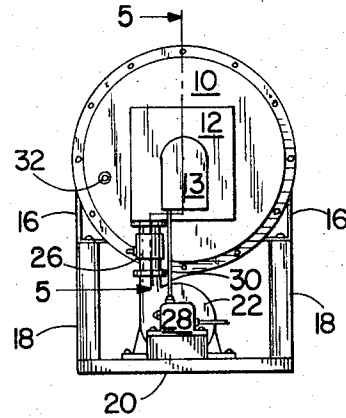


FIG. 3

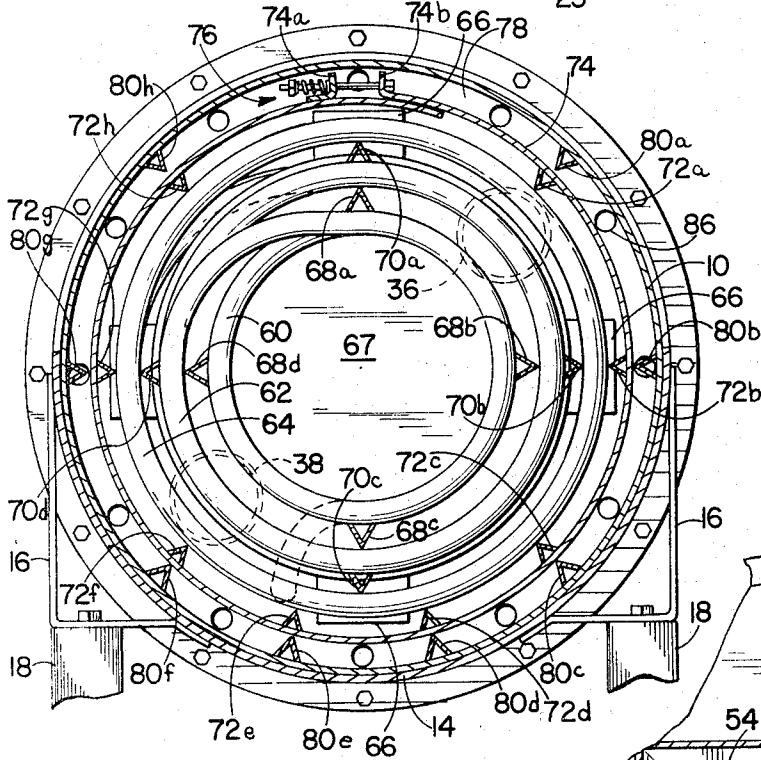
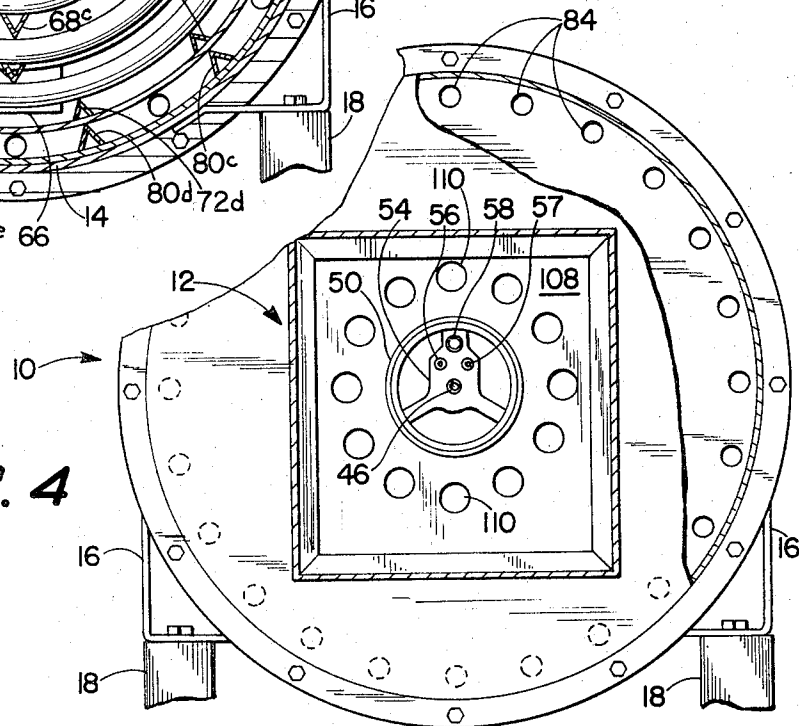
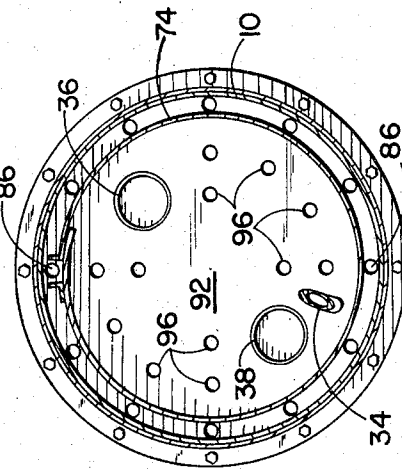
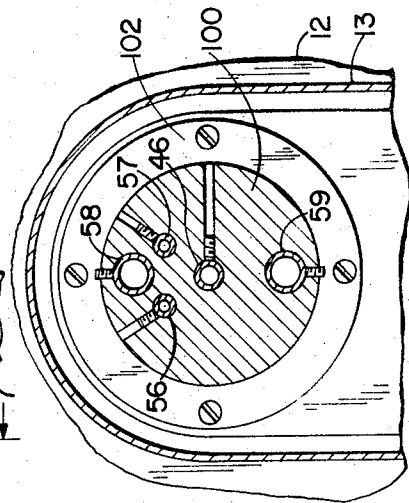
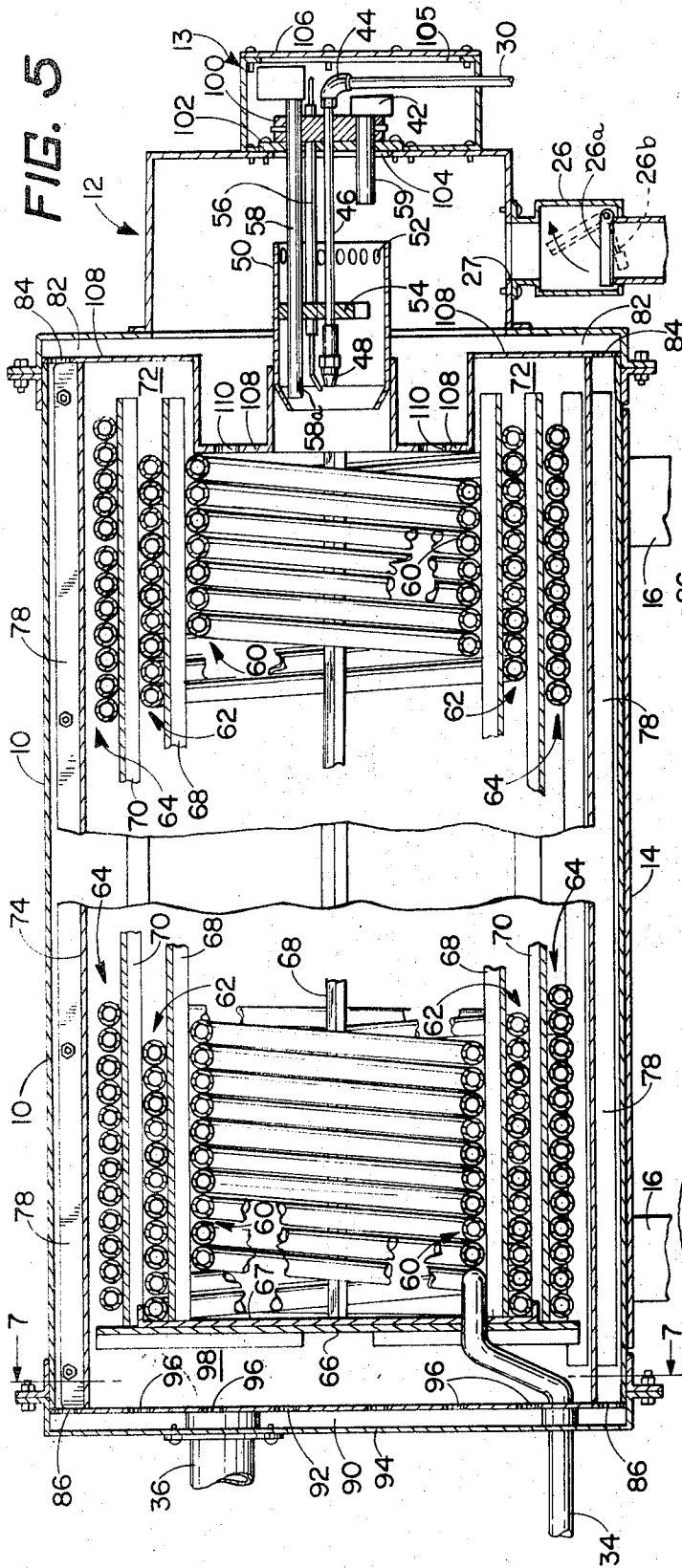


FIG. 4





MULTI-PASS HEATING APPARATUS WITH EXPANDABLE AIR COOLED JACKET

BACKGROUND OF THE INVENTION

The invention concerns heating apparatus of the multi-pass type, including an air-cooled, expandable jacket. The coolant air is ported into the discharge end of the combustion chamber where it mixes with the exhaust gases and affects the combustion.

In the prior art, as exemplified by U.S. Pat. No. 3,529,579 (Wanson), the jackets are not expandable and the coolant air is not ported into the discharge end of the combustion chamber to affect the combustion therein. Furthermore Wanson does not use a separate baffle mounted within the combustion chamber, but uses the end wall of his chamber for deflection of the hot gases.

SUMMARY OF THE INVENTION

The invention is a heating apparatus of the multi-pass type having a jacket which defines a passageway for the flow of coolant air. A portion of the air developed by the burner blower is delivered to the passageway, flows through it, and cools the jacket of the burner. The passageway communicates with ports located in the discharge end of the burner combustion chamber and the coolant air flows out the ports into the discharge end of the chamber.

The heating apparatus includes a set of concentric coiled tubes for heating fluid. One of the set of coiled tubes is mounted adjacent the interior wall of the jacket and is tightly wound so that adjacent coils substantially touch and form a barrier between the burner flame and the interior wall of the jacket. This prevents excessive heating of the jacket and thereby increases the reliability and the efficiency of the heating apparatus. The tubing forms three concentric spirals or helices, an inner, outer, and middle helix. A baffle is connected to the middle helix at the discharge end of the burner combustion chamber. The hot gases produced by the burner pass through the center of the helices, past the inner helix. The baffle deflects the hot gases which then make a second pass between the inner and middle helices. The hot gases are then deflected from an interior surface of the combustion chamber and then pass between the middle and outer helices. The gases are then discharged at the discharge end of the combustion chamber and merge there with the coolant air coming from the passageway in the jacket and discharging through ports in the discharge end of the combustion chamber. For some reason not clearly known, the discharge of coolant air into the exhaust gases in the discharge end of the burner seems to promote more effective combustion, producing a flame which is bright red and intensely hot in the center and yellow and not so intense at the periphery. Therefore the coils are not subjected to intense heat.

The jacket of the heating apparatus is expandable and permits the expansion of the outer helix, whereby a tight alignment between the outer helix and the jacket is maintained. The jacket comprises a cylindrical fire-wall which includes a longitudinally extending expansion joint. The fire-wall is mounted within a cylindrical housing and spaced therefrom with a plurality of longitudinal support spacers attached around the inner periphery of the housing. The space formed between the

fire-wall and the housing forms a passageway through which air from the burner blower passes and cools the jacket.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an external front view of the heating apparatus;

FIG. 2 is an external end view of the heating apparatus;

FIG. 3 is a transverse sectional view along a cutting plane 3—3 in FIG. 1, showing the interior of the heat exchanger portion of the heating apparatus;

FIG. 4 is a transverse sectional view along a cutting plane 4—4 in FIG. 1, showing the interior of the burner portion of the heating apparatus;

FIG. 5 is a longitudinal sectional view along an offset cutting plane 5—5 in FIG. 2, showing the interior of the heat exchanger and the burner;

FIG. 6 is a transverse sectional view along a cutting plane 6—6 in FIG. 1, showing the interior of the burner portion of the heating apparatus; and

FIG. 7 is a transverse sectional view along a cutting plane 7—7 in FIG. 5, showing the discharge end of the heat exchanger portion of the heating apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The heating apparatus of FIG. 1 includes a circular heat exchanger housing 10 and a smaller, rectangular burner housing 12 located on the right side of housing 10. Housing 10 rests in a semi-circular saddle 14 which has support brackets 16 welded thereto. The entire apparatus rests on vertical legs 18, the tops of which are bolted to brackets 16 and the bottoms of which are mounted on a base member or platform 20.

Air for supporting combustion in the heating apparatus is provided by a blower 22 which is driven by a motor 24, blower 22 and motor 24 both being mounted on platform 20. Air from blower 22 is delivered to the interior of burner housing 12 through an air check valve 26 which functions as an anti-blow-back device, preventing the flames in the apparatus from penetrating down into blower 26.

Fuel is transferred to the heating apparatus by means of a fuel pump 28 which is also driven by motor 24 by means of a shaft 25 which is common to both blower 22 and pump 28. Fuel from pump 28 is delivered to the interior of burner housing 12 by a fuel line 30.

A fluid to be heated, such as water, is delivered to the interior of heat exchanger housing 10 by means of an inlet pipe 32 entering the right end of housing 10. The hot water produced by the apparatus exits from the heat exchanger housing 10 through outlet pipe 34 at the left end of housing 10. Exhaust gases from the discharge end of the combustion chamber defined by housing 10 are conveyed or vented to the exterior by ducts 36 and 38 located in the left end of housing 10.

The heating apparatus is shown in more detail in the longitudinal sectional view of FIG. 5 which is a view taken from the offset cutting plane 5—5 in FIG. 2. Air from blower 22 passes through valve 26 and enters housing 12 through an opening 27 in the bottom thereof. Valve 26 includes a flapper 26a pivoted at the right side, allowing air from blower 22 to flow upward into housing 12, but preventing the flames and hot air in the apparatus from blowing-back into blower 22. For

this reason valve 26 is called an anti-blow-back device. A counterweight 26b is mounted on flapper 26 and controls its operation. Counterweight 26b may be adjustable.

The fuel coming in through line 30 passes through an elbow 44 and flows to the left through a horizontal pipe 46 to a nozzle 48 which is contained in an internal housing 50 which protrudes into the right end of the combustion chamber in the center of heat exchanger housing 10. Air from blower 22 arriving in housing 12 also enters housing 50 through a circular array of input ports 52 located around the periphery of housing 50 at the right end thereof.

Pipe 46 is supported in housing 50 by means of a vertical support member 54 fastened to the top of housing 50. Member 54 also provides support for an electric ignitor having a pair of probes 56 and 57 and a pair of flame detectors 58 and 59 (probe 27 and detector 59 are not shown in FIG. 5, but are shown in FIG. 6). Ignitor probes 56 and 57 are horizontally oriented and located adjacent and above pipe 46. Detectors 58 and 59 are also horizontally oriented with detector 58 located adjacent and above ignitor probes 56 and 57 and with detector 59 located adjacent and below pipe 46 and nozzle 48. Ignitor probes 56 and 57 terminate adjacent nozzle 48 and provide a spark to ignite the fuel issuing from nozzle 48. Detector 58 terminates in an area adjacent the flame associated with nozzle 48 and generates signals for controlling the heating apparatus depending on the presence or absence of a flame. Detector 58 includes a mirror 58a located on the inner end of detector 58.

Water from inlet pipe 32 is fed through three concentric sets of coils 60, 62 and 64 mounted within heat exchanger housing 10. Water from pipe 32 flows from right to left through the outer set of coils 64, then from left to right through the middle set of coils 62, then from right to left through the inner set of coils 60, and finally the water, which has become hot in its passage through the coils, exits from housing 10 through outlet pipe 34 at the left end of housing 10.

The means for mounting the sets of coils 60, 62 and 64 within housing 10 includes a vertical metal baffle comprising a cross-shaped member 66 and a stainless steel cup 67 at the left end of housing 10, and a plurality of longitudinal support members, two sets of which are designated by the numerals 68 and 70 in FIG. 5. The support members support the coils along the length thereof. The right ends of support member sets 68 and 70 extend into an annular recess 72 in the right end of housing 10. The edges of cross-shaped member 66, referenced as 66a in FIG. 5, are bent over to stiffen member 66.

The nature of support member sets 68 and 70 is clearly seen in FIG. 3 which is a transverse sectional view taken from the cutting plane 3—3 in FIG. 1. Support member set 68 includes four V-shaped members 68a, b, c, and d spaced about 90° apart around the outside of the periphery of inner coil set 60. Similarly support member set 70 includes four V-shaped members 70a, b, c, and d spaced about 90° apart around the outside of the periphery of intermediate coil set 62 and aligned with support member set 68. Member sets 68 and 70 support and space coil sets 60 and 62. Another support member set 72 comprising V-shaped members 72a, b, c, d, e, f, g, and h are spaced around the outside periphery of outer coil set 64. Note that whereas the

V-shaped members of sets 68 and 70 point outward, the V-shaped members of set 72 are inverted and point inward. The bases of the members of set 72 are in contact with the inner periphery of an expandable cylindrical jacket 74 (sometimes called the fire-wall) which forms the inner wall of housing 10. A set of spring-loaded expansion bolt assemblies 76 are mounted between flanges 74a and 74b defining a longitudinal expansion joint on jacket 74, which allows expansion and contraction of coil sets 60, 62 and 64.

An annular space or passageway 78 is formed between jacket 74 and housing 10. Some of the blower air entering housing 12 is diverted to flow through passage 78 to provide cooling for the heating apparatus. This feature will be described more fully below.

Another set of V-shaped support members 80, inverted like set 72, space jacket 74 from housing 10 and are referenced as 80a, b, c, d, e, f, g, and h. The bases of support member set 80 are in contact with the inner periphery of housing 10.

The air diverted for cooling flows as follows: from blower 22, through valve 26, through opening 27 in the bottom of housing 12, through housing 12, through an annular space 82 at the right end of housing 10, through a set of circularly arranged inlet ports 84 communicating between space 82 and passageway 78, through passageway 78 to the left, through a set of circularly arranged outlet ports 86 in an inner end plate 88 of housing 10 at the left end thereof, into a dish-shaped space 90 formed between end wall members 92 and 94 on housing 10, through a set of ports 96 in member 92, into a space 98 between end wall member 92 and baffle member 66, where the coolant air meets and mixes with the exhaust gases generated by the apparatus, the mixture of coolant air and exhaust gases being vented to the exterior through duct 36 and duct 38 (shown in FIG. 1). Ducts 36 and 38 may incorporate devices such as dampers, etc., for controlling the apparatus by regulating the venting of exhaust gases. Air flowing through passageway 78 keeps housing 10 cool, thereby increasing the efficiency of the apparatus by decreasing the radiation of heat from housing 10.

The transverse sectional view of FIG. 6 is a view taken from the cutting plane 6—6 in FIG. 2 which passes through a small housing 13 fastened to the right end of housing 12. Housing 13 covers a block 100 which is welded to a base 102 which is bolted over an opening 104 in the right end of housing 12. Block 100 serves to precisely position the right ends of the flame detectors 58 and 59, ignitor probes 56 and 57, and fuel pipe 46, which are held in place in block 100 by set screws (not numbered). Access to the interior of housing 13 is through a cover 106 which is bolted over an opening 108 in the right end of housing 13.

FIG. 4 is a transverse sectional view taken along the plane 4—4 cutting housing 12 in FIG. 1. Most of the air from blower 22 flowing through valve 26 and entering housing 12 through opening 27 flows to the left and enters the combustion chamber in the interior of housing 10 through twelve ports arranged in a circle in right end wall 108 of housing 10. Only two of the ports are referenced with the numeral 110 in FIG. 4. Note that wall 108 which is offset also provides support for the left end of housing 50.

The hot gases produced by the combustion of fuel issuing from nozzle 48 follow a course through the apparatus as follows: flow to the left through the middle of

inner coil set 60, are reflected at baffle 66, flow back to the right in the annular space between inner coil set 60 and intermediate coil set 62, are reflected at the interior surface of wall 108 adjacent space 72, flow back to the left in the annular space between intermediate 5 coil set 62 and outer coil set 64, enter space 98, are mixed with the coolant air, and is vented out ducts 36 and 38. The transfer efficiency of the apparatus is increased because the hot gases make a triple pass through the heating coils.

Although all the sets of coils are shown as being tightly wound, at least the outer set of coils 64 should be tightly wound to prevent the burner flame from penetrating through the coils to the expandable jacket 74.

The distribution of air directly through the burner package, i.e., through ports 52; around the periphery of the combustion chamber, i.e., through ports 110, and around the outer circumference of the heat exchanger housing, i.e., through ports 84, etc., provides a swirling 20 motion to the air, generating a bright red intensely hot flame in the center of the combustion chamber and a relatively cool yellow flame around the periphery of the chamber to prevent excessive temperatures in the heating coils.

The overall result is an almost ideal transfer of heat with high efficiency and relatively long life of the mechanical elements of the apparatus. By reintroducing the coolant air back into the hot gases at the discharge end of the combustion chamber, the combustion is made more complete, the jacket around the heating coils stays cooler, and the exhaust gases are burned more completely. In addition the presence of excess air tends to control the flame within the combustion chamber, reducing the temperature of discharging gases and improving the efficiency.

What is claimed is:

1. A jacket for heating apparatus, adapted to be air cooled, comprising:

- a. a cylindrical fire-wall, including a longitudinally extending expansion joint;
- b. a cylindrical housing;
- c. means for mounting the cylindrical fire-wall within the cylindrical housing, including means for spacing the fire-wall from the housing, the cylindrical housing and the cylindrical fire-wall defining a space therebetween for the passage of air for cooling the jacket.

2. The jacket as recited in claim 1 wherein the spacing means comprises a plurality of longitudinal spacers attached around the inner periphery of the housing.

3. Heating apparatus comprising:

- a. a jacket, the interior surface thereof defining an enclosed combustion chamber having an inlet end and a discharge end;

b. burner means in communication with said combustion chamber for providing heat to said combustion chamber;

c. a housing surrounding said jacket, said housing spaced apart from said jacket to form a cooling passageway there between;

d. blower means in communication with said combustion chamber and said cooling passageway for supplying combustion air to said combustion chamber and cooling air to said cooling passageway;

e. said jacket containing ports communicating between said cooling passageway and the discharge end of said combustion chamber to vent the cooling air from said cooling passageway back into said combustion chamber;

f. vent means for venting combustion products from said combustion chamber, said vent means including a passageway through said housing and jacket from said combustion chamber;

g. tubing mounted within said combustion chamber for carrying a fluid to be heated, said tubing forming at least an inner first and a second concentric helix, said helices spaced apart from each other and from said jacket to form at least two generally concentric heating passageways between the inlet and discharge ends of said combustion chamber for carrying heated air therethrough;

and

h. a baffle positioned at the discharge end of said combustion chamber, said baffle spaced apart from said jacket and the end of said first coil and abutting the end of said second coil to thereby deflect heated air through said heating passageways.

4. The heating apparatus of claim 3 wherein said jacket is expandable for permitting expansion of said jacket in response to expansion of said helices when heated.

5. In heating apparatus having a combustion chamber, a burner within the combustion chamber, the chamber having a discharge end opposite the burner, and a blower for supplying air to the combustion chamber, the combination therewith of a jacket apparatus substantially defining the combustion chamber and adapted to be air cooled, comprising;

- a. a cylindrical fire-wall, including a longitudinally extending expansion joint;
- b. a cylindrical housing;
- c. means for mounting the cylindrical fire-wall within the cylindrical housing, including means for spacing the fire-wall from the housing, the cylindrical housing and the cylindrical fire-wall defining a space therebetween for the passage of air for cooling the jacket.

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