

March 31, 1936.

H. D. LOEB

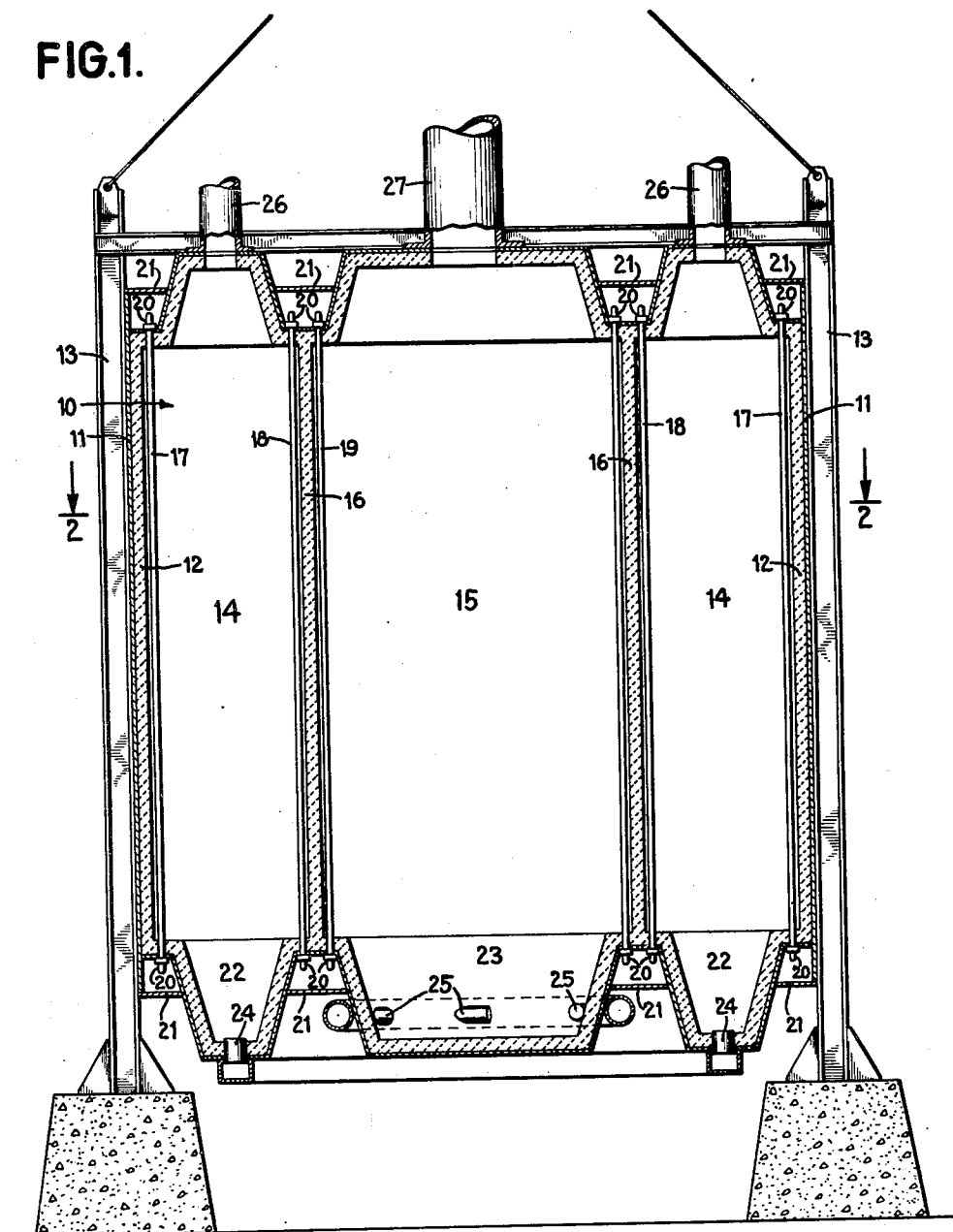
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FURNACE FOR HEATING FLUIDS

Filed Dec. 7, 1933

3 Sheets-Sheet 1

FIG. 1.



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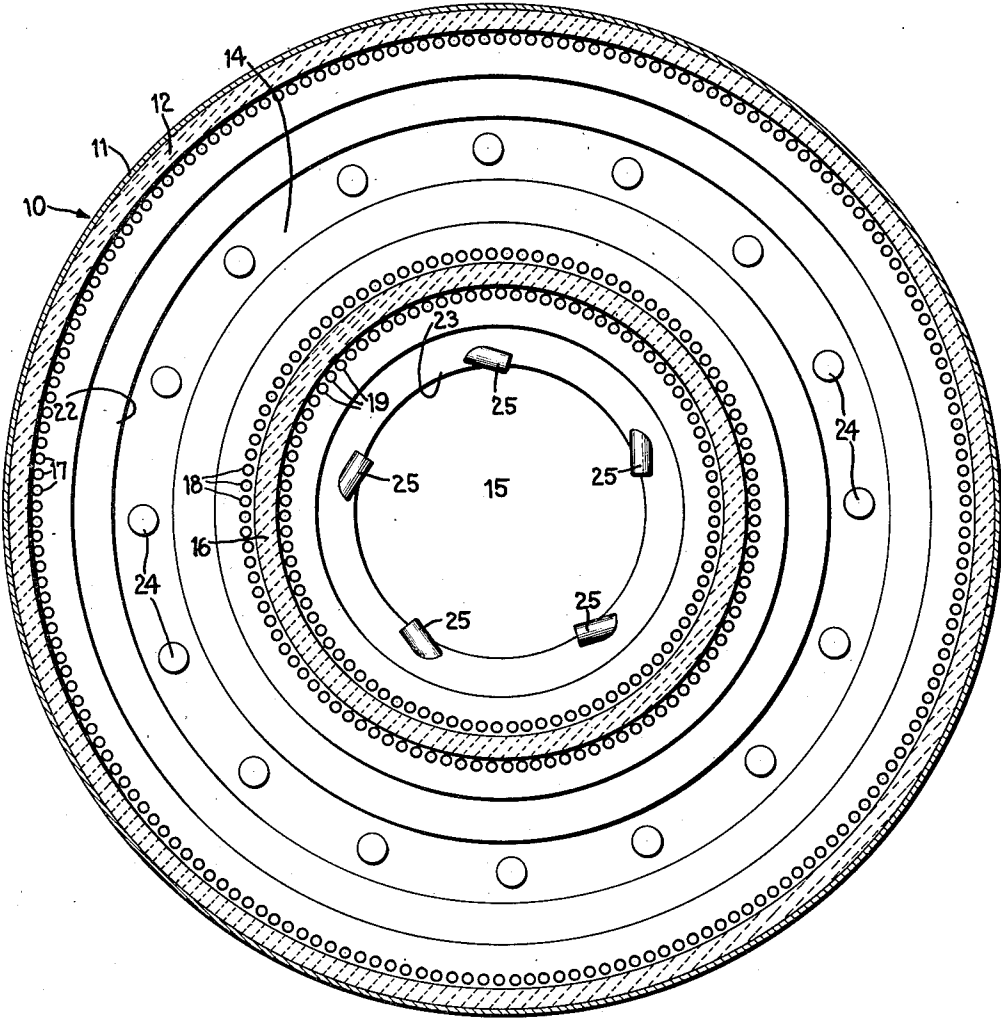
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Filed Dec. 7, 1933

3 Sheets-Sheet 2

FIG.2.



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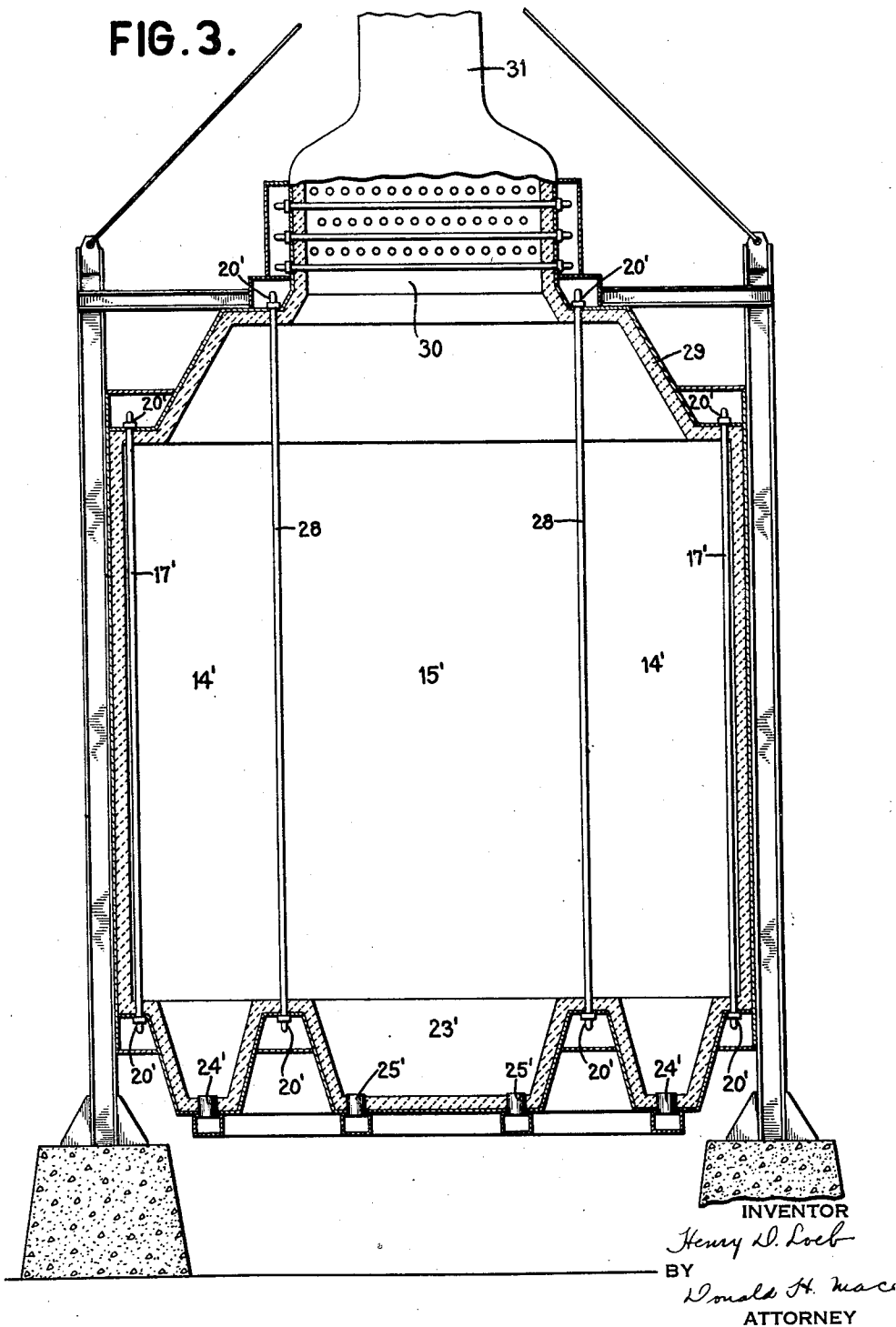
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FURNACE FOR HEATING FLUIDS

Filed Dec. 7, 1933

3 Sheets-Sheet 3

FIG. 3.



UNITED STATES PATENT OFFICE

2,035,900

FURNACE FOR HEATING FLUIDS

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Application December 7, 1933, Serial No. 701,325

3 Claims. (Cl. 196—116)

This invention relates to furnaces and has particular reference to furnaces for heating fluids in which the fluids are heated to the required temperature while passing through a series or bank or interconnected tubular members mounted within a furnace chamber.

While the invention will have wider application, as will be manifest from the detailed description hereinafter, it is of particular advantage for the pyrolytic treatment of hydrocarbon oils in which a stream, or a plurality of streams, of oil to be treated are heated to the required temperature during passage through banks of interconnected tubes located in a furnace setting. In the pyrolytic treatment of hydrocarbon oils it has been found that by heating the oil rapidly and uniformly to the final desired temperature there is less formation and deposition of coke within the heating tubes.

In modern refining operation it may be a desirable practice to simultaneously heat a plurality of independent streams of oil having different characteristics in a single furnace. These different streams of oil ordinarily require different heat treatment.

My invention provides a heating apparatus particularly adapted to heat a large volume of fluid passing therethrough and if desired to simultaneously heat a plurality of streams of fluid, which may have different characteristics, to the desired temperature.

One of the principal objects of the present invention is to provide a furnace which will be more compact and more economical to construct and operate for a given heat-absorbing capacity.

Another important feature of the invention is the provision of a plurality of independent radiant heat sections within a single enclosure each of said sections being capable of separate and independent temperature control.

Another object of the invention is to provide a furnace having a plurality of separate and independent radiant heat zones arranged in concentric relation one to another whereby separate streams of oil or other fluid passing through each may be heated to the desired temperature.

A further object of the invention is to provide a furnace for heating fluids in which the fluid may be rapidly and uniformly heated to the required temperature.

Other objects and advantages of the invention will be evident from the more complete description hereinafter.

For a better understanding of the invention

reference is now made to the drawings forming a part of this application and in which:

Fig. 1 is a vertical section of a furnace embodying the invention;

Fig. 2 is a transverse section as taken along the lines 2—2 of Fig. 1 in the direction indicated;

Fig. 3 is a vertical section of a modified construction.

The invention comprehends a furnace having a plurality of independent radiant heat sections arranged in concentric relation and in each of which series, or banks, of interconnected tubular members are mounted.

As illustrated the separate concentric radiant heat sections are of circular form but it will be apparent, however, that other concentric geometric forms may be substituted such as ovals, ellipses, or rectangles. In general, however, the round or circular form of furnace construction is favored because it more readily lends itself to uniform heat distribution and the avoidance of quiescent or stagnant areas adjacent the tubes.

Referring now to the drawings the reference character 10 generally designates a furnace structure having an outer shell 11 and a refractory lining 12 suitably supported and reinforced by steel framework 13.

In the modification shown in Figs. 1 and 2 the furnace is divided into a plurality of independent chambers 14 and 15 arranged in concentric relation and separated by a refractory wall 16. While only two concentric radiant heat chambers are shown for purposes of illustration it is to be understood that additional concentric chambers may be added to those shown, if so desired.

The chambers 14 and 15 are provided with a circular bank of tubes, 17, 18 and 19, located adjacent the walls of the chambers. The individual tubes forming each of the banks 17, 18 and 19 are interconnected at their upper and lower ends by return bend connections 20 preferably located outside of the furnace so that ready access may be had to the tubes for inspection, cleaning and repairs. If desired the return bend connections may be enclosed in suitable housings 21 having removable lids.

The bottom of the radiant heat chambers 14 and 15 preferably extend below the ends of the tube banks to form an outer annular burner well 22 and an inner circular burner well 23 provided with a plurality of burner nozzles 24 and 25 respectively. The burners may be of any of conventional type capable of using solid, liquid or gas as fuel.

As illustrated the outer burners 24 are located

in bottom of the well and are preferably of the flat or fan type so as to spread the flame circumferentially of the well, whereas the inner burners 25, located in the central well, are shown disposed in tangential relation about the side walls of the well so as to set up a whirling action as the gases issue from the burners. To this end the burners 25 are preferably spaced and regulated to cause the flame from a burner to impinge upon the flame of the next adjacent burner so as to produce a circular wall of flame within the central well 23. It is to be understood that a burner arrangement similar to that described in connection with the central well may also be used for the outer well.

To obtain more uniform heat transfer throughout the full length of the tubes within the radiant heat sections it is preferable to regulate the burners so that combustion is substantially completed within the wells.

The products of combustion produced in the burner wells 22 and 23 pass upwardly through the radiant heat chambers 14 and 15, respectively, wherein heat from these hot products is radiated to the banks of tubes 17, 18 and 19 located within the furnace and out of the path of the heating gases. In this manner the tubes are heated without being directly impinged by the hot gases and a more uniform and rapid heat transfer is attained.

The products of combustion, after imparting the required heat to the fluid passing through the tubes are withdrawn from the radiant heat sections 14 and 15 through flues 26 and 27, respectively, located in the roof of the furnace. As illustrated the roofs of the radiant heat chambers 14 and 15 are preferably dome shaped, having the crowns of the domes, in which the flue ducts 26 and 27 are located, positioned above the tube banks so that channeling of the gases adjacent the outlet flues is effected within the respective domes and above the radiant heat zones, thus avoiding dead pockets and stagnant areas adjacent the tube banks.

In practice the products of combustion withdrawn from the radiant heat sections 14 and 15, through the flue ducts 26 and 27, are preferably passed to a convection chamber (not shown) wherein additional heat is abstracted by convection and then to other waste heat exchangers (not shown) such as economizers or waste heat boilers et cetera, before being finally exhausted to the atmosphere.

Fig. 3 illustrates a slightly different type of construction embodying the same principles. In this modification the central refractory wall 16 has been omitted and a single inner circular bank of tubes 28 is shown disposed between the separate radiant heat sections 14' and 15' so that both sides of the tubes 28 are exposed directly to intense radiant heat from the products of combustion in the respective radiant heat sections and consequently heat may be transferred to the fluid passing through the inner circle of tubes 28 more rapidly than when the tubes are heated from one side only. This is of particular advantage when extremely rapid heating of fluid is desired. For example, as hereinbefore mentioned, the rate of heat input is an important factor in preventing or minimizing the formation and deposition of coke within the tubes during pyrolytic treatment of hydrocarbon oils. Figure 3 illustrates a simple and compact construction wherein a more rapid and uniform heat transfer may be effected.

As a further modification Fig. 3 illustrates a slightly different roof construction than that

illustrated in Figs. 1 and 2. As shown in Fig. 3 the roof is in the form of a single dome 29 and the products of combustion from both radiant heat sections 14' and 15' are withdrawn through a central convection section 30 where further heat is abstracted and thence through a central flue 31 to other waste heat exchangers (not shown) before being exhausted to the atmosphere.

When a single central withdrawal flue is provided as here shown, it is preferable to regulate and control the burners 24' and 25' so that the products of combustion project upwardly in a vertical direction for substantially the full height of the radiant heat sections before converging to central withdrawal flue 31.

It will be manifest that this type of roof construction is not dependent on the presence or absence of a refractory wall between the radiant heat zones 14' and 15' and that if desired a roof construction like that illustrated in Figs. 1 and 2 may be employed with radiant heat sections separated simply by banks of tubes such as illustrated in Fig. 3 or if desired, a roof construction such as illustrated in Fig. 3 may be employed with a refractory wall separating the radiant heat sections as shown in Figs. 1 and 2. In the latter case it will be desirable to terminate the dividing refractory wall below the roof so as to provide communication between the outer radiant heat zone with the central withdrawal flue 31. When a separating refractory wall is provided between the radiant heat sections in conjunction with a single dome roof construction, such as illustrated in Fig. 3, the refractory wall may extend to any desired height within the furnace. It is ordinarily preferable to extend the refractory wall up into the dome and have it terminate a short distance below the roof so that the products of combustion flow the full length of the outer radiant heat section before converging toward the central flue.

As further illustrated in Fig. 3 the inner circular bank of tubes 28 are of greater length than the outer bank 17' and project upwardly through the dome of the roof where the ends of the adjacent tubes are interconnected by return bend connections 20'.

Instead of a single row or bank of tubes 28 between the radiant heat sections 14' and 15' as shown in Fig. 3, a plurality of circular banks or rows of tubes may be provided, in which case the tubes in each circular row are preferably arranged in staggered relation to the tubes in the next adjacent row.

In addition Fig. 3 shows the burners 25', for heating the central radiant zone 15', positioned in the bottom of the burner well 23' adjacent the periphery rather than in the side walls of the burner well as shown in Figs. 1 and 2. It will be apparent that the burners may be mounted either in the side walls or in the bottom of the burner wells or both and that the burners may be mounted either tangentially or otherwise so as to effect a uniform and an equal distribution of heat within the radiant heat zones.

The tubes within the different sections of the furnace may be interconnected so that the fluid to be heated may pass therethrough in any desired sequence conducive to bringing the fluid to the final temperature at the proper rate. For example, the banks of tubes (17, 18 and 19 as shown in Fig. 1 and 17' and 28 as shown in Fig. 3) may be interconnected so that a single, or plurality of independent, streams may be passed either in series or in parallel through all of the

respective banks or each bank may be maintained independent, in which case a single, or plurality of independent streams, may be caused to pass through each bank.

5 In the pyrolytic treatment of hydrocarbon oil, for example, a single stream of oil may, if desired, be passed through the central banks of tubes (18 and 19 in Figs. 1 and 2, and 28 in Fig. 3) wherein the oil is rapidly and uniformly heated to conversion temperature, after which it may pass through the outer bank where it is permitted to soak at the conversion temperature for a definite period before being passed to other apparatus for separation of the converted products. As
10 a further illustration a separate and independent stream of oil may be passed through each bank of tubes and then passed to other apparatus for further treatment.

It is to be understood, however, that the examples given above are simply for illustrative purposes and that the invention is not directed primarily to any specific sequence for the passage of fluid.

The invention thus provides a furnace for heating fluids which is compact and which has an increased heating capacity per unit area with a consequent reduction in construction costs for a furnace of given capacity. In addition the reduction in size of the furnace for a given capacity, made possible by the construction embodying my invention, reduces the total radiation losses with a resultant increase in overall efficiency. For example, by simple mathematics it can be demonstrated that upwards of 65% of heat liberated may
25 be recovered in the radiant heat zones whereas in previous types of furnaces used in oil cracking service recovery in the radiant heat section seldom exceeds 60% and ordinarily not over 50%.

Moreover, by heating opposite sides of the banks of tubes by radiation as illustrated in Fig. 3, a more rapid heating of the fluid may be effected.

Another important advantage of my invention is that the burners for each of the radiant heat zones may be independently regulated so that any desired temperature conditions may be maintained within the respective radiant heat zones.

While the burners have been shown located in wells disposed in the bottom of the furnace, a flat bottom furnace may be employed, if desired. Also, the burners may be located in the roof of the furnace and the products of combustion caused to pass downwardly rather than upwardly as here shown.

55 Having described the invention in its preferred forms it is understood that various other modifications may be made without departing from the spirit and scope of the invention and that no limitations are to be imposed except as necessary to distinguish from prior art.

What I claim is:

1. A furnace for subjecting hydrocarbons to a cracking temperature comprising refractory side, top and bottom walls forming a substantially
65 cylindrical furnace enclosure, an inner refrac-

tory wall arranged in concentric spaced relationship to the side walls of said furnace enclosure to divide said furnace enclosure into concentric heating chambers and form an additional side wall therefor, vertically extending interconnected
5 tubular members positioned about the side walls interiorly of said heating chambers, means for establishing and maintaining a column of combustion products in the central zones of the heating chambers to radiantly heat the tubular members consisting of burner elements at one end of
10 said heating chambers positioned medially of the side walls and flues disposed at the other end of said heating chambers and positioned medially of the side walls thereof for withdrawing products
15 of combustion directly and separately from said heating chambers.

2. A furnace for subjecting hydrocarbons to a cracking temperature comprising refractory side, top and bottom walls forming a substantially
20 cylindrical furnace enclosure, an inner refractory wall arranged in concentric spaced relationship to the side wall of said furnace enclosure to divide said furnace enclosure into concentric heating chambers and form an additional side wall
25 therefor, vertically extending interconnected tubular members positioned about the side walls interiorly of said heating chambers, means for establishing and maintaining a column of combustion products in the central zones of the heating
30 chambers to radiantly heat the tubular members consisting of burner elements in the bottom of each heating chamber positioned medially of the side walls and flues disposed at the top of the heating chambers opposite the burners and positioned
35 medially of the side walls thereof for withdrawing products of combustion directly and separately from said heating chambers.

3. A furnace for subjecting hydrocarbons to a cracking temperature comprising refractory side, top and bottom walls forming a substantially
40 cylindrical furnace enclosure, an inner refractory wall arranged in concentric spaced relationship to the side wall of said furnace enclosure to divide said furnace enclosure into concentric heating
45 chambers and form an additional side wall therefor, vertically extending interconnected tubular members positioned about the side walls interiorly of said heating chambers and extending outside the top wall and outside the bottom wall of
50 the furnace, means for establishing and maintaining a column of combustion products in the central zones of the heating chambers to radiantly heat the tubular members consisting of burner elements in the bottom of each heating
55 chamber positioned medially of the side walls and flues located at the top of the heating chambers communicating with said heating chambers by means of substantially dome shaped elements formed in the top wall of the furnace medially of
60 the side walls of the heating chambers for withdrawing products of combustion directly and separately therefrom.

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