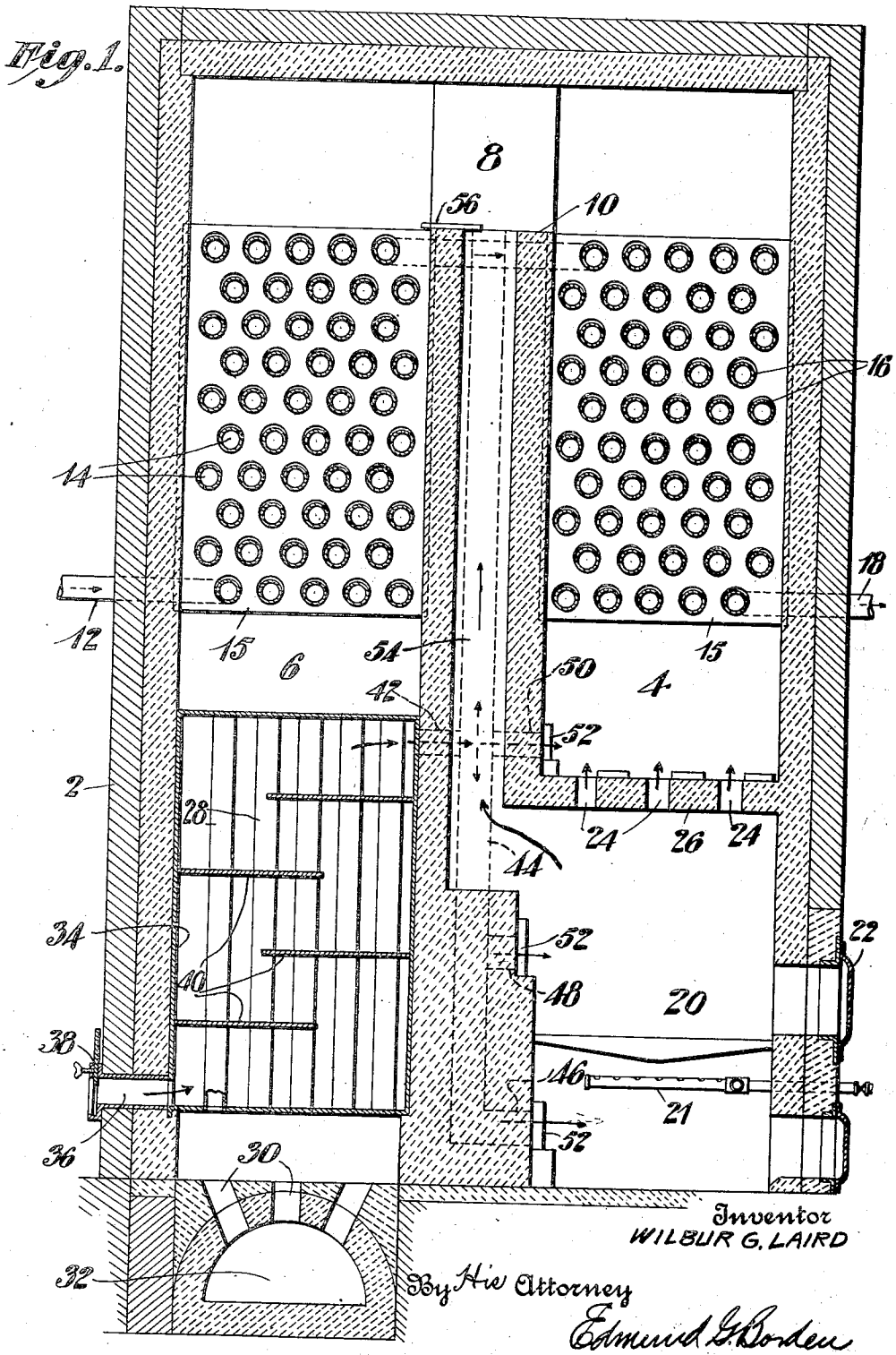
Oct. 9, 1934. W. G. LAIRD 1,976,029

METHOD OF HEATING A PIPE STILL

Filed Aug. 14, 1926 3 Sheets-Sheet 1

Fig. 1.



Inventor
WILBUR G. LAIRD

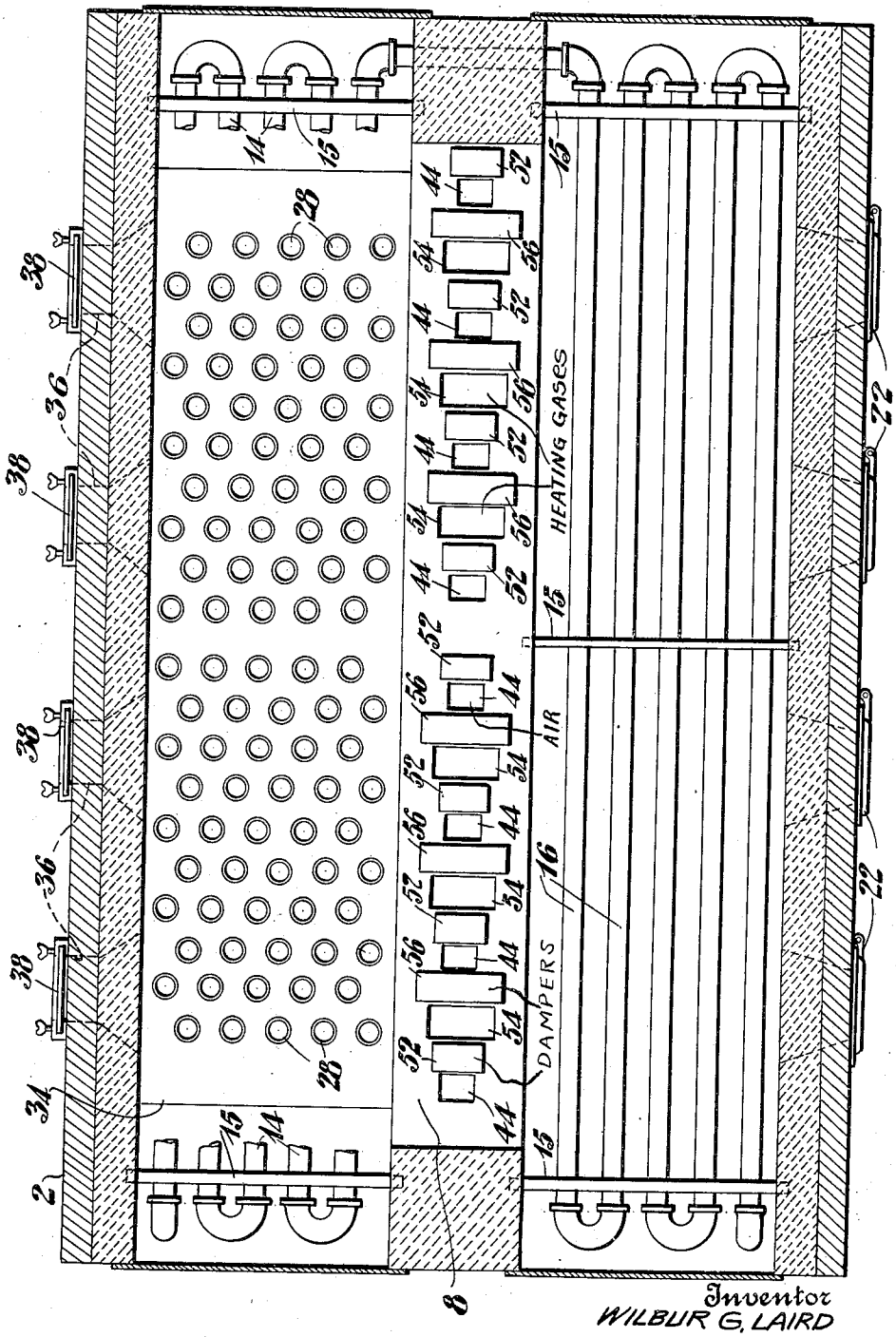
By His Attorney
Edmund G. Borden

Oct. 9, 1934. W. G. LAIRD 1,976,029

METHOD OF HEATING A PIPE STILL

Filed Aug. 14, 1926 3 Sheets-Sheet 2

Fig. 2.



Inventor
WILBUR G. LAIRD

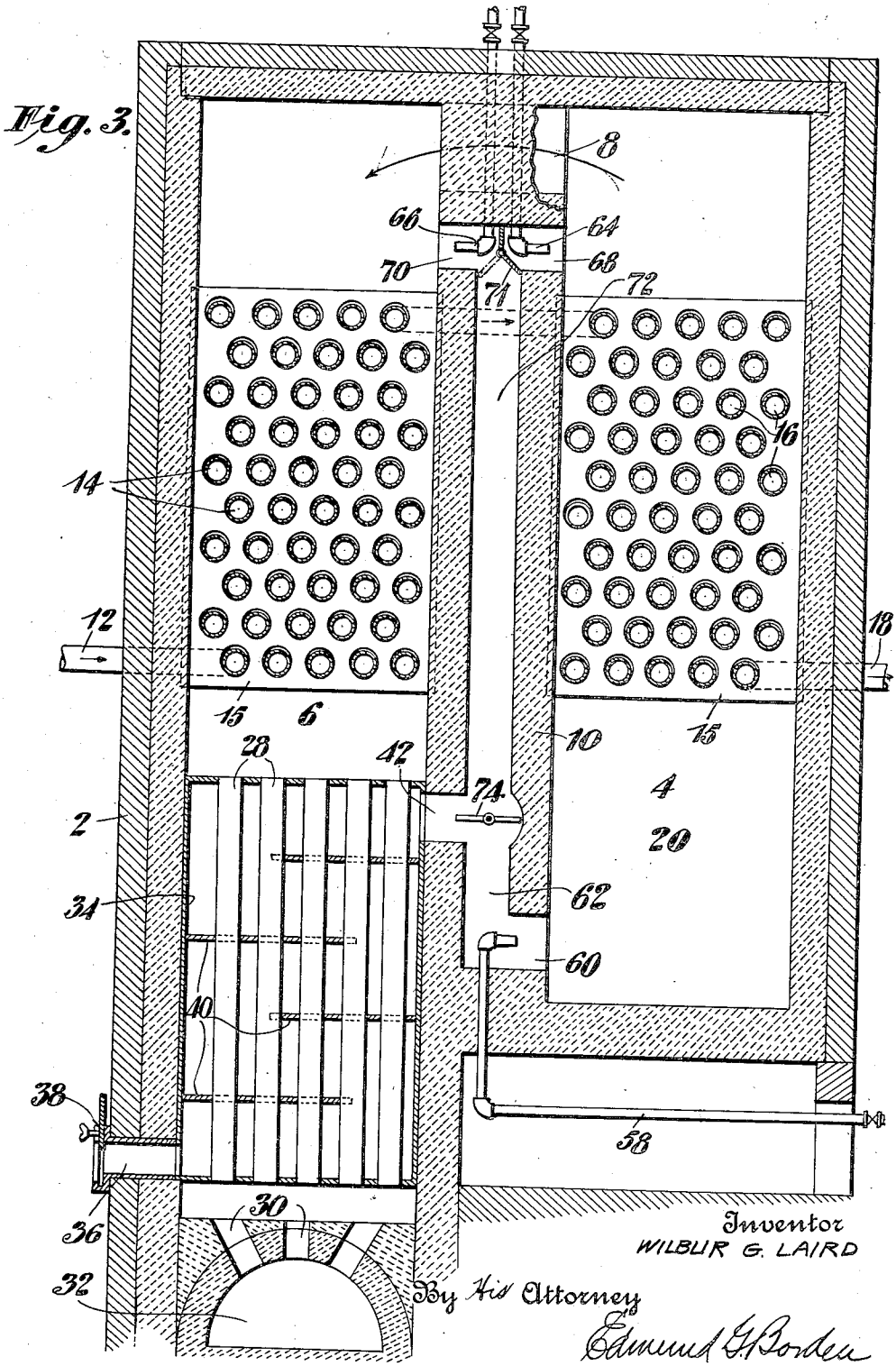
By His Attorney
Edmund G. Borden

Oct. 9, 1934. W. G. LAIRD 1,976,029

METHOD OF HEATING A PIPE STILL

Filed Aug. 14, 1926 3 Sheets-Sheet 3

Fig. 3.



Inventor
WILBUR G. LAIRD

By his Attorney
Edmund G. Borden

Patented Oct. 9, 1934 1,976,029

UNITED STATES PATENT OFFICE

1,976,029

METHOD OF HEATING A PIPE STILL

Wilbur G. Laird, New York, N. Y., assignor, by mesne assignments, to Gasoline Products Company, Inc., Newark, N. J., a corporation of Delaware

Application August 14, 1926, Serial No. 129,247

21 Claims. (Cl. 196—116)

This invention relates to an improved method of heating and particularly to an improved method of controlling the temperature applied to the heating of pipe still furnaces used for the distillation or cracking of petroleum oils.

In pipe still furnaces having banks of tubes in several compartments communicating above or below a bridge wall the usual practice is to circulate hot products of combustion from an adjacent fire box, or a fire box below one bank of tubes, upward through the first bank of tubes and downward through the next bank and so on. In stills of this type considerable difficulty is experienced in preventing the lower tubes of the first bank from becoming overheated and burning out, whereas no difficulty is experienced in succeeding banks.

If, in furnaces of the kind referred to, the fire box temperature is reduced in order to prevent the burning out of the lower tubes of the first bank then the heating gases passing to succeeding banks will have a temperature too low to give good results.

The principal object of the present invention is to overcome the above mentioned difficulties and at the same time provide a method of operating a pipe still with great flexibility in order to control the temperature in any bank of tubes.

Essentially the pipe still setting comprises a series of connecting compartments, in each of which is mounted a bank of tubes, through which the oil to be heated is passed in series.

The heating of the tubes is controlled by the extent to which the fuel is burned before or during passage of heating gases thru the tube bank. The flame temperature in the fire box may be controlled either by producing an over-ventilated or an under-ventilated combustion therein so that the heating gases entering the first compartment of the series are at a temperature insufficiently high to overheat the tubes but are maintained at the desired temperature for giving the oil its desired final temperature before leaving the furnace. Before the partially spent heating gases pass from the first compartment to the second compartment and so on they are brought up to the temperature desired to be maintained therein. This may be accomplished in case of overventilation, either by admitting additional fuel to be burned by the excess air in the heating gases from the first compartment, or by mingling with the partially spent gases from the first, or a previous compartment, fresh heating gases by-passed from the fire box or from a burner or burners mounted between the compartments. The temperature of the gases leaving the fire box and entering the first bank of tubes is controlled by regulating the amount of air supplied thereto, while the temperature of the heating gases entering any succeeding bank of tubes is controlled by the amount of fuel or heating gases from the fire box or burners, mixed with the partially spent heating gases leaving a previous bank of tubes.

When underventilation is used in the fire box to control the heat applied to the first bank of tubes a constant supply of fuel such as coke, coke oven gas, producer gas or water gas with a regulated quantity of air, less than that required to burn the fuel, is supplied to give the desired temperature in the first bank of tubes. In order to control the temperature in succeeding banks and to give a sufficiently high temperature therein, a regulated supply of air is mixed with the heating gases leaving the first bank to burn excess fuel therein.

The above and other objects of the invention and features of novelty, will appear from the following detailed description taken in connection with the accompanying drawings, forming a part of this specification.

Referring to the drawings:

Fig. 1 is a vertical sectional view of the pipe still furnace embodying one form of the present invention.

Fig. 2 is a horizontal sectional view of the furnace shown in Fig. 1, taken above the bridge wall; one bank of heating tubes being partly broken away to show the recuperator tubes below.

Fig. 3 is a vertical sectional view of a slightly modified form of the furnace shown in Figures 1 and 2.

In the construction shown in Figs. 1 and 2 the furnace 2 comprises a series of compartments 4 and 6, connected by a passage 8 over the bridge wall 10. For simplicity only two compartments are shown but the invention includes the use of any number of compartments. The oil to be cracked or distilled enters the last compartment 6 by a pipe 12 and passes through a bank of tubes 14 therein from which it passes to a second bank of tubes 16 in the compartment 4, finally leaving the furnace in a highly heated condition by the pipe 18. The banks of tubes preferably comprise a plurality of long pipes connected in series with return bends as are commonly used in practice, and mounted in supporting tube sheets 15 as shown in the drawings.

As shown in Figure 1 the banks of tubes in the compartments 4 and 6 are heated by products of combustion from the grate fire box 20 which

may be supplied with a regulated amount of solid fuel in any convenient manner, doors 22 being shown for that purpose. Air for combustion in the fire box 20 may be supplied below the grate either by forced draft or by the induced draft of a chimney or fan. The products of combustion used for heating the first bank of tubes leave the fire box 20 through the ports 24 in distributor wall 26 and pass upward through the bank of tubes 16 where they impart their heat to the oil flowing through these tubes and are consequently cooled thereby. The partially spent heating gases leaving the bank of tubes 16 pass over the bridge wall 10 by passage 8 and then downward through tube bank 14 and into recuperator tubes 28, finally leaving the furnace through the ports 30 and passage 32 which lead to a stack or blower (not shown).

The recuperator referred to is preferably built in the structure of the furnace and as shown is located below the final tube bank where it receives the partially spent heating gases therefrom. It comprises a plurality of vertically placed tubes 28, which may be either tile or metal, mounted in a casing 34, which is set in the furnace. Air to be used for combustion in the furnace is supplied to the lower end of this casing 34 through openings 36, controlled by valves 38, and passes upward through the casing around the tubes 28 and baffles 40, being heated by the heating gases leaving the furnace through the tubes 28. The air thus preheated leaves the upper portion of the casing 34 by conduits 42 and is distributed by conduits 44, and branches 46, below the grate to support combustion in the fire box 20. The conduits 44 extend up through the bridge wall 10 so that air may be supplied either above the fuel bed by the branches 48, or above the distributor wall 26 by branches 50 or above the bridge wall 10 into the passage 8 from the upper ends of the conduits 44. The various branches supplying air to the furnace are controlled by tile dampers 52 which may be adjusted by a hooked rod as is common in the art.

In addition to the air conduits 44 in the bridge wall 10 are flues 54, which may be used to bypass some of the heating gases from the fire box 20 around the first bank of tubes. These flues have control dampers 56 by which the amount of heating gases by-passed can be regulated to secure the desired temperature for the gases passing through tube bank 14.

In the construction shown in Fig. 3 the same elements as shown in Figs. 1 and 2 are designated by the same reference characters. The furnace shown in this figure is substantially the same as that shown in Figs. 1 and 2 with the exception that means are provided for using liquid or gaseous fuels instead of solid fuels for heating the furnace. The means for supplying liquid or gaseous fuel to fire box 20 comprises valved supply pipes 58 supplying burners 60, distributed along the furnaces, which discharge their fuel and air for combustion directly into the fire box 20 where the combustion is completed. Preheated air is supplied for the burners 60 by conduits 62 which connect with conduits 42 from the recuperator. The hot gases from the fire box 20 pass upward through the bank of tubes 16 then across the bridge wall 10 by the passage 8 and down through the bank 14 as previously described in connection with Figures 1 and 2. In the upper part of the bridge wall 10 and below the passage 8 are mounted valved fuel supply pipes 64 and 66 which discharge respectively above the tube banks 16 and 14 through openings 68 and 70. Air may be supplied to either or both of these openings from the conduits 42 by the conduits 72 located in the bridge wall 10. By properly setting the valve 71 the air may be regulated as desired. The valves 38 are used to control the total air supplied to the furnace, while the amount supplied to the conduits 62 and 72 is regulated by valves 74 placed at the juncture of these conduits with the conduits 42.

The operation of the furnace shown in Figures 1 and 2 is as follows: Combustion having been started in the fire box, preheated air is introduced through conduits 46 in a sufficient excess to give a temperature in the heating gases passing around the tubes in the bank 16 the desired heating effect but insufficiently high to overheat and burn out the lower tubes of this bank. If this result is obtained it is evident that the heating gases leaving the first bank of tubes are not hot enough to do any appreciable heating in the second bank, therefore their temperature is raised by mixing therewith fresh heating gases from the fire box, via the flues 54, in a quantity sufficient to obtain the desired heating gas temperature for the second bank of tubes, which is usually somewhat lower than that used for the first bank (that is, the bank last to be traversed by the oil).

The excess air used in heating the first bank of tubes need not all be introduced below the grate but some or all the excess air may be admitted through the ports 48 or 50. In case all the excess air is introduced through the port 50 only a small amount of furnace gases will need to be by-passed through the flues 54 because they will be at a much higher temperature than in the case where the overventilation was produced by the ports 46 or 48. Provision is made, however, for the direct control of the temperature of the gases leaving the flues 54 by using air conduits 44.

The distributor wall 26 is provided with tile valves for the openings 24 in order to properly distribute the heating gases throughout the length of the furnace. After the furnace has been once adjusted for the use of any particular fuel on the grate 20 little need will be found for disturbing the valves controlling the various conduits.

The furnace shown in Fig. 3 is operated in a similar manner to that shown in Figs. 1 and 2. An overventilated combustion is obtained in fire box 20 by the burners 60 so that the proper temperature is maintained for heating the tube bank 16 without burning out the lower tubes. Additional fuel is added through the pipe 64 or 66 or both, which fuel is burned by the excess air in the gases leaving the tube bank 16, thus giving heating gases of the desired temperature for heating the second tube bank. If a constant amount of air is admitted through valves 38 and conduits 62 the temperature for each bank of tubes is controlled by regulating the amount of fuel fed through pipes 58, 64 and 66. It may be desirable in certain cases to admit part of the air through one or both of the ports 68 or 70 in which case the conduits 72 are used by proper manipulation of the valve 74.

In either construction shown the furnace may be operated so that the combustion in the fire box 20 may be underventilated in order to have a combustible gas above the tube banks and which may be burned by supplying secondary air at the top of the bridge wall 10, whereby the desired increase in temperature of the heating

gases is obtained for the second or next succeeding tube bank. The temperature of the first tube bank is controlled in this instance by introducing just sufficient air to the fire box to give the desired temperature. If this mode of operation is adopted in the construction shown in Figures 1 and 2 and coke is the fuel used, the efficiency of the furnace will be greatly increased by distributing a small amount of steam below the grate bars, for example, by means of steam pipes 21. This reduces the temperature of the fire box and produces a large volume of combustible gas, a portion of which may be burned, by air admitted through ports 48 or 50 and the remainder by air admitted by ports 44 at the top of the furnace to give the desired increase in temperature of the gases entering the second bank of tubes.

If underventilation is used in the fire box of the construction shown in Fig. 1 the products entering the tube-bank 16 may be actually overventilated by admitting excess air through port 50. If this is done the desired rise in temperature at the top of the furnace may be obtained by taking the proper amount of gases from the fire box through the flues 54 to use up the excess air.

From the description given above it will be evident that by the use of my novel furnace and method of heating, I am able to increase the life of the heating tubes and at the same time obtain any desired temperature for the cracking or distillation of oils. Furthermore, by preventing the tubes from being burned out I decrease the chances of explosions due to the rupture of any of the tubes in the furnace.

As previously explained, the invention may be applied to any number of heating compartments or zones since in using certain sized tubes, a definite rate of flow of oil and a certain temperature difference between the heating gases and oil being heated, it may be necessary to increase the amount of tubing. In this case it would be advisable to use additional compartments for the tubes.

Instead of making the furnace into compartments each containing a bank of tubes, I may have a continuous bank of tubes and increase the temperature of the heating gases at various points along the bank by admitting high temperature gases or adding fuel the same as when using compartments.

In operating the furnace above described, a suitable number of pyrometers may be placed at advantageous positions in the furnace or heating tubes to aid in the proper regulation of the temperature.

While I have described my furnace in connection with oil heating, it is obvious that the furnace may be used for heating other substances or used in domestic or commercial heating plants to heat a circulating heat transfer medium.

Having thus described my invention, what I claim is:

1. A method of heating hydrocarbon oil passing through a series of still tubes which comprises heating the oil passing through a portion of said tubes by an overventilated combustion of fuel and heating the oil passing through the remaining tubes by burning additional fuel with only the excess oxygen supplied in the first heating.

2. A method of heating hydrocarbon oil passing through a series of still tubes which comprises, heating the oil passing through a portion of said tubes by burning a regulated quantity of fuel with a large excess of air and heating the oil passing through the remaining tubes by burning additional fuel with only the air in the products from the first heating.

3. A method of heating hydrocarbon oil passing through a plurality of banks of still tubes comprising burning fuel with an excess of air and passing the resulting products over the tubes of one bank to heat the oil passing therethrough, mixing additional fuel with said products after leaving said bank whereby said fuel is burned only by the excess air and passing the resulting mixture over the tubes in a succeeding bank thereby to heat the oil passing through said last named bank.

4. The method defined in claim 3 in which the waste heat from the heating gases leaving the last bank is used to preheat said air.

5. In the method of heating hydrocarbon oil passing through a still by contacting said still with hot products of combustion from a fire box, the improvement which comprises supplying excess air to said fire box, contacting the resulting products of combustion with a portion of said still to thereby heat the oil passing therethrough and thereafter supplying additional fuel to be burned only by the excess air and using the resulting mixture to heat the oil passing through the remainder of said still.

6. In the method of heating hydrocarbon oil passing through a series of banks of tubes mounted in a furnace chamber by passing hot products of combustion from a fire box through the banks in succession, the improvement which comprises heating the oil passing through the first bank by regulating the excess of air supplied and controlling the temperature in a succeeding bank through which the oil passes by introducing a regulated quantity of fuel only, to the heating gases before passing through the last named bank.

7. The method of controlling the temperature applied to a series of banks of heating tubes in a furnace in which heating gases from a fire box are passed through said banks in succession to heat hydrocarbon oil passing therethrough, which comprises, overventilating the combustion in the fire box to produce the desired temperature for the first bank through which the oil is passed and increasing the temperature of the heating gases leaving said bank by introducing only fuel thereto to produce the desired temperature in the next succeeding bank to thereby supply the desired heat to the oil.

8. The method of controlling the heat applied to hydrocarbon oil passing through individual tube banks of a plurality of banks of heating tubes by products of combustion passed from a combustion chamber in heat exchange relation with said banks in series, which comprises mixing a controlled amount of excess air with the hot products of combustion passing from the combustion chamber to the first bank of tubes to control the temperature of the oil passing therethrough, and mixing a regulated quantity of fuel with the products of combustion from the first bank of tubes to be burned only by the air previously admixed therewith, and thereby increase the temperature of said products of combustion to the extent desired for heating the oil passing through a succeeding bank of tubes.

9. The method of heating treatment of hydrocarbon oils in which the oil is heated in two successive stages and wherein at least one stage consists in heating the oil in a single confined stream of restricted cross-section, which comprises burning a fuel with a substantial excess of air to main-

tain the temperature of the products of combustion materially below the normal combustion temperature, passing the products of combustion and excess air over heating elements in one of said stages, passing the products of combustion and excess air to the other stage, burning additional fuel with said excess air and thereafter passing all the products of combustion over heating elements in said other stage.

10. The method of cracking hydrocarbon oils to produce lower boiling hydrocarbon oils, characterized by subjecting the oil to heat treatment under pressure in two successive stages, comprising passing the oil through the first stage in countercurrent relation to hot gases evolved from the combustion of fuel for the first stage, passing the oil into the second stage, independently supplying additional heat by combustion of other fuel to said second stage, withdrawing combustion gases from said second stage of treatment, and admixing at least a portion of them with air for independently supporting the combustion of fuel for said first stage of treatment.

11. In the method of heating hydrocarbon oils in which the oil is heated in heating elements in successive stages, in at least one stage of which the oil is heated in a confined stream of restricted cross-section, the improvement which comprises passing hot products of combustion evolved from the combustion of fuel over the heating elements in one stage, withdrawing waste products of combustion from said stage and using the same with added air as an independent combustion supporting medium to burn additional fuel, and passing the products of combustion resulting therefrom over heating elements in another heating stage.

12. In the art of heating hydrocarbon oil wherein the oil is passed in a stream once through an elongated heated passageway heated by hot products of combustion and the stream is thereafter discharged from said passageway, the steps which comprise passing hot products of combustion formed by supplying a controlled excess of one of the materials used to produce them in heat exchange relation with the stream of oil passing through a portion of said passageway, increasing the temperature of said products of combustion after heating the said portion of said passageway by adding thereto a controlled amount of the other of said materials only and passing the resulting hot products of combustion at the increased temperature in heat exchange relation with the stream of oil passing through another portion of said passageway.

13. In the art of heating hydrocarbon oil wherein the oil is passed in a stream once through an elongated heated passageway heated by hot products of combustion and the stream is thereafter discharged from said passageway, the steps which comprise passing hot products of combustion formed by burning fuel and an excess of air in heat exchange relation with the stream of oil passing through a portion of said passageway, increasing the temperature of the products of combustion after heating said portion of said passageway by burning additional fuel with the excess air and passing the resulting hot products of combustion at the increased temperature in heat exchange relation with the stream of oil passing through another portion of said passageway.

14. The method of heat treating hydrocarbon oils passing through a plurality of banks of still tubes which comprises burning fuel with air and conducting the products of combustion resulting therefrom in heat exchange relationship with the oil passing through a portion of said still tubes, supplying a controlled excess of one of the materials used to produce said products of combustion to thereby reduce and control the temperature of the products of combustion in heat exchange relationship with the oil passing through said portion of the still tubes, and admixing a controlled amount of the other of said materials with the products of combustion after they have passed in heat exchange relationship with the oil passing through the said portion of the still tubes to thereby effect additional combustion to increase the temperature of the products of combustion and thereafter passing the products of combustion at the increased temperature in contact with another portion of the still tubes to supply heat to the oil passing therethrough.

15. The method of heat treating hydrocarbon oils passing through a plurality of banks of still tubes which comprises burning fuel with air and conducting the products of combustion resulting therefrom in heat exchange relationship with the oil passing through a portion of said still tubes, supplying a controlled excess of one of the materials used to produce said products of combustion to thereby reduce and control the temperature of the products of combustion in heat exchange relationship with the oil passing through said portion of the still tubes, and admixing a controlled amount of the other of said materials with the products of combustion after they have passed in heat exchange relationship with the oil passing through the said portion of the still tubes to thereby effect additional combustion to increase the temperature of the products of combustion and thereafter passing the products of combustion at the increased temperature in heat exchange relation with another portion of the still tubes to supply heat to the oil passing therethrough.

16. The method of heating hydrocarbon oil passing through a heat exchanging unit in which at least one portion thereof consists of a tubular heat absorbing section, which comprises initially burning a fuel, adding sufficient excess air to the products of combustion to reduce the temperature thereof below normal combustion temperature, conducting said air and combustion products in heat exchange relation with the oil passing through a portion of the heat exchanging unit, utilizing the excess air mixed with said products of combustion to support the combustion of additional fuel and thereafter passing the products of combustion over another portion of the heat exchanging unit to heat the oil passing therethrough.

17. The method of heat treating hydrocarbon oils in which the oil is heated in two stages and wherein at least one stage consists in heating the oil in a confined stream of restricted cross-section, which comprises burning a fuel with a substantial excess of air to maintain the temperature of the products of combustion below normal combustion temperatures, conducting the products of combustion and excess air through one of said stages in heat exchange relation with heating elements therein, passing the products of combustion and excess air to the other stage, burning additional fuel with said excess air and thereafter passing all the products of combustion over heating elements in said other stage.

18. The method of heat treating hydrocarbon oils in which the oil is heated in two stages and wherein at least one stage consists in heating the oil in a confined stream of restricted cross-section,

which comprises burning a fuel with a substantial excess of air to maintain the temperature of the products of combustion below normal combustion temperatures, conducting the products of combustion and excess air through one of said stages in heat exchange relation with heating elements therein, passing the products of combustion and excess air to the other stage, burning additional fuel with said excess air and thereafter passing all the products of combustion in heat exchange relation with heating elements in said other stage.

19. The method of cracking hydrocarbon oils to produce lower boiling hydrocarbon oils, characterized by subjecting the oil to heat treatment under pressure in two successive stages, comprising passing the oil through the first stage in countercurrent relation to hot gases evolved from the combustion of fuel, passing the oil into the second stage, independently supplying additional heat by combustion to said second stage, withdrawing combustion gases from said second stage of treatment and admixing at least a portion of them before entering into said first stage with air for supporting combustion in said first stage of treatment.

20. A method of heating hydrocarbon fluid passing through heat absorbing elements which comprises burning fuel with air to form hot products of combustion, supplying a controlled excess of one of the materials used to produce said products of combustion to thereby reduce and control the temperature of the products of combustion, passing a portion of the thus formed products of combustion in heat exchange relation with hydrocarbon fluid passing through a portion of the heat absorbing elements, by-passing another portion of the products of combustion around the first of said elements prior to coming in heat exchange relation therewith, combining the portions of combustion products, after the first mentioned portion has passed in heat exchange relation with the oil passing through the first mentioned portion of heat absorbing elements, admixing a controlled amount of the other of said materials with the products of combustion to thereby effect additional combustion to increase the temperature thereof and passing the products of combustion at an increased temperature in heat exchange relation with the hydrocarbon fluid passing through the remainder of the heat absorbing elements.

21. In the heating of hydrocarbon fluids in a heating apparatus having a heating chamber divided into sections by a bridge wall with heat absorbing elements in each section, the method of heating hydrocarbon fluid passing through said heat absorbing elements which comprises burning fuel with air to form hot products of combustion, supplying a controlled excess of one of the materials used to produce said products of combustion to thereby reduce and control the temperature of the products of combustion, passing a portion of the thus formed products of combustion in heat exchange relation with hydrocarbon fluid passing through the heat absorbing elements in one of said sections and by-passing another portion thereof prior to coming in heat exchange relation therewith, combining the portions of combustion products after the first mentioned portion has passed in heat exchange relation with the hydrocarbon fluid passing through the heat absorbing elements in one of said sections, admixing a controlled amount of the other of said materials with the products of combustion to increase the temperature thereof and passing the products of combustion at an increased temperature in heat exchange relation with the hydrocarbon fluid passing through the heat absorbing elements in the other of said sections.

WILBUR G. LAIRD.