Jan. 18, 1938. R. M. PARSONS 2,105,500

FURNACE

Filed April 25, 1935 3 Sheets-Sheet 1

Fig. 1

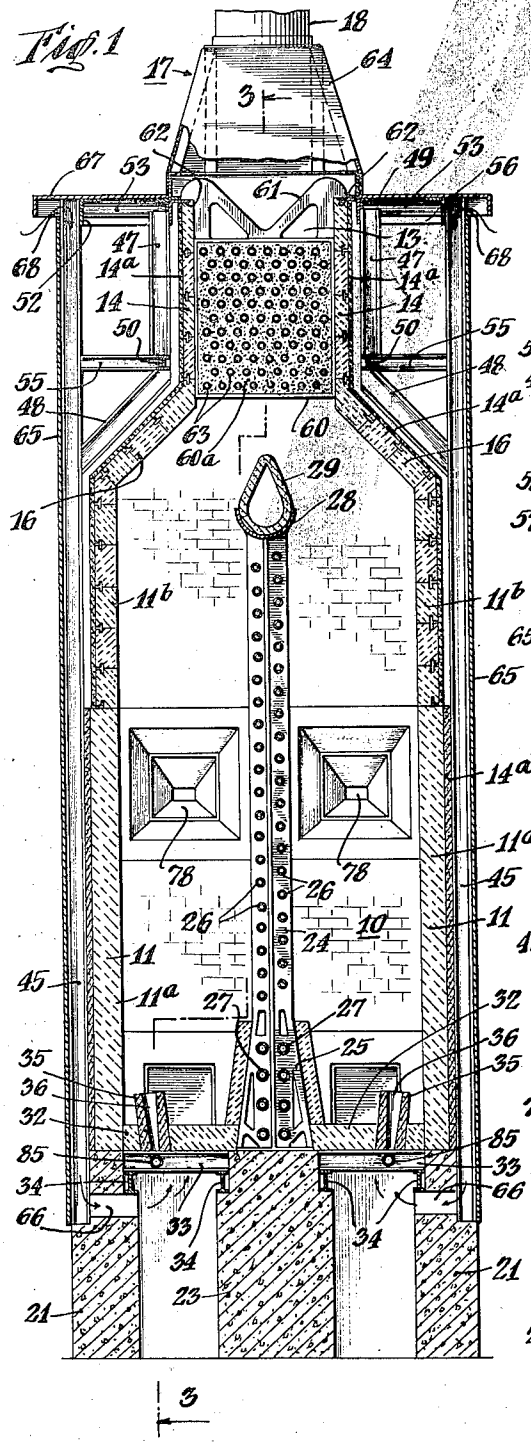
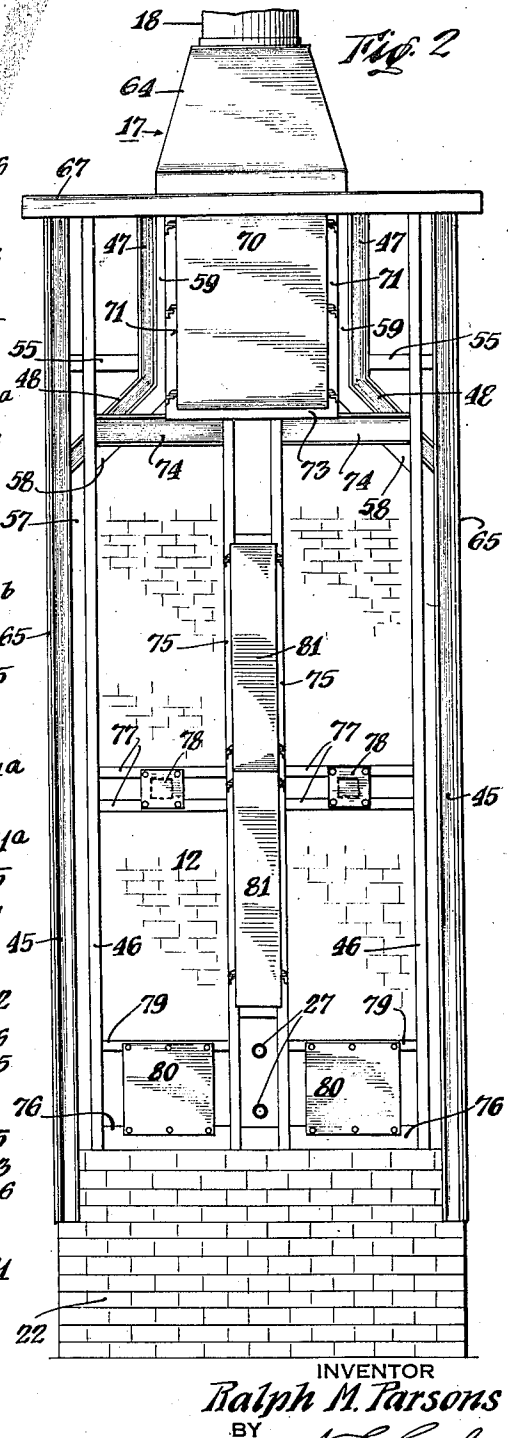


Fig. 2



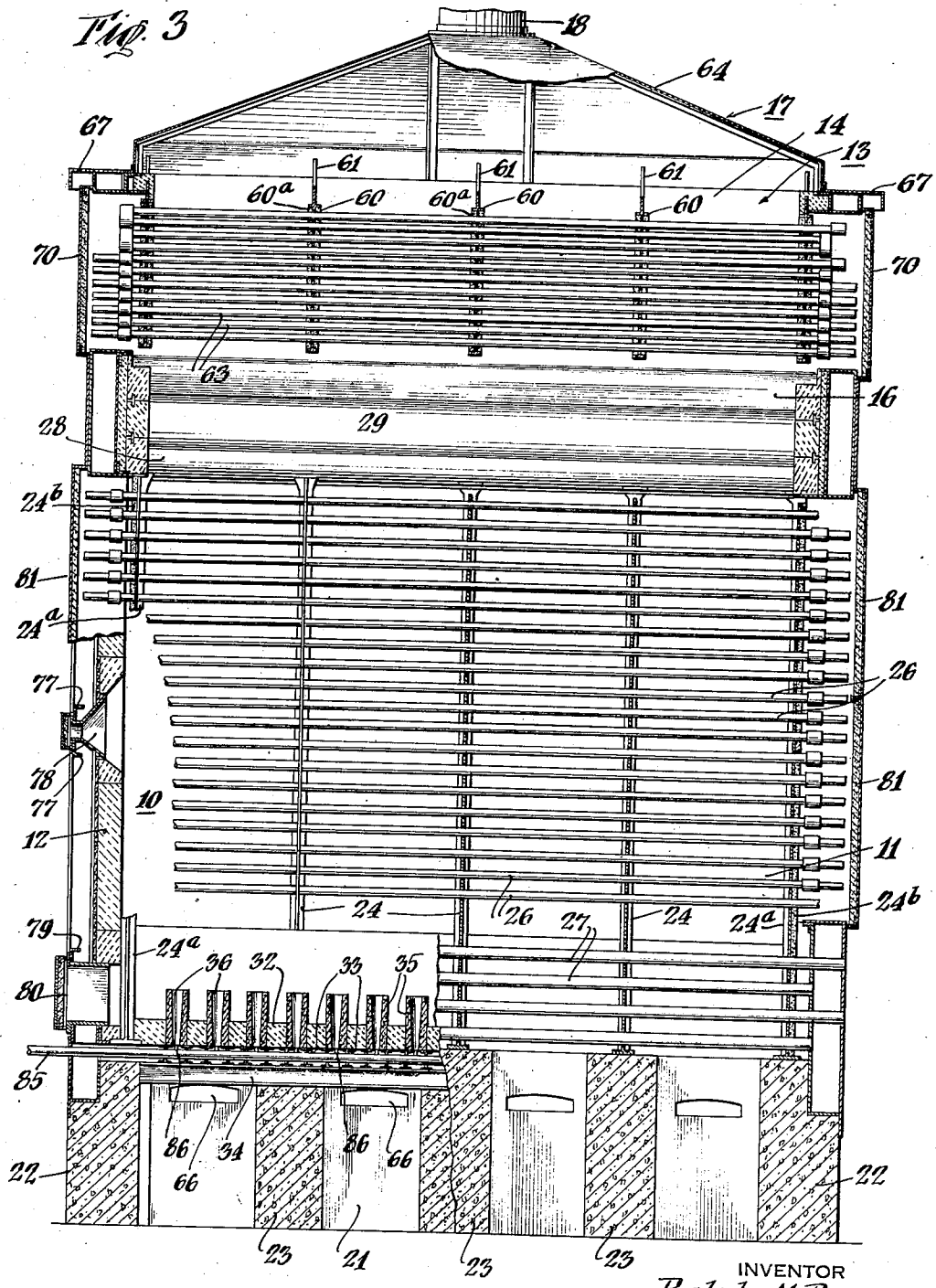
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Jan. 18, 1938. R. M. PARSONS 2,105,500

FURNACE

Filed April 25, 1935 3 Sheets-Sheet 2

Fig. 3

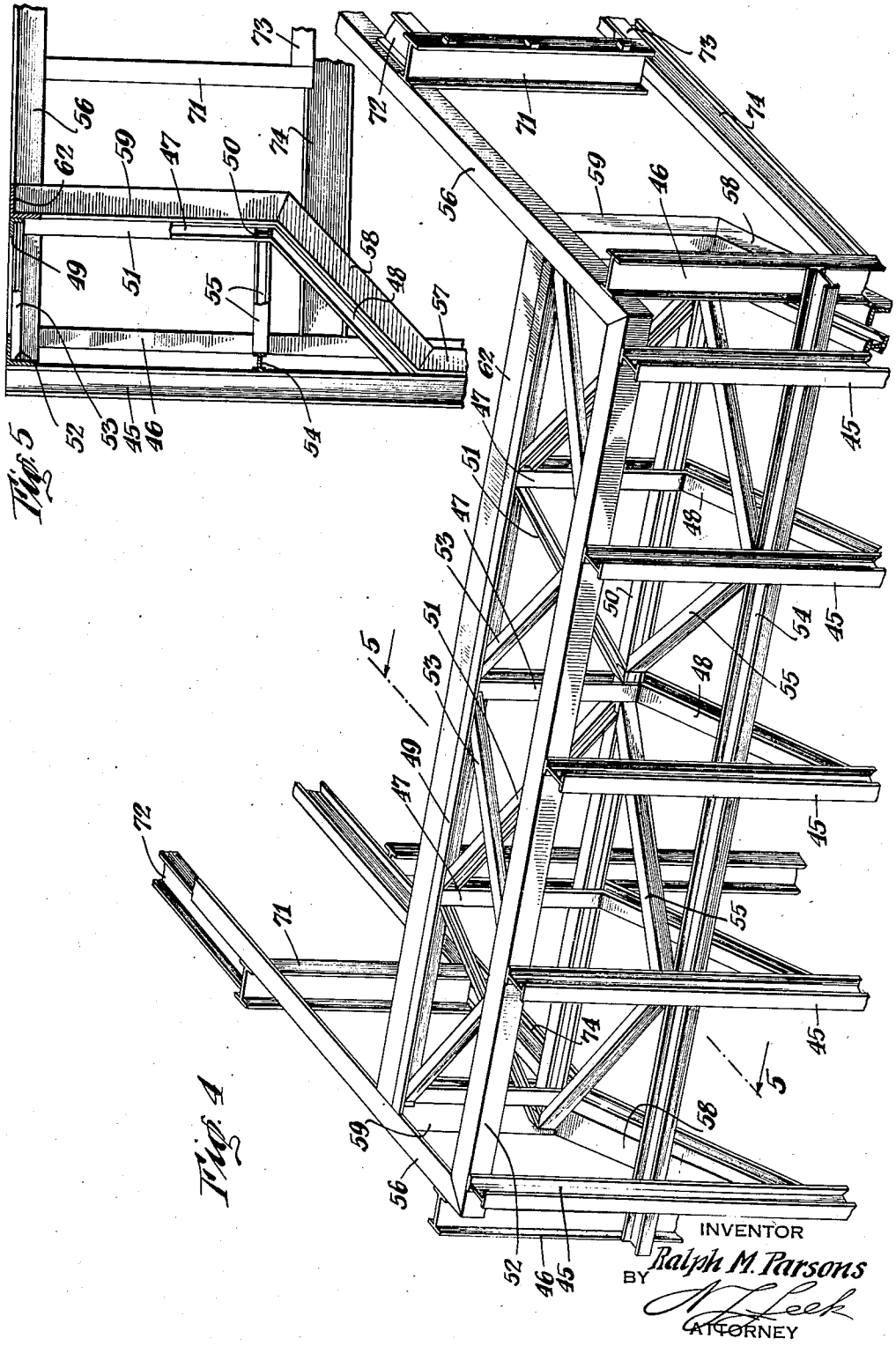


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FURNACE

Filed April 25, 1935 3 Sheets-Sheet 3



Patented Jan. 18, 1938 2,105,500

UNITED STATES PATENT OFFICE

2,105,500

FURNACE

Ralph M. Parsons, Mount Vernon, Ohio, assignor to The Ralph M. Parsons Company, Mount Vernon, Ohio, a corporation of Delaware

Application April 25, 1935, Serial No. 18,125

11 Claims. (Cl. 196—110)

This invention relates to furnaces and more particularly to tube stills for use in oil cracking or refining plants.

An object of the invention is to improve the details of construction and method of operation of a furnace of the above type.

In accordance with the present invention the furnace is provided with an elongated combustion chamber having a bank of radiant heat tubes located centrally thereof and dividing the combustion chamber into two sections. Rows of burners are located on each side of the radiant heat tubes for applying heat equally to the two sides thereof. The combustion gases pass over the radiant heat tubes and into a convection chamber which is located in line with the normal flow of gases and is of smaller cross-section than the combustion chamber so that the gases pass therethrough at an increased velocity.

In one embodiment, the combustion chamber is elongated vertically with the bank of radiant heat tubes extending vertically from the floor at about the center line thereof. The burners are mounted in or near the floor in a position to heat the side walls to radiance whereby the radiant heat is reradiated onto the tubes. The convection chamber is located over the combustion chamber and is joined thereto by sloping walls which define a passage for the combustion gases.

A feature of the invention consists in the provision of a member in alignment with the radiant heat tubes, which is stream lined in the direction of gas flow so as to direct the gases into the convection chamber with a minimum of turbulence and to cause a uniform distribution of gases over the convection tubes.

Another feature consists in the provision of air passages or channels on the outside of the furnace walls which are so arranged that the air for combustion is caused to pass downwardly over the walls on its way to the burners.

A further feature consists in the truss structure which is adapted to support the walls, the convection tubes and the hood.

Various other features will be apparent as the nature of the invention is more fully disclosed.

Although the novel features which are believed to be characteristic of this invention will be more particularly pointed out in the claims appended hereto, the invention itself, as to its objects and advantages, and the manner of its operation, will be better understood by referring to the following description, taken in connection with the accompanying drawings forming a part thereof, in which:

Fig. 1 is a transverse vertical section through a furnace illustrating an embodiment of the present invention;

Fig. 2 is an end elevation thereof;

Fig. 3 is a longitudinal section taken along the line 3—3 of Fig. 1 but with parts of the tubes broken away to show the burners;

Fig. 4 is a detail view of a part of the truss structure; and

Fig. 5 is a section taken on the line 5—5 of Fig. 4.

Specific terms are used herein for convenience of description but they are to be interpreted as broadly as the state of the art will permit.

Referring to the drawings more in detail, the invention is shown as applied to a furnace comprising a vertically elongated combustion chamber 10 having side walls 11 and end walls 12, and a convection chamber 13 of smaller cross-section than the combustion chamber 10 and located directly thereover. The convection chamber 13 is provided with side walls 14, which may be joined to the side walls 11 by sloping walls 16. A hood 17 is mounted above the convection chamber 13 and is adapted to conduct exhaust gases to a stack 18.

The walls 11 and 12 may be supported upon side and end foundations 21 and 22 respectively, such as brickwork. A plurality of spaced central piers 23 are arranged to support lower tube sheets 24 which are preferably made of a heat resisting material such as alloy steel. They may comprise four angles which are secured together, as by welding, to provide a rigid structure. At their lower ends they may be provided with flared bracing members 25 which rest upon the central piers 23. The two end tube sheets 24a may be insulated on the outside only, as by insulation 24b, to prevent escape of heat. The tube sheets 24 may be apertured to receive two vertical rows of radiant heat tubes 26. At their lower ends they may be apertured to receive an additional set of tubes 27 such as boiler tubes for utilizing the heat in the lower part of the furnace below the zone of radiance or cooling the bottoms of tube supports 24.

A cradle member 28 may be mounted on the tops of the tube sheets 24. This cradle member is adapted to receive and support a guide member 29 having a tear drop or stream lined section, which is adapted to direct the gases from the combustion chamber 10 to the convection chamber 13 with a minimum of turbulence and to cause uniform distribution of such gases in the convection chamber. The guide member 29

is preferably hollow and may be made of any suitable heat resisting material such as firebrick, fireclay or concrete.

A floor 32 may be supported by a plurality of transverse beams 33, mounted upon longitudinal girders 34, which rest upon the side foundations 21 and upon the central piers 23. Burners 35 may also be supported by the transverse beams 33. These burners may comprise a block of refractory material having a flared central bore 36 for passage of the gaseous fuel and air. The bores 36 are preferably formed in the shape of a Venturi tube. When so formed they constitute an efficient mixing device for the fuel and air. Furthermore, the flow of fuel may induce the flow of air for combustion thereby eliminating the necessity for a forced air feed. The burners may be located in rows extending longitudinally of the furnace on both sides of the radiant heat tubes 26 and may be directed somewhat toward the side walls 11 so as to heat the walls to radiance and so as to prevent the direct heat of the flame from being applied to the radiant heat tubes.

The part 11*a* of the side walls 11, against which the flame from the burners 35 is directed, may be thicker than the upper part 11*b* of the walls which is not required to withstand as much heat and is not relied upon to absorb the radiant heat and to reradiate the same to the tubes. The side walls 14 of the convection chamber 13 may be of still thinner construction as they are subjected only to convection heat. The sloping walls 16 are preferably similar to the upper part 11*b* of the walls 11 although the walls may taper in thickness from the hottest portion, near the burners 35, to the coolest portion, at the top or bottom, if such construction is desired for purposes of economy. The walls may have an outer covering 14*a* of impervious material such as plaster board or metal to prevent escape of air or combustion gases, unless the walls are monolithic in which case the walls themselves are substantially air and gas tight.

For supporting the walls 14 and 16, upper tube sheets 60 and hood 17, there may be provided a framework comprising side buck stays 45 and end buck stays 46 which may rest upon the foundations 21 and 22 respectively. The side walls 11 may be anchored to the side buck stays 45 at convenient points. A set of vertical truss members 47 and inclined truss members 48 are positioned adjacent the side walls 14 and the sloping walls 16 respectively. Suitable anchors, not shown, may be provided to secure the walls 14 and 16 to these truss members.

The vertical truss members 47 form a part of a vertical truss, comprising top member 49, bottom member 50 and bracing members 51. The tops of the buck stays 45 are joined by a member 52 forming, with the top member 49, and with bracing members 53, an upper horizontal truss. A longitudinal member 54, secured to the side buck stays 45, forms, with the bottom member 50 and with bracing members 55, a lower horizontal truss. The inclined truss members 48 are joined to the side buck stays 45 and to the vertical truss members 47, as by welding, to form a rigid structure. End top members 56, secured to the end buck stays 46, are joined to the members 52 to form a frame extending entirely around the top of the furnace. Lower vertical angles 57, inclined angles 58 and upper vertical angles 59 may be joined to the end truss members to form the end frames of the furnace.

Upper tube sheets 60 are provided with hangers 61 which are supported by members 62, joined to the top members 49. These tube sheets 60 may be made of cast iron and are preferably insulated on both sides, as by insulation 60*a*, to prevent deterioration thereof. The tube sheets 60 are apertured to receive a bank of convection tubes 63 which substantially fill the convection chamber 13.

The hood 17 may rest upon the members 62 and 56 and is thus supported by the framework above described. The hood 17 may have sloping sides 64 which converge to the stack 18.

The side buck stays 45 may be covered with a thin sheet material 65 such as plaster board, so as to provide channels between the buck stays for the passage of air. These channels may connect, by transverse passages 66 formed in the side foundations 21, with the space below the floor 32 and burners 35. The top of the furnace on both sides of the hood 17 may be covered with a similar material 67. An opening 68 may be provided to afford an air intake passage over the sheet material 65 and below the material 67.

The end of the convection chamber 13 may be closed by a door 70 which may be hung on a frame comprising side members 71, top member 72 and bottom member 73. The top member 72 may be secured to the end top members 56. The bottom member 73 may be supported by beams 74 carried between end buck stays 46 and uprights 75 which also form the sides of the radiant tube door frame. The end buck stays 46 and uprights 75 may be joined at the bottom by a beam 76.

A pair of cross members 77 may extend between the end buck stays 46 and uprights 75 to form supports for peep-hole castings 78. Similar cross members 79 form frames on which entrance doors 80 are hung. Radiant tube doors 81 may be hung between the uprights 75. It is to be understood that the end walls have openings corresponding to the frames above mentioned and that entrance doors and peep-hole castings may be omitted from one end of the furnace if desired.

Fuel may be supplied to the burners 35 by fuel pipes 85 which may extend through holes in the transverse beams 33 and may have nozzles 86 in alignment with the bores 36 of the various burners 35. Fuel is thus caused to pass through the bores 36 of the burners 35 and to induce a flow of air for combustion without other blower means. The burners may be regulated by controlling the supply of fuel.

The radiant heat tubes 26 and the convection tubes 63 are provided with suitable headers by which they are connected for oil flow through the various tubes in series in the usual manner. The tubes 27 may be connected to an outside system such as a steam boiler system in which case they utilize the waste heat of the lower part of the furnace for producing steam. In some instances the tubes 27 may remain open for the passage of cooling air therethrough in which case they constitute air cooled strengthening means for the assembly of tube sheets 24.

In the operation of the above described furnace, the oil to be heated enters one of the tubes 63 of the convection bank, for example one of the tubes in the top row thereof, and passes in series through all of the convection tubes 63 wherein it receives heat from the combustion gases. Thence it passes through the radiant heat tubes 26, preferably from top to bottom,

where it is heated by radiant heat reradiated from the furnace walls and by convection heat from the combustion gases. It may be discharged from the lower tube of the radiant group.

It is to be noted that the oil is subjected to a moderate heat in the convection bank and is subjected to a much more intense heat in the radiant heat tubes. The location of the radiant heat tubes 26 in the center of the combustion chamber 10 permits heat to be applied to both sides thereof. Hence, a maximum tube area is utilized for the heat transfer, and a maximum quantity of heat may be transferred to the oil without causing local overheating or carbonization thereof.

The combustion gases pass upwardly on both sides of the radiant heat tubes 26 and are thence directed by the sloping walls 16 and by the guide member 29 into the convection chamber 13. The guide member 29 is stream lined in the direction of gas flow so that the gases are caused to pass into the convection chamber 13 with a minimum of turbulence. By this means the upper tubes of the radiant group and the lower tubes of the convection bank are uniformly heated and a uniform distribution of gases is obtained.

The location of the stack 18 over the convection chamber 13 permits the gases to be withdrawn without substantial change in direction, thereby utilizing the natural flow of gases and eliminating the necessity for a forced draft or blower means.

The provision of a convection chamber of smaller cross section than the combustion chamber causes the gases to flow over the convection tubes 63 at an increased velocity which increases the efficiency of heat transfer thereto.

It is to be noted that the burners 35 are inclined toward the side walls 11 and away from the radiant heat tubes 26. This prevents the intense heat of the flame from being applied directly to the radiant heat tubes and thereby causing local overheating or carbonization of the oil.

By passing the air for combustion down over the outer surface of the walls 11, the walls are cooled and the air is preheated before application to the burners. Safety is also promoted as there is no outside opening at the bottom of the furnace through which inflammable material can enter.

The suspension of the convection tubes over the center of the combustion chamber and the support of the hood in a similar position presents constructional problems which have been solved by the framework described above. It is evident that a considerable weight must be suspended at a point removed from the side buck stays. The upper and lower horizontal trusses, the vertical truss and the inclined members 48 cooperate to form a rigid support which is capable of transferring the load to the buck stays. It is to be noted that all supporting members are located outside of the furnace walls where they are not subjected to the heat of the combustion gases and where they are readily accessible for inspection or repair. By this construction the furnace may be made of any desired size. Two or more combustion chambers may be combined with a single convection chamber by a simple change in the dimensions of the supporting members.

The entire furnace and the stack are economical to construct and to operate. All heavy walls are eliminated as they are not required to support the furnace roof or tubes and a high and expensive stack is not required.

Although a specific embodiment of the invention has been shown and described for purposes of illustration, it is to be understood that various changes and modifications may be made therein without departing from the scope of the invention, which is to be limited only in accordance with the following claims when interpreted in view of the prior art.

What is claimed is:

1. In a furnace of the class described, a vertically elongated combustion chamber, a bank of radiant tubes located in the center thereof and dividing the combustion chamber into two sections, a row of burners arranged in the lower part of said chamber on each side of said bank of tubes, a convection chamber containing a bank of convection tubes carrying hydrocarbon oil above said combustion chamber and in alignment therewith, and a stream lined guide member extending longitudinally above said bank of radiant tubes adapted to direct the gases into said convection chamber with a minimum of turbulence.

2. In a furnace of the class described, a vertically elongated combustion chamber, a bank of radiant tubes located in the center thereof and dividing the combustion chamber into two sections, a row of burners arranged in the lower part of said chamber on each side of said bank of tubes, a convection chamber containing a bank of convection tubes carrying hydrocarbon oil above said combustion chamber and in alignment therewith, said convection chamber being of smaller cross-section than said combustion chamber and being joined thereto by sloping walls forming a passage for gases, and a stream lined guide member extending longitudinally above said bank of radiant tubes adapted to direct the gases into said convection chamber with a minimum of turbulence.

3. In a furnace of the class described, in combination, side walls defining a combustion chamber, additional side walls defining a convection chamber of smaller cross-section than said combustion chamber, said additional side walls being located above said first walls and joined thereto by sloping walls, a bank of convection tubes in said convection chamber, hangers therefor, a hood above said convection chamber, and supporting means for said additional side walls, sloping walls, hangers and hood, comprising a framework entirely outside of said walls, said framework comprising vertical buck stays outside of said first walls and adjacent thereto, a vertical truss adjacent said additional walls and supporting the same, upper and lower horizontal trusses joining the top and bottom respectively of said vertical truss to said buck stays, and inclined members extending from the bottom of said vertical truss to said buck stays along said sloping walls and supporting the same.

4. In a furnace of the class described, in combination, side walls defining a combustion chamber, additional side walls defining a convection chamber of smaller cross-section than said combustion chamber, said additional side walls being located above said first walls and joined thereto by sloping walls, a bank of convection tubes in said convection chamber, hangers therefor, a hood above said convection chamber, and supporting means for said additional side walls, sloping walls, hangers and hood, comprising a framework having vertical truss members and

inclined truss members supporting said additional side walls and said sloping walls respectively, vertical buck stays spaced from said vertical truss members and joined to said inclined truss members, and trusses connecting said vertical truss members to said buck stays.

5. In a furnace of the class described, an elongated combustion chamber having side and end walls, a foundation supporting said walls, a plurality of spaced radiant tube sheets carrying radiant tubes located in a row in the center of said combustion chamber, piers supporting said tube sheets, a floor, burners projecting upwardly therethrough, and supporting means for said floor comprising structural members supported by said foundation and by said piers, said furnace having an air space below said floor for passage of air for combustion to said burners.

6. In a furnace of the class described, side and end walls forming a vertically elongated combustion chamber, a vertically extending bank of horizontal radiant tubes located in the center thereof and dividing the combustion chamber into two sections, a row of burners spaced along the bottom of said chamber on each side of said bank of tubes, said burners being inclined toward the side walls for directing the flame thereon so as to heat said walls to radiance, a convection chamber containing a bank of convection tubes carrying hydrocarbon oil above said combustion chamber and in alignment therewith, said convection chamber being of smaller cross-section than said combustion chamber and being joined thereto by sloping walls forming a passage for gases and a stream lined guide member extending longitudinally above said bank of radiant tubes to direct the gases into said convection chamber with a minimum of turbulence.

7. In a furnace of the class described, a vertically elongated combustion chamber, a bank of radiant tubes located in the center thereof and dividing said chamber into two sections, vertical tube sheets supporting said bank of tubes, said tube sheets being supported at the bottom and extending upwardly into said combustion chamber, a row of burners on each side of said bank of tubes, said burners being mounted in the lower part of said chamber to direct the flame upwardly therein, a convection chamber containing a bank of convection tubes carrying hydrocarbon oil above said combustion chamber and in alignment therewith, said convection chamber being of smaller cross section than said combustion chamber and being joined thereto by sloping walls forming a passage for gases and a stream lined guide member supported by said tube sheets and extending longitudinally above said bank of radiant tubes to direct the gases into said convection chamber with a minimum of turbulence.

8. In a furnace of the class described, an elongated combustion chamber having side and end walls, a foundation supporting said walls, a plurality of spaced radiant tube sheets carrying radiant tubes located in a row in the center of said combustion chamber, a central foundation supporting said tube sheets, a floor, burners projecting upwardly therethrough and supporting means for said floor comprising structural members extending between and supported by said first foundation and said central foundation, said furnace having an air space below said floor for passage of air for combustion to said burners.

9. In a furnace of the class described, an elongated combustion chamber having side and end walls, a foundation supporting said walls, a plurality of spaced radiant tube sheets carrying radiant tubes located in a row in the center of said combustion chamber, a central foundation supporting said tube sheets, a floor, burners projecting upwardly therethrough and supporting means for said floor comprising structural members extending between and supported by said first foundation and said central foundation, said furnace having an air space below said floor for passage of air for combustion to said burners and means forming an air passage at the outer side of said side walls through which air is caused to pass downwardly over said walls on its way to said air space.

10. An upshot oil cracking still comprising, in combination, a rectangular, elongated combustion chamber, a convection chamber above said combustion chamber and formed as a continuation thereof, a bank of horizontal, longitudinally extending convection tubes carrying hydrocarbon oil substantially filling said convection chamber, transverse tube sheets carrying said convection tubes, a row of horizontal, longitudinally extending radiant heat tubes, said row extending vertically below said convection tubes, a plurality of vertical brackets supported only at the bottom, each bracket extending into supporting engagement with the entire row of said radiant heat tubes, a row of burners at the bottom of said combustion chamber and spaced longitudinally thereof to direct the flame upwardly past said radiant heat tubes onto the lower tubes of said convection bank, and means to withdraw combustion gases from the top of said combustion chamber in substantially a direct line with said burners whereby the combustion gases pass through said furnace upwardly without substantial change in direction.

11. An upshot oil cracking still comprising, in combination, a rectangular, elongated combustion chamber, a convection chamber above said combustion chamber and formed as a continuation thereof, a bank of horizontal, longitudinally extending convection tubes carrying hydrocarbon oil substantially filling said convection chamber, transverse tube sheets carrying said convection tubes, a row of horizontal, longitudinally extending radiant heat tubes, said row extending vertically below said convection tubes, a foundation extending longitudinally beneath the central part of said combustion chamber, a plurality of vertical brackets supported at their bottom ends by said foundation, each bracket extending into supporting engagement with the entire row of said radiant heat tubes, a row of burners at the bottom of said combustion chamber and spaced longitudinally thereof to direct the flame upwardly past said radiant heat tubes onto the lower tubes of said convection bank, and means to withdraw combustion gases from the top of said combustion chamber in substantially a direct line with said burners whereby the combustion gases pass through said furnace upwardly without substantial change in direction.

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