This invention relates to fluid heating apparatus and more particularly to a furnace for heating oil in tubes.

The invention has among its general objects to provide a furnace wherein fluid-handling tubes may be subjected from opposite sides to radiant heat and withal to provide a furnace wherein other fluid-handling tubes may be heated by combined radiant and convected heat and still other tubes by convected heat alone. Other more detailed objects will more freely appear hereinafter.

Generally speaking, the present invention provides a walled structure forming a closed furnace chamber wherein are provided a plurality of combustion chambers divided by bridge walls thus forming sections A and B. Section A is of course the main furnace chamber. Rising from the floor of chamber A are a succession of refractory walls forming a succession of compartments 15 and 16. These walls preferably extend the full width of the chamber; terminate a substantial distance below the roof; may be and preferably are multi-apertured as indicated at 18 and are supported on pedestals 19. Any suitable means not shown may be employed for bracing the walls against lateral deflection.

Compartments 18 constitute combustion chambers wherein fuel delivered by any suitable burners generally indicated at 20 is burned. The kind of fuel used is immaterial but will ordinarily be oil or gas. The burners preferably fire from opposite ends of the respective combustion chambers and there may be a vertical series of such burners for each chamber. For illustrative purposes, only one burner at each end of each combustion chamber is shown.

The hot gases generated in the combustion chambers flow upwardly between the walls forming such chambers and into the space immediately below the roof of the closed chamber, thence over the bridge wall and downwardly through chamber B on their way to the opening leading to the stack, not shown. Mounted in chamber B is a bank of tubes C, the bank being heated by the outgoing gases of combustion as will be readily understood and hence may be termed a convection bank. The lower and upper terminals of the bank are indicated at 22 and 23, respectively, and are un derstood that the tubes are serially connected. As shown, these tubes extend through the side walls 12 of the closed chamber and at their outer ends are serially connected by removable return bends.

In the space immediately below the roof is provided a bank of tubes F which may extend lengthwise or crosswise of the roof. As shown they extend crosswise and out through the side walls 12 of the closed chamber and at their outer ends are connected by removable return bends. One terminal of this bank is indicated at 27. While I have shown but a single row or level of tubes as comprising bank F nevertheless it will be readily understood that there may be several of such rows one above the other.

Arranged in each of the compartments 16 is a bank of tubes D. Since each of the compartments or heating chambers 15 is bounded or flanked by combustion chambers 16, the walls...
separating the respective chambers will be heated to incandescence with the result that the tubes comprising the respective banks D will be heated by radiant heat from opposite sides. This is an important feature of the invention and quite apart from other features marks a decided improvement in the art of oil-heating furnaces.

Due to the fact that the walls 17 are in parallelism, are of considerable height and open into a space below the roof 10 of the closed chamber, there is produced a chimney effect tending to cause the gases of combustion to flow directly upward rather than laterally through the apertures 18, even though the individual apertures may be of substantial sectional area. These apertures may be termed radiant gaps since they permit heat from the flames to be radiated directly into the heating chambers 18. Such gases of combustion as may flow through the apertures are not objectionable but rather set up a desirable circulating effect in the heating chambers. The apertures also permit more uniform and rapid heating of the walls 17.

In the space between the bridge wall 14 and the adjacent radiant walls 17 is a bank of tubes D corresponding to the banks D and in the space between the end wall 13 of the closed chamber and the adjacent radiant wall 17 is a bank of tubes E also corresponding to the banks D but being of greater height for connection with the bank D.

Bank C is of course heated solely by convection whereas bank D is heated partly by convection and partly by radiant heat.

As shown in Figs. 1 and 5 the banks C, D, E and F are in series connection in the order named.

The course of the fluid to be heated may be through the banks in the order named as shown in Fig. 5 or in the reverse order as shown in Fig. 1 depending upon the particular oil processing method used. In Fig. 1, pump P is shown as coupled to terminal 27 of bank F for forcing the oil first through that bank and then through the other banks as will be readily understood whereas in Fig. 6 pump P is shown as delivering directly to bank C.

In Figs. 1, 2 and 4, those tubes of banks D, D', E and F that are in a common level are shown as connected in series by pipes 24 with the various levels connected in series. However in so far as the present invention is concerned it is immaterial whether the said tubes be connected in that manner or in some other manner. Thus as shown in Fig. 6 the tubes comprising such individual banks may be connected in vertical series and the various banks connected in series. In Fig. 6, reference characters A, AD, AE and AP correspond to reference characters D, D', E and F, respectively, in the other figures.

Instead of connecting the tubes of the radiant banks by pipes 24 which are wholly outside of the closed chamber as shown in Fig. 2, they may be connected as shown in Fig. 5. That is to say, the adjacent tubes D in a common level may be connected by a pipe 24' so formed as to extend back into the chambers 15 and then alongside of the inner side of wall 12 and through the combustion chamber 19 that communicates the heating chambers 15. The danger of overheating such connecting pipes 24' is reduced to a minimum since they are located in close proximity to the relatively cool outer walls 12 of the closed chamber.

Since the tubes comprising the various banks extend through the opposite side walls 12 of the closed chamber they may be readily cleaned and replaced as necessity demands, the various connections at the outer ends of the tubes being removable for that purpose as will be readily understood.

Instead of providing an upstanding bridge wall 14 as in Fig. 1, there may be provided a depending bridge wall 14' as in Fig. 7 with the result that the bank D corresponding to the bank D' in Fig. 1 will be heated partly by radiation from the adjacent radiant wall 17 and partly by downgoing gases of combustion. Within the chamber B thus formed by the bridge wall 14' is an upstanding bridge wall 14, the outlet from the chamber being indicated at 21'. Two banks of tubes C' and C' are located in chamber B'. Bank C' is shown in series connection with bank F and bank D' with bank C'. With this hook-up the course of the oil would be first through connection bank C', thence through roof bank F, thence through the next succeeding banks between banks F and D', and finally through banks D' and C'. P' indicates a pump for circulating the oil in the manner just described.

While I have shown and described a number of different hook-ups that may be used nevertheless it will be understood that the present invention is primarily concerned not so much with any particular hook-up as with a furnace that is readily adapted for such hook-ups or in other words with a furnace construction as particularly set forth in the appended claims.

What I claim is:

1. A furnace comprising in combination a series of combustion and heating chambers arranged in alternating relation and separated by heat-permeable walls, means for burning fuel in the combustion chambers, fluid-handling tubes in said heating chambers, and a chamber common to all of the said chambers for receiving combustion gases from the combustion chambers.

2. A furnace comprising in combination a series of combustion and heating chambers arranged in alternating relation and separated by heat-permeable walls, means for burning fuel in the combustion chambers, fluid-handling tubes in said heating chambers, and a chamber common to all of the said chambers for receiving combustion gases from the combustion chambers, said walls being apertured to permit hot gases in the combustion chambers to radiate heat directly into the next adjacent heating chamber.

3. A furnace comprising in combination a series of combustion and heating chambers arranged in alternating relation and separated by heat-permeable walls, means for burning fuel in the combustion chambers, fluid-handling tubes in said heating chambers, a chamber common to all of the said chambers for receiving combustion gases from the combustion chambers, and fluid-handling tubes arranged in said common chamber.

4. A furnace comprising in combination a succession of upright heat-permeable walls forming a succession of open-top compartments, fluid handling tubes in alternate of said compartments, means for introducing fuel into the other of said compartments, and a compartment above 70 and in direct communication with said compartments for receiving gases resulting from the combustion of said fuel.

5. A furnace comprising in combination a walled structure forming a closed chamber, fluid-
handling tubes arranged immediately below the roof of said chamber, other fluid-handling tubes arranged in laterally spaced banks below the roof tubes, and a combustion chamber between each pair of adjacent banks and formed by a pair of laterally spaced walls between such banks, said walls terminating a substantial distance below the roof of said closed chamber whereby the roof tubes will be heated by the hot gases coming from the various combustion chambers.

6. Fluid heating apparatus comprising a walled structure forming a closed chamber, fluid-handling tubes arranged in said chamber in a radiant bank and in a convection bank, said radiant bank being formed in several groups of tubes positioned in compartments separated by radiant heating walls, and one group covering a substantial portion of the roof of the closed chamber, heating compartments in said chamber formed by said radiant heating walls, means for generating hot gases in said heating compartments and means for circulating gases from the heating compartments across the roof tubes and through the convection bank.

7. In combination, a walled structure forming a closed furnace chamber, fluid-handling tubes arranged within and projecting through the walls of the chamber, and means for connecting adjacent paired ends of said tubes comprising a U-shaped conduit the bend of which is within said chamber between said tubes and the legs of which extend outwardly through the same wall as the tubes to be connected, the outer terminals of said legs being connected to the respective ends of said paired tubes.

8. In combination, a walled structure forming a closed furnace chamber, fluid-handling tubes arranged within and projecting through the walls of the chamber, a combustion chamber between the tubes, and means connecting adjacent paired ends of tubes on either side of the combustion chamber comprising a U-shape conduit the bend of which is located in said combustion chamber and the legs of which extend outwardly through the same wall as the tubes to be connected, the outer terminals of the legs being connected to the respective ends of said paired tubes.

9. A furnace comprising, in combination, a walled structure forming a closed chamber, a series of pairs of walls extending upwardly from the floor of the chamber, each pair constituting the side walls of a combustion chamber, said walls terminating short of the roof of said walled structure whereby to provide an exhaust passage common to all of said combustion chambers, and fluid-heating tubes arranged between the adjacent combustion chambers.

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