July 22, 1952 T. H. SHERMAN 2,604,084

FLUID HEATER

Filed Nov. 10, 1947 2 SHEETS—SHEET 1

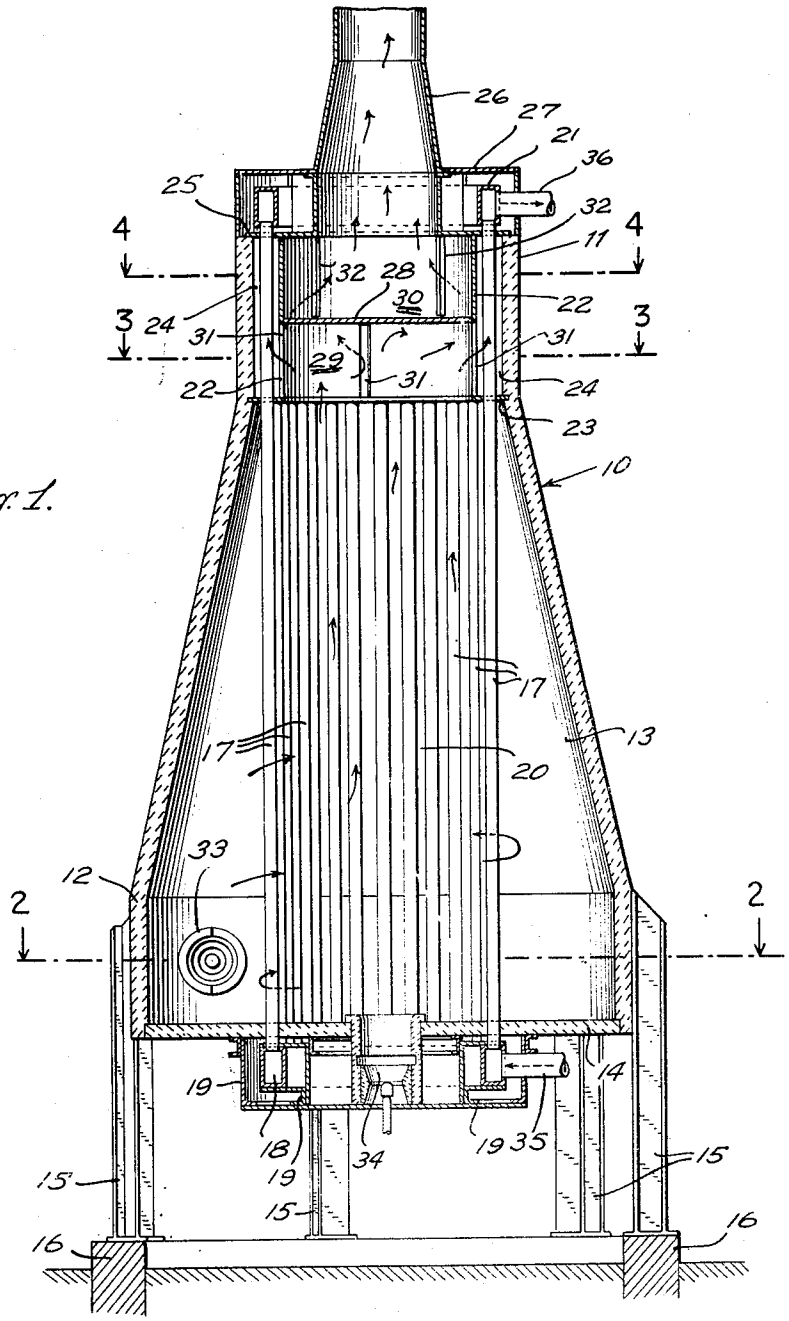


Fig. 1.

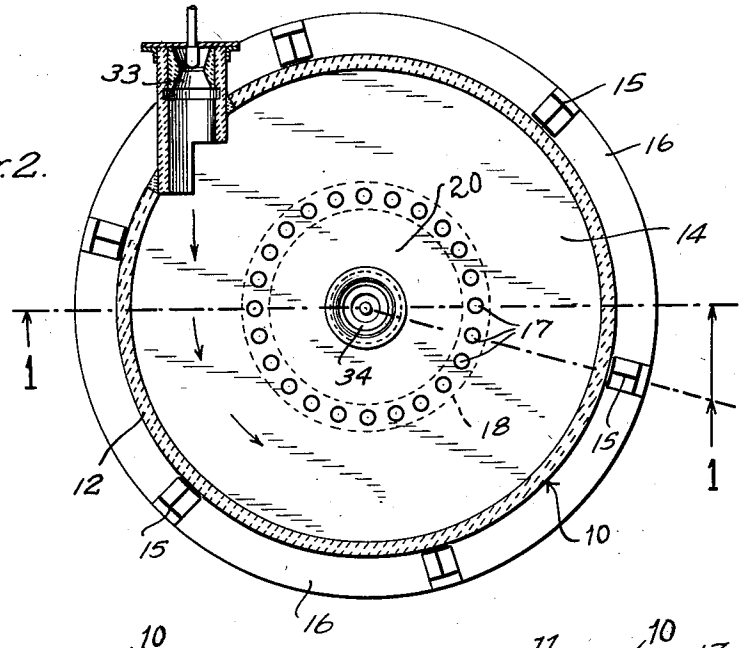
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Fig. 2.



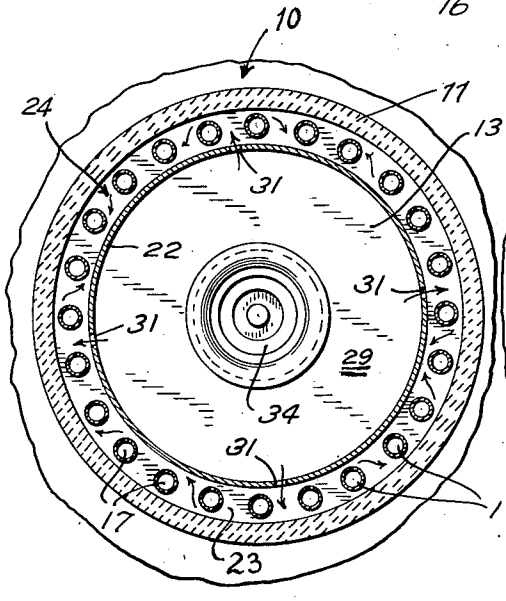


Fig. 3.

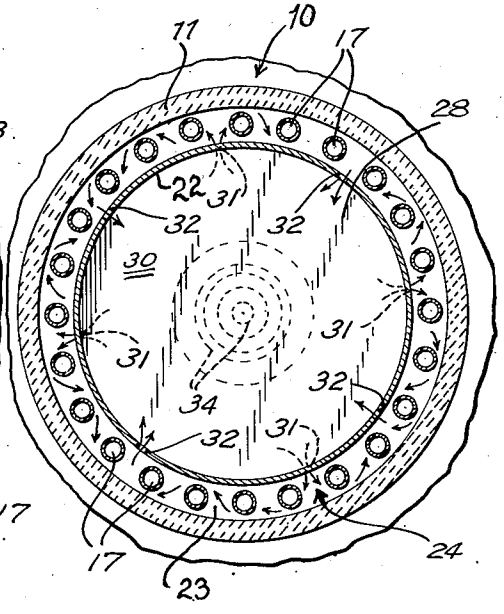


Fig. 4.

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FLUID HEATER

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10 Claims. (Cl. 122—338)

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This invention relates to heaters and more particularly to fluid heaters in which products of combustion flow in indirect heat exchange relationship with fluid to be heated.

The present invention provides a heater for the conversion of fluids, particularly the conversion of hydrocarbon oil, in which the fluid is passed through a plurality of tubular members and the tubular members are uniformly heated both circumferentially and longitudinally thereof.

This invention further provides a fluid heater which is efficient and of relatively simple construction.

This invention will be understood from the following description when considered in connection with the accompanying drawings forming a part thereof and in which:

Fig. 1 is a vertical sectional view taken on the line 1—1 of Fig. 2;

Fig. 2 is a sectional plan view taken on the line 2—2 of Fig. 1;

Fig. 3 is a view similar to Fig. 2 but taken on the line 3—3 of Fig. 1, and

Fig. 4 is a sectional plan view taken on the line 4—4 of Fig. 1.

Like characters of reference refer to the same or to similar parts throughout the several views.

Referring to the drawings, the heater of the present invention comprises a generally frustoconically shaped refractory shell or outer wall 10 having a cylindrical portion 11 at the top thereof and another cylindrical portion 12 at the base. The shell forms a combustion chamber 13 which is closed at the base by an annular refractory bottom 14. The shell is supported by girders 15 which are secured adjacent one end thereof to portion 12 of the shell. The opposite end of said girders rest on foundation 16.

An annular row of vertically disposed, spaced tubular members 17, the outside diameter of which row is slightly less than the inside diameter of upper portion 11 extends longitudinally of the chamber 13. Annular row of tubular members 17 forms the periphery of a passage 20 which extends longitudinally of the chamber 13. The lower ends of the tubular members pass through the bottom 14 and are in communication with an annular lower header 18 to which the tubes are secured. Header 18 is supported by supporting members 19 cooperating with bottom plate 14. The upper ends of the tubular members 17 extend beyond the upper end of the shell 11 and communicate with an annular upper header 21 to which the tubes are connected.

A cylindrical baffle plate or inner wall 22, having an outside diameter slightly less than the diameter of the passage 20, is positioned within the passage 20 at the top thereof, said baffle plate extending substantially vertically in the passage

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and being longitudinally coextensive with the cylindrical portion 11 of the shell. A bottom ring plate 23, through which tubular members 17 extend in a fluid-tight manner at the outer periphery thereof, is securely mounted in fluid-tight relationship in the shell 10 and at the inner periphery thereof is secured in a fluid-tight manner to the baffle plate 22 thereby forming a bottom wall for a passage or convection heating chamber 24 the inner periphery of which is formed by the baffle plate 22 while the outer periphery thereof is formed by the inner surface of the cylindrical portion 11 of shell 10. The passage 24 is closed at the top thereof by an annular top plate 25, which is in the form of a ring, and is in communication at the central portion thereof with a flue 26. Header 21 is enclosed by an enclosing box structure 27.

A circular plate 28 extends horizontally within the cylindrical baffle plate 22 intermediate the top and bottom thereof, the outer periphery of plate 28 engaging the inner periphery of baffle 22 thereby forming a lower gas space 29 and an upper gas space 30 within the cylindrical baffle plate 22. Lower gas space 29, which receives gases from passage 20, communicates with convection heating chamber 24 through a plurality of elongated gas inlet openings 31. The gas inlet openings extend longitudinally through baffle 22 from a point beneath plate 28 to the lower end of said baffle and are, as shown (Fig. 3), spaced substantially 90° from one another circumferentially of baffle 22. Upper gas space 30 is in communication with passage 24 through a plurality of gas outlet openings 32, which are similar to openings 31 but extend from a point adjacent the upper surface of plate 28 to the upper edge of cylindrical baffle 22. The gas outlet openings 32, as shown (Fig. 4), are spaced substantially 90° from one another, circumferentially of baffle 22 and are so positioned in relationship to inlet openings 31 as to be substantially equidistant between openings 31, or spaced substantially 45° from each of said openings 32 circumferentially of the cylindrical baffle 22.

The heater of the present invention is fired by one or more burners. As shown, burners 33 and 34 are provided to fire the heater, burner 33 being so disposed in relationship to the chamber 13 as to direct a stream of gases of combustion to flow tangentially of said chamber and tubular members 17. The burner 33, as shown more particularly in Figs. 1 and 2, is mounted in the shell 10 at one side of the portion 12 thereof so that a stream of gases therefrom will flow in a circular direction within the chamber 13. Other burner 34 is mounted in bottom 14 of the setting and positioned centrally of passage 20 within the row of tubular members 17 to direct

a stream of gases of combustion substantially vertically.

Oil, or other fluid, to be heated enters lower header 18 through inlet pipe 35 and flows through tubular members 17 into upper header 21. Heated fluid is withdrawn from header 21 through outlet pipe 36.

In operation, gases of combustion from burner 33 flow in a circular direction within chamber 13 and in heat exchange relationship with the outer periphery of the circular row of tubular members 17. As the gases rise, the diameter of the circular flow path of the gases of combustion gradually decreases due to the shape of shell 10 and chamber 13. Gases of combustion flowing from burner 34 flow vertically upwardly in passage 20 within the circular row of tubular members 17 and pass in heat exchange relationship with the inner periphery of said row of tubes.

The gases of combustion flowing upwardly pass into lower gas space 29 of cylindrical baffle 22 and impinge on the under surface of plate 28 thereafter to flow into passage 24 through gas inlets 31. The gases entering passage 24 flow in clockwise and in counterclockwise directions and also upwardly to enter gas outlet openings 32 at opposite sides of a gas inlet opening 31 after passing in convection heat exchange relationship with the upper portion of tubular members 17 within passage 24. A portion of the gases from each gas inlet opening 31 will flow in a counterclockwise direction over tubes comprising a substantially 45° portion of the circular row of tubular members before entering a gas outlet slot 32 while another portion of the gases will flow in a clockwise direction over other tubes comprising another substantially 45° portion of said circular row of tubes. From the gas outlets 32, the gases of combustion enter upper gas space 30 above cylindrical baffle 22 and flow outwardly of the setting through flue 26.

From the foregoing it will be readily understood that an efficient transfer of heat from the gases of combustion to the fluid flowing through the tubular members is attained.

While the spacing of the gas inlets 31 from one another and the spacing of the gas outlets 32 from one another has been shown and described as substantially 90° and the spacing of the gas inlets and gas outlets from one another has been set forth as substantially 45°, the spacing may be of a greater or lesser degree without departing from the invention.

Changes may be made in the form, location and relative arrangement of the several parts of the heater disclosed and many embodiments of the invention may be made without departing from the principles thereof. It will be understood that the invention is not to be limited excepting by the scope of the appended claims.

What is claimed is:

1. A furnace having a vertically extending chamber comprising an annular outer wall, said chamber being substantially circular in transverse cross-section, a substantially annular group of fluid conducting tubular members disposed in said chamber to extend longitudinally thereof, said tubes being spaced from the outer wall and arranged to form an axial passage within the group, means for producing a stream of gases of combustion disposed in the lower portion of the furnace to direct said stream upwardly and longitudinally of the axial passage, means forming a convection heating chamber around the upper portion of said tubes and extending axially thereof, the annular outer wall forming the outer periphery of the convection heating chamber, an annular inner wall in spaced relationship with the outer wall and the tubular members and expending axially of said members, the space between the outer wall and the tubes and the space between the inner wall and the tubes being such as to cause the gases to flow in heat exchange relationship with the tubular members in a confined space around said members, said convection heating chamber being separated from the first-mentioned chamber and having a plurality of gas inlet and gas outlet openings, the gas inlet openings being positioned to communicate with the lower portion of the convection chamber and with said axial passage at a plurality of circumferentially spaced points and the gas outlet openings being positioned to communicate with the upper portion of the convection chamber at a plurality of circumferentially spaced points above and intermediate said inlet openings, said inlet openings and the outlet openings being spaced from one another such distance that a stream of gases passing from an inlet opening divides and the gases flow to adjacent outlet openings transversely of the upper portion of a plurality of tubular members in a generally horizontal direction, a baffle disposed above the inlet openings, below the outlet openings and in the path of flow of the gases in said first-mentioned chamber so as to direct said gases into the convection section through said gas inlet openings, and gas outlet means for the furnace in communication with said gas outlet openings.

2. A furnace having a vertically extending circular chamber comprising an annular outer wall, an annular row of spaced tubes spaced from the outer wall, said row being of lesser diameter than the chamber, the tubes being disposed to extend longitudinally of the chamber and arranged to surround an axial passage, means for producing a stream of gases of combustion disposed in the lower portion of the furnace to direct said stream upwardly and longitudinally of the axial passage, means forming a convection heating chamber around the upper portion of said tubes and extending axially thereof, the annular outer wall forming the outer periphery of the convection heating chamber, said means comprising an annular inner wall of a diameter slightly less than the diameter of said annular row of tubes, a bottom wall through which the tubes extend arranged to close the bottom of the convection chamber in a fluid-tight manner, and a top wall above the bottom wall in spaced relationship thereto and arranged to close the top of said convection heating chamber in a fluid-tight manner, the space between the outer wall and the tubes and the space between the inner wall and the tubes being such as to cause the gases to flow in heat exchange relationship with the tubular members in a confined space around said members, the inner wall having a plurality of gas inlet and gas outlet openings therethrough, the gas inlet openings being positioned in the lower portion of the wall and spaced circumferentially from one another, the gas outlet openings being positioned in the upper portion of the wall above the inlet openings and at spaced points intermediate said inlet openings, said inlet openings and the outlet openings being spaced from one another such distance that a stream of gases passing from an inlet opening divides and the gases flow to adjacent outlet openings transversely of the upper portion of a plurality of tubular mem-

bers in a generally horizontal direction, a baffle extending transversely of the first-mentioned chamber in the path of flow of the gases of combustion and disposed in fluid-tight relationship with said inner wall above said inlet openings and below said outlet openings, and gas outlet means for the furnace in communication with said gas outlet openings.

3. A furnace having a vertically extending circular chamber comprising an annular outer wall, an annular row of spaced tubes spaced from the outer wall, said row being of lesser diameter than the chamber, the tubes being disposed to extend longitudinally of the chamber and arranged to surround an axial passage, means for producing a stream of gases of combustion disposed in the lower portion of the furnace to direct said stream upwardly and longitudinally of the axial passage, other means for producing a stream of gases of combustion, said other means being disposed in the lower portion of the furnace chamber so as to direct a stream of gases of combustion tangentially of the furnace chamber and circumferentially of the annular row of tubes, means forming a convection heating chamber around the upper portion of said tubes and extending axially thereof, the annular outer wall forming the outer periphery of the convection heating chamber, said means comprising an annular inner wall of a diameter slightly less than the diameter of said annular row of tubes, a bottom wall through which the tubes extend arranged to close the bottom of the convection chamber in a fluid-tight manner, and a top wall above the bottom wall in spaced relationship thereto and arranged to close the top of said convection heating chamber in a fluid-tight manner, the space between the outer wall and the tubes and the space between the inner wall and the tubes being such as to cause the gases to flow in heat exchange relationship with the tubular members in a confined space around said members, the inner wall having a plurality of gas inlet and gas outlet openings therethrough, the gas inlet openings being positioned in the lower portion of the wall and spaced circumferentially from one another, the gas outlet openings being positioned in the upper portion of the wall above the inlet openings and at spaced points intermediate said inlet openings, said inlet openings and the outlet openings being spaced from one another such distance that a stream of gases passing from an inlet opening divides and the gases flow to adjacent outlet openings transversely of the upper portion of a plurality of tubular members in a generally horizontal direction, a baffle extending transversely of the first-mentioned chamber in the path of flow of the gases of combustion and disposed in fluid-tight relationship with said inner wall above said inlet openings and below said outlet openings, and gas outlet means for the furnace in communication with said gas outlet openings.

4. A heater having a substantially vertically extending circular furnace chamber comprising an annular outer wall the top of the chamber being cylindrically shaped and of lesser diameter than the bottom of the furnace, the portion of said chamber intermediate the top and bottom being of frusto-conical shape, a substantially annular group of fluid conducting tubular members spaced from the outer wall, the tube group being of slightly lesser diameter than said top of the chamber and extending longitudinally of the furnace chamber, the tubes being arranged to form an axial passage within the group, means forming a convection heating chamber in said top of the chamber and around the upper end of the tubes the annular outer wall forming the outer periphery of the convection heating chamber which chamber comprises an annular inner wall of a diameter slightly less than the diameter of said annular row of tubes, a bottom wall through which the tubes extend arranged to close the bottom of the convection chamber in a fluid-tight manner. and a top wall above the bottom wall in spaced relationship thereto and arranged to close the top of said convection heating chamber in a fluid-tight manner, the space between the outer wall and the tubes and the space between the inner wall and the tubes being such as to cause the gases to flow in heat exchange relationship with the tubular members in a confined space around said members, the inner wall having a plurality of gas inlet and gas outlet openings therethrough, the gas inlet openings being positioned in the lower portion of the wall and spaced circumferentially from one another, the gas outlet openings being positioned in the upper portion of wall above the inlet openings and at spaced points intermediate said inlet openings, said inlet openings and the outlet openings being spaced from one another such distance that a stream of gases passing from an inlet opening divides and the gases flow to adjacent outlet openings transversely of the upper portion of a plurality of tubular members in a generally horizontal direction, a baffle extending transversely of the first-mentioned chamber in the path of flow of the gases of combustion and disposed in fluid-tight relationship with said inner wall above said inlet openings and below said outlet openings, means adjacent said bottom of the furnace for producing a stream of products of combustion and disposed to direct said gases longitudinally of the axial passage and toward the top of the furnace, other means adjacent the bottom of the furnace chamber for producing a stream of gases of combustion, said other means being so disposed as to direct a stream of gases tangentially of said chamber and circumferentially of the tube group, and gas outlet means in communication with said gas outlet openings.

5. A furnace having a vertically extending chamber comprising an annular outer wall, said chamber being substantially circular in transverse cross-section, a substantially annular group of fluid conducting tubular members disposed in said chamber to extend longitudinally thereof, said tubes being spaced from the outer wall and arranged to form an axial passage within the group, firing means for firing the furnace disposed in the lower portion thereof, means forming a convection heating chamber around the upper portion of said tubes and extending axially thereof, the annular outer wall forming the outer periphery of the convection heating chamber, an annular inner wall in spaced relationship with the outer wall and the tubular members and extending axially of said members, the space between the outer wall and the tubes and the space between the inner wall and the tubes being such as to cause the gases to flow in heat exchange relationship with the tubular members in a confined space around said members, said convection heating chamber being separated from the first-mentioned chamber and having a plurality of gas inlet and gas outlet openings, the gas inlet openings being positioned to communicate with the lower portion of the convection chamber and with

said axial passage at a plurality of circumferentially spaced points and the gas outlet openings being positioned to communicate with the upper portion of the convection chamber at a plurality of circumferentially spaced points above and intermediate said inlet openings, said inlet openings and the outlet openings being spaced from one another such distance that a stream of gases passing from an inlet opening divides and the gases flow to adjacent outlet openings transversely of the upper portion of a plurality of tubular members in a generally horizontal direction, a baffle disposed above the inlet openings, below the outlet openings and in the path of flow of the gases in said first-mentioned chamber so as to direct said gases into the convection section through said gas inlet openings, and gas outlet means for the furnace in communication with said gas outlet openings.

6. A furnace having a vertically extending chamber comprising an annular outer wall, said chamber being substantially circular in transverse cross-section, a substantially annular group of fluid conducting tubular members disposed in said chamber to extend longitudinally thereof, said tubes being spaced from the outer wall and arranged to form an axial passages within the group, firing means for firing the furnace disposed in the lower portion thereof, means forming a convection heating chamber around the upper portion of said tubes and extending axially thereof, the annular outer wall forming the outer periphery of the convection heating chamber, an annular inner wall in spaced relationship with the outer wall and the tubular members and extending axially of said members, the space between the outer wall and the tubes and the space between the inner wall and the tubes being such as to cause the gases to flow in heat exchange relationship with the tubular members in a confined space around said members, said convection heating chamber being separated from the first-mentioned chamber and having a plurality of gas inlet and gas outlet openings, the gas inlet openings being positioned to communicate with the lower portion of the convection chamber and with said axial passage at a plurality of points spaced circumferentially from one another substantially 90° and the gas outlet openings being positioned to communicate with the upper convection chamber at a plurality of points above the inlet openings and spaced circumferentially from one another substantially 90° and spaced circumferentially from the inlet openings substantially 45°, said inlet openings and the outlet openings being spaced from one another such distance that a stream of gases passing from an inlet opening divides and the gases flow to adjacent outlet openings transversely of the upper portion of a plurality of tubular members in a generally horizontal direction, a baffle disposed above the inlet openings, below the outlet openings and in the path of flow of the gases in said first-mentioned chamber so as to direct said gases into the convection section through said gas inlet openings, and gas outlet means for the furnace in communication with said gas outlet openings.

7. A heater having a substantially vertically extending circular furnace chamber comprising an annular outer wall the top of the chamber being cylindrically shaped and of lesser diameter than the bottom of the furnace, the portion of said chamber intermediate the top and bottom being of frusto-conical shape, a substantially annular group of fluid conducting tubular members spaced from the outer wall, the group being of slightly lesser diameter than said top of the chamber and extending longitudinally of the furnace chamber, the tubes being arranged to form an axial passage within the group, firing means for firing the furnace disposed in the lower portion thereof, means forming a convection heating chamber in said top of the chamber extending around the upper end of the tubes and axially thereof, the annular outer wall forming the outer periphery of the convection heating chamber, an annular inner wall in spaced relationship with the outer wall and the tubular members and extending axially of said members, the space between the outer wall and the tubes and the space between the inner wall and the tubes being such as to cause the gases to flow in heat exchange relationship with the tubular members in a confined space around said members, said convection heating chamber being separated from the first-mentioned chamber and having a plurality of gas inlet and gas outlet openings, the gas inlet openings being positioned to communicate with the lower portion of the convection chamber and with said axial passage at a plurality of circumferentially spaced points and the gas outlet openings being positioned to communicate with the upper portion of the convection chamber at a plurality of circumferentially spaced points above and intermediate said inlet openings, said inlet openings and the outlet openings being spaced from one another such distance that a stream of gases passing from an inlet opening divides and the gases flow to adjacent outlet openings transversely of the upper portion of a plurality of tubular members in a generally horizontal direction, a baffle disposed above the inlet openings, below the outlet openings and in the path of flow of the gases in said first-mentioned chamber so as to direct said gases into the convection section through said gas inlet openings, and gas outlet means for the furnace in communication with said gas outlet openings.

8. A heater having a substantially vertically extending circular furnace chamber comprising an annular outer wall the top of the chamber being cylindrically shaped and of lesser diameter than the bottom of the furnace, the portion of said chamber intermediate the top and bottom being of frusto-conical shape, a substantially annular group of fluid conducting tubular members spaced from the outer wall, the group being of slightly lesser diameter than said top of the chamber and extending longitudinally of the furnace chamber, the tubes being arranged to form an axial passage within the group, firing means for firing the furnace disposed in the lower portion thereof, means forming a convection heating chamber in said top of the chamber extending around the upper end of the tubes and axially thereof, the annular outer wall forming the outer periphery of the convection heating chamber, an annular inner wall in spaced relationship with the outer wall and the tubular members and extending axially of said members, the space between the outer wall and the tubes and the space between the inner wall and the tubes being such as to cause the gases to flow in heat exchange relationship with the tubular members in a confined space around said members, said convection heating chamber being separated from the first-mentioned chamber and having a plurality of gas inlet and gas outlet openings, the gas inlet openings being positioned to communicate with the lower portion of the convection chamber and with

said axial passage at a plurality of points spaced circumferentially from one another substantially 90° and the gas outlet openings being positioned to communicate with the upper convection chamber at a plurality of points above the inlet openings and spaced circumferentially from one another substantially 90° and spaced circumferentially from the inlet openings substantially 45°, said inlet opening and the outlet openings being spaced from one another such distance that a stream of gases passing from an inlet opening divides and the gases flow to adjacent outlet openings transversely of the upper portion of a plurality of tubular members in a generally horizontal direction, a baffle disposed above the inlet openings, below the outlet openings and in the path of flow of the gases in said first-mentioned chamber so as to direct said gases into the convection section through said gas inlet openings, and gas outlet means for the furnace in communication with said gas outlet openings.

9. A furnace having a vertically extending circular chamber comprising an annular outer wall, an annular row of spaced tubes spaced from the outer wall, said row being of lesser diameter than the chamber, the tubes being disposed to extend longitudinally of the chamber and arranged to surround an axial passage, means for producing a stream of gases of combustion disposed in the lower portion of the furnace to direct said stream upwardly and longitudinally of the axial passage, other means for producing a stream of gases of combustion, said other means being disposed in the lower portion of the furnace chamber so as to direct a stream of gases of combustion tangentially of the furnace chamber and circumferentially of the annular row of tubes, means forming a convection heating chamber around the upper portion of said tubes and extending axially thereof, the annular outer wall forming the outer periphery of the convection heating chamber, said means comprising an annular inner wall of a diameter slightly less than the diameter of said annular row of tubes, a bottom wall through which the tubes extend arranged to close the bottom of the convection chamber in a fluid-tight manner, and a top wall above the bottom wall in spaced relationship thereto and arranged to close the top of said convection heating chamber in a fluid-tight manner, the space between the outer wall and the tubes and the space between the inner wall and the tubes being such as to cause the gases to flow in heat exchange relationship with the tubular members in a confined space around said members, the inner wall having a plurality of gas inlet and gas outlet openings therethrough, the gas inlet openings being positioned in the lower portion of the wall and spaced circumferentially from one another substantially 90° and the gas outlet openings being positioned in the upper portion of the wall above the inlet openings and spaced circumferentially of one another substantially 90° and spaced circumferentially from the inlet openings substantially 45°, said inlet openings and the outlet openings being spaced from one another such distance that a stream of gases passing from an inlet opening divides and the gases flow to adjacent outlet openings transversely of the upper portion of a plurality of tubular members in a generally horizontal direction, a baffle extending transversely of the first-mentioned chamber in the path of flow of the gases of combustion and disposed in fluid-tight relationship with said inner wall above said inlet openings and below said outlet openings, and gas outlet means for the furnace in communication with said gas outlet openings.

10. A heater having a substantially vertically extending circular furnace chamber comprising an annular outer wall, the top of the chamber being cylindrically shaped and of lesser diameter than the bottom of the furnace, the portion of said chamber intermediate the top and bottom being of frusto-conical shape, a substantially annular group of fluid conducting tubular members spaced from the outer wall, the tube group being of slightly lesser diameter than said top of the chamber and extending longitudinally of the furnace chamber, the tubes being arranged to form an axial passage within the group, means forming a convection heating chamber in said top of the chamber and around the upper end of the tubes the annular outer wall forming the outer periphery of the convection heating chamber which chamber comprises an annular inner wall of a diameter slightly less than the diameter of said annular row of tubes, a bottom wall through which the tubes extend arranged to close the bottom of the convection chamber in a fluid-tight manner, and a top wall above the bottom wall in spaced relationship thereto and arranged to close the top of said convection heating chamber in a fluid-tight manner, the space between the outer wall and the tubes and the space between the inner wall and the tubes being such as to cause the gases to flow in heat exchange relationship with the tubular members in a confined space around said members, the inner wall having a plurality of gas inlet and gas outlet openings therethrough, the gas inlet openings being positioned in the lower portion of the wall and spaced circumferentially from one another substantially 90° and the gas outlet openings being positioned in the upper portion of the wall above the inlet openings and spaced circumferentially of one another substantially 90° and spaced circumferentially from the inlet openings substantially 45°, said inlet openings and the outlet openings being spaced from one another such distance that a stream of gases passing from an inlet opening divides and the gases flow to adjacent outlet openings transversely of the upper portion of a plurality of tubular members in a generally horizontal direction, a baffle extending transversely of the first-mentioned chamber in the path of flow of the gases of combustion and disposed in fluid-tight relationship with said inner wall above said inlet openings and below said outlet openings, means adjacent said bottom of the furnace for producing a stream of products of combustion and disposed to direct said gases longitudinally of the axial passage and toward the top of the furnace, other means adjacent the bottom of the furnace chamber for producing a stream of gases of combustion, said other means being so disposed as to direct a stream of gases tangentially of said chamber and circumferentially of the tube group, and gas outlet means in communication with said gas outlet openings.

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