

May 2, 1944.

F. H. PRAEGER

2,348,181

PETROLEUM HEATER

Filed June 8, 1942

3 Sheets-Sheet 1

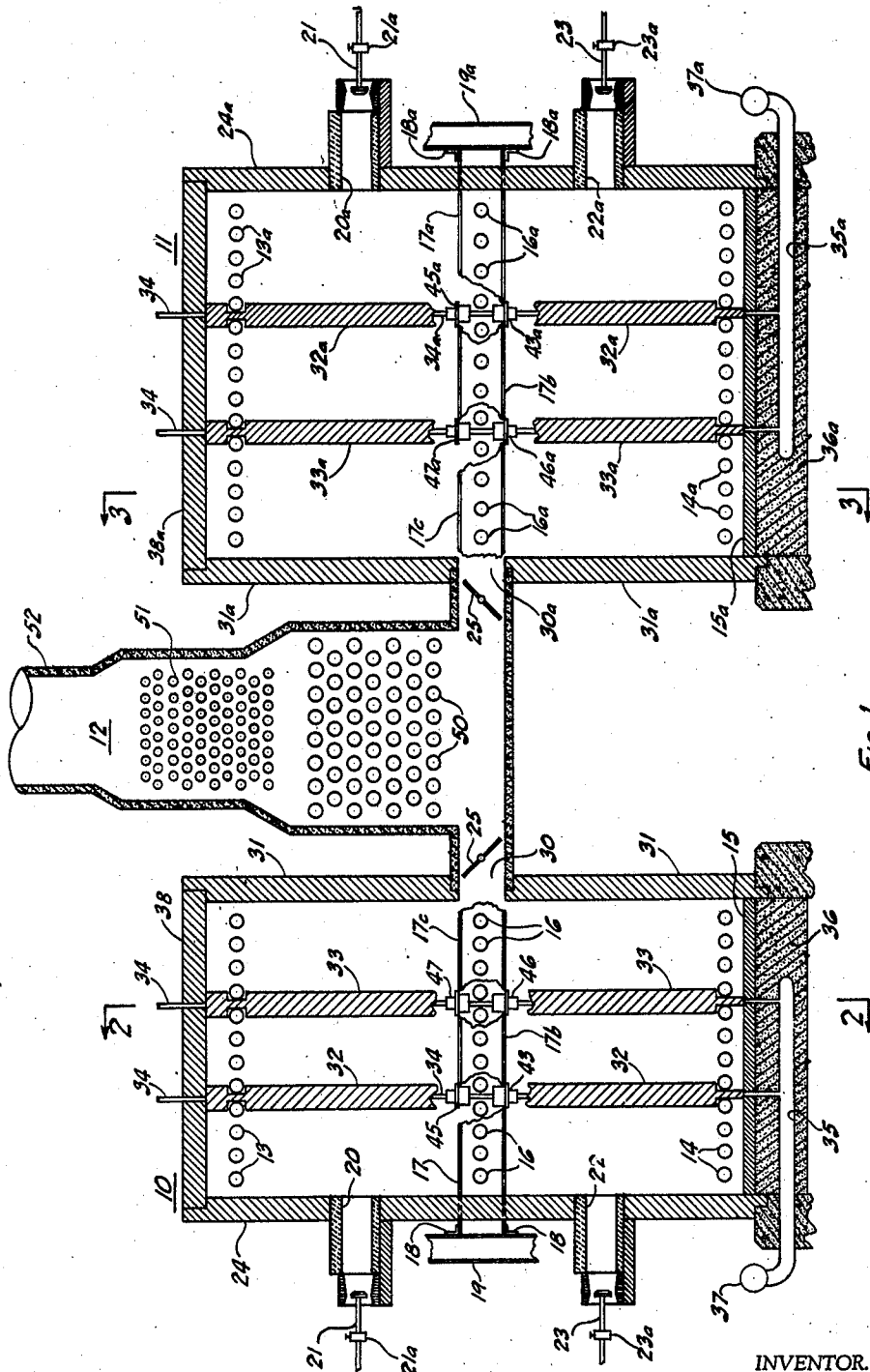


Fig. 1

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3 Sheets-Sheet 2

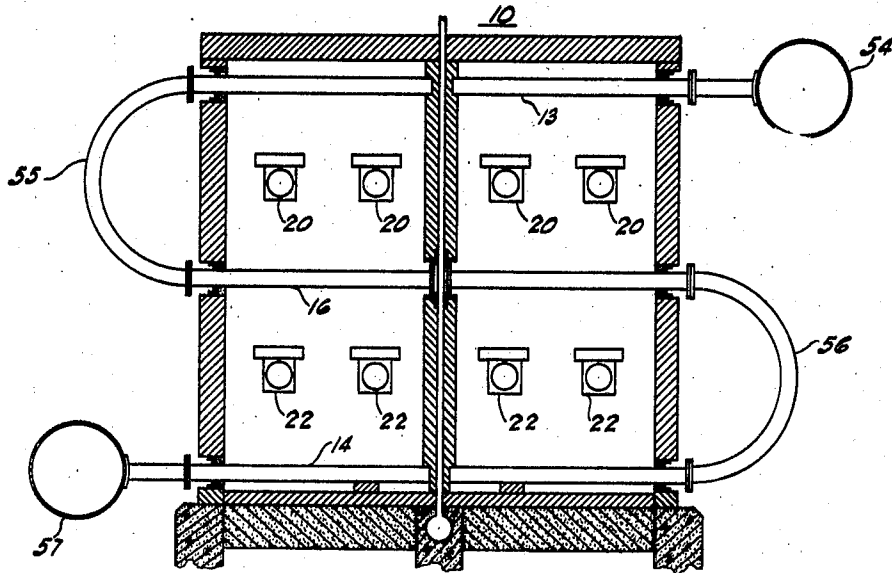


FIG. 2

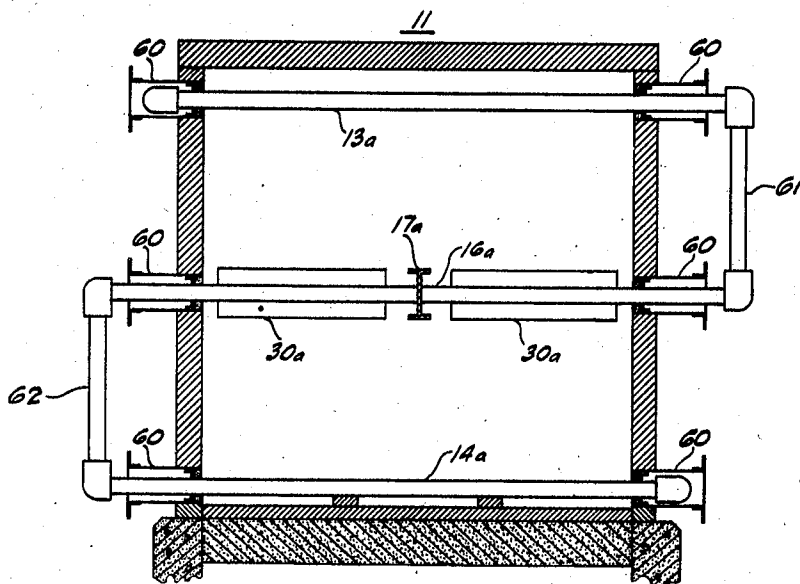


FIG. 3

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3 Sheets-Sheet 3

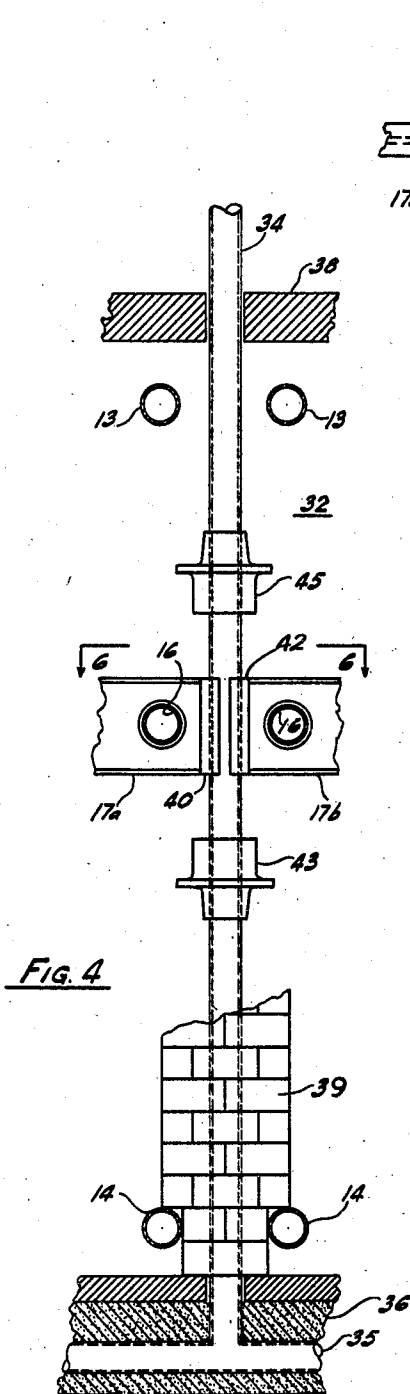


FIG. 4

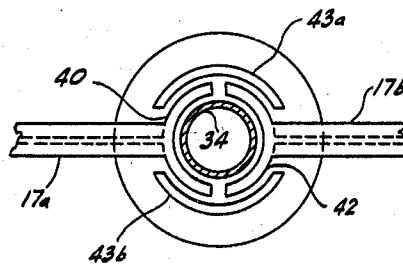


FIG. 6

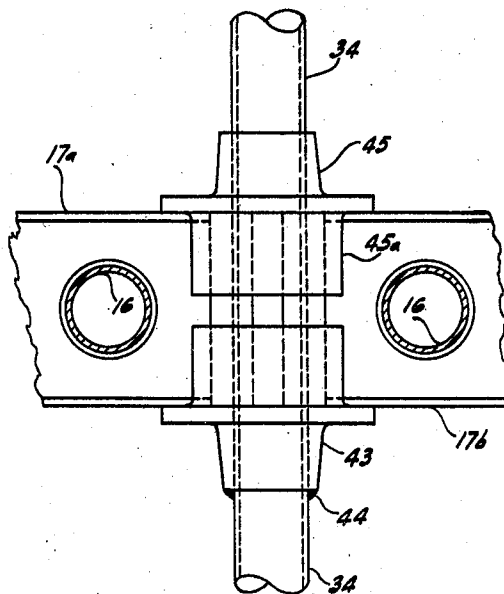


FIG. 5

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PETROLEUM HEATER

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Application June 8, 1942, Serial No. 446,300

10 Claims. (Cl. 122—240)

My invention relates to heaters, more particularly to heaters of the type used by heating petroleum, its components, and similar fluids, and has for an object the provision of a heater, the heating capacity of which is large in comparison with the cubical content of the heater.

In my concurrently filed application Serial #446,298, and entitled "Petroleum heater," I have disclosed and claimed heaters having a plurality of tubes disposed in rows along the roof and floor of each fire chamber together with an intermediate row of tubes extending horizontally across each fire chamber. In my concurrently filed application Serial #446,299, entitled "Method and means of supporting heater tubes," I have disclosed and claimed fluid-cooled pillars which provide for the support of the intermediate bank of tubes.

In accordance with my present invention, a plurality of streams of still-burning gases are directed horizontally between adjacent tube banks. These gases travel across the tube banks and exit through outlets located substantially in line with the intermediate row or bank of tubes, after which the gases traverse a convection section for the absorption of additional heat therefrom. The intermediate bank of tubes is supported by means of tube sheets supported at each end by steel columns and intermediate its ends by means of pillars having distinctive and novel features of design which will be more fully set forth hereinafter.

For a more complete understanding of my invention, reference is to be had to the drawings in which:

Fig. 1 is a sectional elevation of a heater embodying my invention;

Fig. 2 is a section taken on the line 2—2 of Fig. 1;

Fig. 3 is a section taken on the line 3—3 of Fig. 1;

Fig. 4 is an enlarged elevation, partly in section, of one of the intermediate supporting pillars, and illustrates certain of the parts in positions prior to final assembly;

Fig. 5 is an enlarged elevation, partly in section, illustrating the final positions of the parts which mechanically interconnect the intermediate tube sheets; and

Fig. 6 is a view taken on the line 6—6 of Fig. 4.

Referring to Fig. 1 of the drawings, I have shown my invention in one form as applied to a pair of heaters 10 and 11 disposed back to back on either side of a common convection section 12. The heater 10 is provided with a bank of roof

tubes 13 supported from structural steel and by tube sheets in the usual manner. Similarly, a bank of floor tubes 14 is supported adjacent the floor 15. An intermediate row or bank 16 of horizontally extending tubes is supported by means of a tube sheet 17 secured at one end by suitable means such as the angles 18 to an external steel column 19 which forms a part of the external steel framework (not shown).

The intermediate tube bank 16 functionally divides the heater 10 to form one fire chamber between the banks 13 and 16 and another fire chamber between the banks 14 and 16. By means of a plurality of muffles 20, streams of still-burning combustion gases are directed horizontally across the upper fire chamber and intermediate the tubes of banks 13 and 16. Suitable fuel, such as gas or oil, is introduced into each muffle 20 by means of burners 21, each provided with a control valve 21a. Similarly, muffles 22 direct horizontally across the lower fire chamber streams of still-burning gases which result from the introduction of fuel into the muffles by means of burners 23, each controlled by a valve 23a. As shown in Figs. 1 and 2, four muffles 20 and four muffles 22 extend horizontally along the front wall 24 of the heater 10, although as many may be provided as needed for a particular length of the tubes.

To increase the capacity of the heater 10, the tubes of each bank may be made longer, with concurrent increase in the number of muffles and burners. Enough burners and muffles are provided to insure the burning of the desired amount of fuel in streams of gases which extend generally horizontally across and between the tube banks. By sub-dividing the fuel streams and by directing the still-burning gases by means of muffles 20 and 22, convection contact with the tubes of the banks is to large extent avoided. By increasing the number of muffles, the desired amount of fuel may be burned within the fire chambers to provide for the release or generation of the required amount of heat which, by way of example, may vary from twenty to one hundred million B. t. u.'s per hour. The fuel is partially burned within the muffles themselves to insure complete combustion thereof and in avoidance of undesirable secondary combustion of fuel in and around oil-conducting tubes.

The streams of gases extend generally across the respective fire chambers and exit therefrom through ducts or openings 30, which extend horizontally along the rear wall 31 of the heater 10 and to large extent they coincide or are in alignment with the intermediate bank 16. In conse-

quence, the streams of gases flow across each fire chamber and toward the openings and in avoidance of all tubes. In fact the flow is largely away from both the roof and floor banks 13 and 14 and although towards the intermediate bank 16, the tendency of the gases to flow upwardly or downwardly across the tubes of bank 16 is avoided. Since the gases are withdrawn through the openings 30, rising gases from the lower muffles 22 meet descending gases from the muffles 20 and any tendency of a material or substantial flow of gases over the intermediate tubes is counteracted. As shown in my said application Serial #446,298, separate exit openings may be provided intermediate the respective fire chambers, but in accord with my present invention the particular location of the two openings or ducts 30 results, with the proper control of draft, in the substantial avoidance of convection transfer with the intermediate tubes. Overheating of tubes by simultaneous application of radiant heat and variable and excessively high rates of heat transfer by convection heat is avoided. Preferable the stack draft and the setting of each damper 25 is such that there is positive flow of gases along the paths described above.

As explained more at length in my co-pending application, Serial #446,299, particular attention must be given to the support of the intermediate bank of tubes. In accordance with my present invention, the tube sheet 17 is supported intermediate its ends on two pillars 32 and 33 of identical construction and only one of which, the pillar 32, needs be described in detail. The pillar 32 comprises a hollow metal member such as the pipe 34, the base of which is rigidly secured, as by welding, to a hollow steel member such as the pipe 35, itself embedded in the concrete floor 36 of the heater 10. The pipe 35 connects with a header 37 for the ingress of cooling air or steam, which passes through the pipe 35 and into the supporting pipes of each of the pillars 32 and 33. The air exits from the upper end of the pipe 34 at a point above the roof 38 of the heater 10. Though the natural draft may be adequate to insure flow of a sufficient quantity of cooling air, it is to be understood that a small fan (not shown) may be utilized, for example, in the header 37, or a small amount of steam may be introduced directly into the pipe 35 by means of a steam jet (not shown). In any event, a cooling medium is circulated through the pipe 34 in amount adequate to maintain its temperature below that at which it would lose a large part of its strength. The pipe 34 is surrounded by ceramic refractory heat-insulating material 39 which, as shown in Fig. 4, may be semi-circular in shape or it may be of segmental form. The heat insulation together with the circulation of the cooling medium maintains the metal pipe 34 safely within its normal working range of temperature. For heaters designed for high temperature operation, it will of course be understood that pipe 34 as well as the tube sheets may be of heat-resisting alloy.

As best shown in Figs. 4, 5, and 6, the tube sheet 17 is preferably made in three or more parts. For example, section 17a extends from the steel column 19 of Fig. 1 to the pipe 34, Fig. 4, and there terminates in, or has welded to it, a semi-circular shape 40 whose inner diameter is slightly larger than that of tube 34. Similarly, the tube sheet section 17b terminates in a semi-circular shape 42. In order to anchor and support tube sheet sections 17a and 17b in fixed posi-

tions, a supporting and coupling member 43 is shown in Fig. 4 as encircling the pipe 34. During construction of the heater the coupling member 43 is moved to the position shown in Fig. 5 and rigidly secured in place as by welding, a welding bead being shown as at 44. The coupling member 43 is provided with two circular elements 43a and 43b, the inner diameters of which are slightly larger than the outer diameters of the shapes 40 and 42. Hence, when moved into final position, the elements 43a and 43b partially encircle and lock in fixed position the shapes 40 and 42, while the slight clearance provided between the parts provides for some expansion. A second coupling member 45 of identical construction with that of member 43 is, during the construction of the heater, moved from the position shown in Fig. 4 to its final position as shown in Fig. 5 and its two circular elements similarly encircle and lock into position the shapes 40 and 42 of the tube sheets 17a and 17b. In Fig. 5 only one of such elements, the element 45a, is shown. The coupling member 45 need not be welded to the pipe 34. It is to be understood that coupling elements 46 and 47 rigidly interlock and support the respective ends of tube-sheet sections 17b and 17c, as shown in Fig. 1.

The main structural or weight-bearing member of pillar 32 of course comprises the pipe 34. The wall thickness of the pipe is selected with reference to its height and the weight it is to support. Its inner diameter is determined with reference to the character and quantity of cooling medium to be circulated therethrough. In a typical embodiment of my invention, pipe 34 may have an inner diameter of four inches, a wall thickness of one-half inch, for a fire chamber 10 or 12 feet in height. From 25 to 30 cubic feet of air per minute may be readily circulated there-through, or a mixture of low temperature steam and air may be used. Where the pipe 34 is of ordinary carbon steel it is desirable to provide for additional cooling in order to keep the temperature of the pipe within its safe working range, whereas for a pipe or structural member of an alloy including substantial percentages of nickel and chromium, less cooling is required since the strength of such an alloy does not decrease with temperature as rapidly as that of carbon steel. In either case, the refractory heat insulation surrounding the tube or structural member 34 preferably has a thickness of approximately 4 inches.

Insofar as shown in Fig. 1, the heater 11 is of substantially identical construction with the heater 10 and I have therefore marked corresponding parts with the same reference numerals as for the heater 10, except that to most of them there has been added thereto the subscript *a*.

The combustion gases from the respective heater 10 and 11 pass directly into a convection section common to both heaters. First, the gases pass in convective heat exchange with a bank of tubes 50 and then in heat exchange with a bank of tubes 51. The tubes 51 are shown of smaller diameter and in some cases this may be desirable for a petroleum heater, or the tubes 51 may be used for the heating of steam. The convection section terminates at the base of a stack 52 only a fractional part of which is shown in Fig. 1.

A heater embodying my invention is particularly well adapted for the solution of certain unusual and difficult heating problems. For example, where low pressure drop is a prime requisite, all of the tubes 13 may be directly connected to an inlet header 54 as shown in Fig. 2. The en-

tering fluid, hydrocarbon gases or hydrocarbon vapors, in subdivided streams flows through the several roof tubes 13 and by means of a series of return bends 55 then flows directly through corresponding intermediate tubes 16, thence by way of return bends 56 flows through corresponding floor tubes 14 and into a collecting or outlet header 57. The vapor or gases may be rapidly and uniformly heated to high temperature with a minimized low pressure drop, of the order of a few pounds per square inch. Heat is uniformly applied substantially solely by radiation to the roof tubes 13 and to the floor tubes 14. Heat is uniformly and to large extent applied by radiation to the intermediate tubes 16 and substantially uniformly throughout the entire circumference thereof. It is to be further observed that the small amount of heat transferred to the tubes 16 by convection or by movement of hot gases over them is relatively uniform and the tendency toward "hot spots" or excessive application of heat is avoided.

It is to be understood that the tubes may be connected for any desired flow of fluid there-through; as for example, the tubes 13 may be interconnected by means of headers for serial flow through the roof bank and thence for serial flow through the intermediate and floor tube banks 16 and 14. As shown in my co-pending application Serial #446,298, there may be more tubes in the intermediate bank 16 than in either the roof or floor tube banks. For example twice as many tubes 16 may be provided, in which case all of the tubes 16 could be connected to an inlet header, with every other tube 16 being connected to a floor and a roof tube, with outlet headers interconnecting the floor and roof tube banks. Such an arrangement would provide for a further decrease in pressure drop for given conditions.

An alternative arrangement of flow is shown for the heater 11 in Fig. 3. Conventional header boxes 60 are illustrated in single line and headers are enclosed therein for the interconnection of the tubes of the respective banks 13a, 16a, and 14a, the bank 13a being connected by means of transfer line 61 to the bank 16a and the latter connected by transfer line 62 to the floor tube bank 14a. The foregoing serially connected tubes may also be connected in series with tubes 50 in the convection section. In Fig. 3 it will be observed the tube sheet 17a is shown as a structural member of I-shape, although other suitable structural shapes may be used for the tube sheets. It will be observed from Fig. 3 that the outlet openings 30a are located on either side of the tube sheet 17a and it is to be understood that the tube sheet extends through the inner wall 31a of heater 11 and that it is anchored to a steel column in manner as shown for the steel column 19a. Similarly the tube sheet 17 extends through the rear wall 31 of heater 10 and is supported by a similar steel column (not shown).

While I have shown embodiments of my invention, it is to be understood I do not limit myself thereto, but by the appended claims I intend to cover all modifications which fall within the spirit and scope of my invention.

What I claim is:

1. In a heater having refractory walls, the combination of banks of tubes disposed in single rows and respectively adjacent to opposite walls thereof, an intermediate bank of tubes disposed in a single row intermediate said first-named banks,

fuel burners disposed intermediate the adjacent banks for directing still-burning gases between and across and generally in spaced relation with said banks, and outlet means for the flow of gases from said heater extending along the side of said intermediate bank remotely located from said fuel burners for restricting the flow of the outgoing gases generally to the region of said intermediate bank.

2. In a heater, the combination of walls forming a fire chamber, a bank of roof tubes and floor tubes disposed horizontally along the roof and floor of said fire chamber and an intermediate bank of tubes extending generally horizontally across said fire chamber, a plurality of burners for directing streams of still-burning gases generally horizontally between said roof and said intermediate banks, and between said floor and said intermediate banks, and means for withdrawing gases from said fire chamber comprising outlet means restricting the flow of gases from said fire chamber to a region remote from said burners and generally within the horizontal plane of said intermediate bank of tubes.

3. The combination set forth in claim 2, in which said intermediate bank of tubes is supported by means including a tube sheet, said tube sheet extending beyond the front and rear walls of said fire chamber, said withdrawing means being located on either side of said tube sheet for the substantial avoidance of convection contact of the gases with said tube sheet.

4. The combination as set forth in claim 2, in which the tubes of said intermediate bank are interconnected and supported by a tube sheet subdivided into sections, supporting pillars intermediate each section, and coupling members extending in interlocking relationship with each pillar and said tube sheet sections.

5. In a heater having refractory walls forming a fire chamber, the combination of a bank of horizontal tubes disposed adjacent the roof and the floor of said fire chamber, an intermediate bank of horizontal tubes disposed between said roof and floor tube banks and as a bank extending generally across said fire chamber and spaced from said roof and floor tube banks, a plurality of burners spaced horizontally along the front wall of the heater for directing a plurality of streams of burning fuel above and below said intermediate bank of tubes and in spaced relation with, and to a large extent in avoidance of, the tubes of each of said banks, and means including an outlet passage through the rear wall of the heater for withdrawing combustion gases, said outlet passage extending along said rear wall and generally coinciding with the horizontal extent of said intermediate bank.

6. In a heater having refractory walls forming a fire chamber, the combination of a bank of horizontal tubes disposed adjacent the roof and the floor of said fire chamber, an intermediate bank of horizontal tubes disposed between said roof and floor tube banks and as a bank extending generally across said fire chamber and spaced from said roof and floor tube banks, a plurality of burners spaced horizontally along the front wall of the heater for directing a plurality of streams of burning fuel above and below said intermediate bank of tubes and in spaced relation with, and to a large extent in avoidance of, the tubes of each of said banks, a tube sheet for said intermediate bank of tubes extending across said fire chamber and beyond the front and rear walls thereof, outlet passages for withdrawing

flue gases disposed on opposite sides of, and in spaced relation with, said tube sheet, each said outlet passage having a length considerably greater than the height thereof, and each said passage generally coinciding with the plane of said intermediate bank.

7. The combination as set forth in claim 6, in which said tube sheet is supported in part by an intermediate pillar, and means for circulating a cooling medium through said pillar.

8. The combination as set forth in claim 6, in which said tube sheet is supported intermediate its ends upon a pillar, said pillar comprising a tubular member supported below the floor of said chamber and extending vertically through the fire chamber and above the roof thereof, refractory heat-insulation surrounding said pillar and shielding it from the heat of said fire chamber, and means for producing a flow of a cooling medium through said tubular member to prevent loss of strength due to excessive rise of the temperature thereof.

9. In a heater, the combination of walls forming fire chambers disposed back to back and a separate convection section intermediate said fire chambers, a bank of horizontal tubes extending across and intermediate each of said fire chambers, and banks of roof and floor tubes respec-

tively disposed adjacent to the roof and floor of each said fire chamber, fuel burning means disposed in horizontal rows above and below said intermediate banks of tubes for directing a plurality of streams of still-burning gases above and below said intermediate banks of tubes and in avoidance of all of said banks of tubes in each of said fire chambers, openings in each of the rear walls of said fire chambers generally coinciding with the location of each said intermediate bank of tubes, ducts leading from each of said openings to said convection section, and tubes within said convection section heated by convection from the combined currents of combustion gases from said fuel burning means.

10. Means for supporting an intermediate bank of tubes within a fire chamber, comprising a tubular member extending vertically through said fire chamber, a tube sheet for said intermediate bank of tubes terminating at its end in a semi-circular shape for partly encircling said tubular member, means supported by said tubular member and disposed in interlocking engagement with said semi-circular shapes for holding them in place and for supporting a part of the load on said tube sheets, and means for producing flow of a cooling medium through said tubular member.

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