

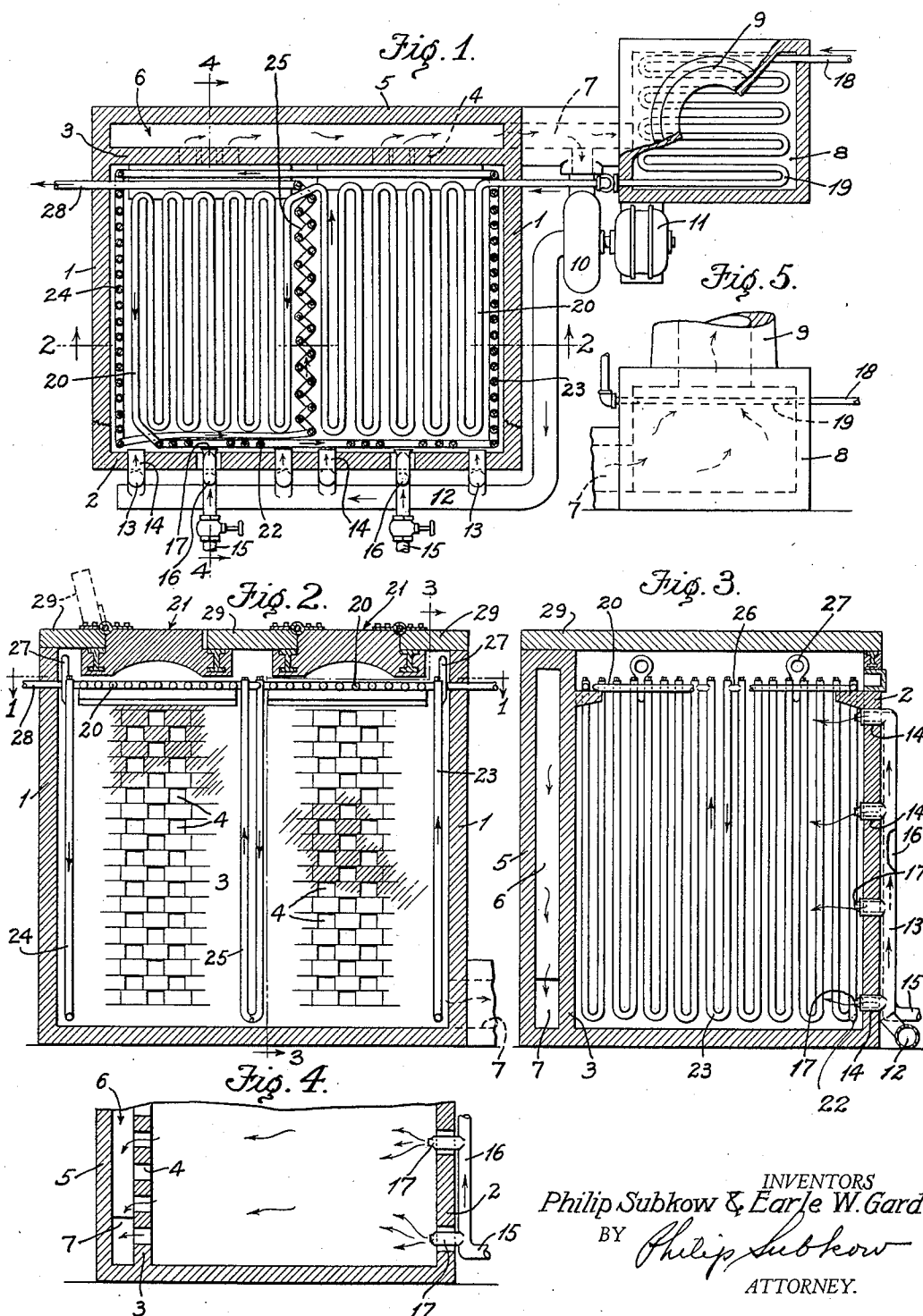
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METHOD AND APPARATUS FOR HEATING AND CRACKING OILS

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METHOD AND APPARATUS FOR HEATING
AND CRACKING OILS

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This invention relates to a process and apparatus for heating oil and other fluids. It is more particularly directed to a process and apparatus for heating an oil for purposes of inducing a change in the composition of the oil. Crude petroleum, gas oil, fuel oil and the like, may be thus heated under such conditions as to induce the decomposition or cracking thereof into more volatile or lower boiling point hydrocarbons such as gasoline.

The invention has for its object a method of heating oil and an apparatus therefor, said heating being accomplished by radiant heat.

Another object of this invention is to cause heat transfer to surfaces in contact with oil whereby said surfaces are heated by radiation from open flames, i.e. incandescent gases.

Another object of this invention is to extend the surfaces of said incandescent gases so that the radiation may be at a maximum efficiency.

Another object of this invention is to extend the incandescent gases into the form of a thin sheet whereby a maximum surface of radiating surface is obtained.

It is another object of this invention to prevent contact of the incandescent combustion gases or flame with the surfaces so as to prevent "licking" of said surfaces by the flame.

It is a more particular object of this invention to introduce a current of gas over said surfaces whereby a pressure gradient is established preventing said "licking".

The invention has for another of its objects, a process and apparatus whereby the oil is heated by a sheet of flame, i. e. incandescent combustion gases issuing from a series of burners positioned one above the other and said sheet is passed adjacent to oil heating surfaces, said sheet being prevented from contacting or "licking" said oil heating surfaces by circulating a portion of waste combustion gases between the sheet of incandescent gases and the oil heating surfaces.

It is well known that in ordinary furnace construction that the tubes through which oil is circulated to be heated to a cracking temperature are constantly in danger of becoming overheated and thus being burnt out. This is due to the fact that in the ordinary furnace construction, there is a tendency for the high temperature flames to contact or "lick" the tubes thereby causing local overheating and corrosion and erosion which results in rupture of the tubes. This effect is caused by the high temperature of the flame and also by the unconsumed oxygen in the gases. It may be said that as a practical mat-

ter, the combustion gases beyond the tip of the flame are of sufficiently low temperature and so poor in oxygen that there is no danger in allowing them to contact with the walls of the oil containers. In order to avoid this difficulty, various means have been devised, such as screening the tubes from the flames by carborundum or other material or by directing the flame from the burners away from the oil heating surfaces. The flames have been cooled down by use of excess air, cooler gases or by use of heat absorbing coils or surfaces. These means, while satisfactory to a certain degree, do not take full advantage of the heat generated in the furnace.

Our invention contemplates the employment of an open flame, i. e. incandescent gases or hot radiating gases for heating and cracking an oil, said open flame being in heat radiating relation to oil heated surfaces but not in direct contact therewith. If the flame be passed very close to the oil heating surfaces there is danger that the flaring at the tip of the flame "licks" the surfaces thereby causing them to burn out in short time. Our invention proposes to inhibit such occurrence. One method which we have found effective to prevent such "licking" of the oil heating surfaces by the flame is to space said surfaces away from the flame so that the flaring out of the flame at the tip will not "lick" the surfaces. Another method is to establish a pressure gradient by the intervention of a gaseous medium.

We have found that if a gaseous medium be directed parallel to and intermediate the flame or incandescent gases and oil heating surfaces, that the tip of the gaseous medium will be controlled and the flame caused to travel in a more perfectly direct course, thereby preventing the flame from "licking" the oil heating surfaces. The oil is thereby heated solely by the heat radiated from the flame through the gaseous medium. The gaseous medium may comprise waste combustion gases, compressed air or any other fluid. It is preferred that it be non-combustible. We prefer to recirculate a portion of the waste combustion gases for this purpose. The gaseous medium may be at any temperature as it is well known that a gas will not appreciably absorb heat transferred to it by radiant surfaces. Such gases are substantially transparent to the radiated heat. Heat transfer to these recirculated gases is only effected by convection. However, it is preferable to employ a hot gas, such as recirculated furnace gases, since while cold gases do not pick up any appreciable amount of radiant heat, they may absorb heat transferred to it from the oil heat-

ing surfaces by rubbing against them or by contact with the incandescent gases and thus diminish the effect of the open flame. The recirculated gases may be preheated, if desired, before introduction into the furnace so that they may be at a temperature approaching the desired temperature of the surfaces to be heated in the furnace.

It is well known that the amount of heat radiated from a flame or other hot combustion gases is directly proportional to the area, also to the fourth power of temperature of the outer shell.

It is thus apparent that the radiation of hot combustion gases falls off very rapidly with a decrease of temperature and the amount of heat radiated per unit of time is directly proportional to the area of the radiating surface. The gases, therefore, which are best suited for heating by radiation are those which are incandescent, i. e. that are flames. However, there is a range below the point at which the gases radiate a visible color wherein they are also effective. Therefore, the length of the stream of gases useful for heating by radiation may extend to a point somewhat beyond the end of the flame proper, i. e., to such a point where the temperature is too low for efficient heating by radiation. At this point, the gases should pass into the convection section.

Assuming an elongated flame of substantially circular cross-section, it will be readily seen that the amount of heat radiated from the flame would depend upon the area of the outer shell, or the average circumference multiplied by the length of the flame. The temperature of the outer sheath is maintained by conduction and convection from the interior of the flame or other hot gas stream. We have found that much more heat may be radiated for the same amount of heat input under the same conditions if the flame be directed into the furnace as an extended sheet of narrow thickness but much wider in width instead of a circular core. Thus, a sheet of flame or hot combustion gases will have a much larger surface area than a cylindrical or conical flame and therefore more heat may be radiated therefrom per unit of time at the same temperature. By so extending the flame into one of very narrow thickness and a correspondingly greater width, it may be seen that a surface will be presented of many times that over the ordinary burner flame which is roughly of cylindrical or conical character. In this manner, not only will the amount of surface area on one side of the sheet of flame be greater but there will be available two surfaces of equal area from which radiant heat may be obtained. The maximum rate of radiation is obtained when the sheet is at its maximum extension, i. e. when the sheet is thinnest.

It is an object of the present invention to heat and crack an oil by utilizing the radiant heat from both surfaces of a sheet of flame. This may be accomplished by placing on each side of said sheet of flame a series of oil cracking tubes so that the heat radiated from both sides of the flame imparts heat to two series of tubes, the side of the tubes which are adjacent the flame and which may be "seen" by the flame being heated by direct radiant heat and the other side of the tubes being heated by reflected radiant heat from the furnace walls. The tubes of the still are prevented from being "licked" by the flame by proper spacing away from the flame and also by introducing a blanket of waste combustion gases parallel to and intermediate the flame and the tubes.

As a preferred embodiment of the invention, the tubes are so arranged in the furnace that all the heat generated therein is utilized efficiently. We prefer to place the tubes through which oil is circulated in three parallel banks, each bank being disposed either horizontally or vertically or in any other manner. Two of the banks of tubes are placed adjacent the furnace walls parallel to the sheets of incandescent gases or flame and the other bank is set in the center of the furnace and is preferably parallel to the other two banks of tubes. By this arrangement, it may be seen that the outer banks are heated by one side of the sheets of flame while the central bank receives radiant heat from two sheets of flame. Two series of parallel burners, each series having the burners disposed one above the other, are provided between the outer and central banks of tubes which generate thin sheets of flame parallel to and intermediate the said banks of tubes. These burners are so designed as to shoot a thin sheet of flame and a number of them are so spaced as to give a substantially continuous vertical sheet of flame. Intermediate each set of burners and the banks of tubes are placed a series of ducts positioned one above the other which introduce hot waste furnace gases, under sufficient pressure, adjacent the tubes to establish a pressure gradient away from said tubes thereby preventing the flames from "licking" the tubes and burning them out. If desired, coils may be disposed adjacent the top and front furnace walls to act as economizer coils and to protect the roof of the furnace. Relatively cool oil is circulated through these coils. The coil adjacent the top furnace wall need not be screened by waste combustion gases since the draft in the furnace may be so arranged that it be downward and away from the top furnace wall thereby preventing the flame from "licking" the top coil. The front coil is so positioned that it will not be contacted by the flame and therefore need not be screened.

In operation, the oil is first preheated by circulating it through a coil positioned outside of the furnace proper but in heat exchange with a portion of the waste combustion gases from the furnace, as for instance, in a flue. The oil is then circulated through those tubes in the furnace which receive radiant heat from one side of the sheets of flame, only, and then through the central bank of tubes receiving radiant heat from two sheets of flame. Cracking may take place therein, if desired. If coils, or tubes are disposed adjacent the front and top furnace walls, the oil from the preheater may be further preheated by first circulating it through these tubes.

A portion of the waste combustion gases are recirculated into the furnace through the ducts or passages which throw the screen of the waste combustion gases adjacent the tubes. The pressure and velocity of these gases should be greater than the flame pressure and velocity. A pressure gradient is thus established away from the tubes. This positively prevents the "licking" of the tubes by the flame.

The invention, therefore, provides an apparatus and process whereby an oil is preheated by a portion of waste combustion gases and then further preheated and cracked by radiant heat from sheets of flame or radiant combustion gases. The invention also provides an apparatus and process whereby a portion of the waste combustion gases are recirculated adjacent to the oil heating surfaces to establish a pressure gradient

away from the oil heating surfaces to prevent the flame from "licking" the oil heating surfaces and to control the course of the flame. The invention also provides for the creation of a downward draft in the furnace to prevent the flame from contacting the top heating surfaces in the furnace.

Further objects will be understood from the following description of the apparatus taken from the drawing:

Fig. 1 is a horizontal section through a cracking furnace with a plan view of the preheater shown partly in section taken on line 1—1 of Fig. 2.

Fig. 2 is a vertical section of the cracking furnace taken on line 2—2 of Fig. 1.

Fig. 3 is a vertical section of the furnace taken on line 3—3 of Fig. 2.

Fig. 4 is a part of a vertical section of the furnace taken on line 4—4 of Fig. 1.

Fig. 5 is an elevation of the preheater.

In the drawing, the furnace consists of side walls 1, front wall 2, an inner rear wall 3 with checkerwork providing waste gas exits 4, and an outer rear wall 5. Only a limited amount of checkerwork is provided in the inner wall 3 and is constructed opposite the burners. The inner and outer rear walls form a flue 6 into which waste combustion gases pass and is connected by a passageway 7 with a preheater 8 provided with a smokestack 9. The passageway 7 is positioned adjacent the bottom of the furnace so as to create a downward draft in the furnace thereby keeping the flame away from the top furnace wall. The passageway 7 is also connected with the intake of blower 10 driven by a motor 11. A manifold 12 connects with the exhaust of blower 10 and is provided with a series of risers 13, each riser also comprising a manifold for a plurality of ducts 14 positioned one above the other which fit into the front furnace wall 2. 15 is a fuel line terminating in a manifold 16. 17 are burners positioned one above the other connected on the manifold 16. The tips of the burners may be of any desired shape depending upon the size of the flame to be thrown into the furnace. It is preferable to employ burners with wide relatively thin tips so that a thin sheet of flame is generated in the furnace. The burners are equally spaced on the manifold and the spacing is such that the flame from one burner meets or merges with the flames of the adjacent burners. Thus, an even vertical distribution of heat is thrown out by the burners. The ducts 14 are likewise spaced on the risers 13.

18 is an oil inlet terminating into a preheating coil 19. The coil 19 connects with coil 20 situated under the top furnace wall 21. 22 is a continuation of coil 20 but is positioned adjacent the front furnace wall 2. 23, 24 and 25 are banks of vertically disposed hairpin tubes connected in any desired manner by crossovers 26, as is usual in such cases. These tubes are also provided with a pair of eye bolts 27 to remove the bank of tubes when desired. The central bank of tubes 25 connects with outlet 28. Trap doors 29 are provided on the top furnace wall 21 for removing the banks of tubes 23, 24 and 25.

As may be seen by examining the drawing, the burners 17 are centrally disposed between the outer and central banks of tubes. The central bank of tubes 25 will receive radiant heat from both sets of burners while the outer banks 23 and 24 are heated by only one set of burners. The ducts 14 are equally spaced from the burners and are placed in front of the banks of tubes as closely

as is possible so that when a gaseous fluid is circulated therethrough, it will prevent the flame from contacting the tubes.

In the operation of the furnace, the burners are ignited and circulating blower 10 is started by motor 11. Thus, a portion of the waste furnace gases is recirculated from the checkerwork openings 4 passing into chamber 6, passageway 7, into manifold 12, risers 13 and ducts 14, thus throwing a protective screen of waste combustion gases in front of the banks of tubes. The velocity and pressure of these gases prevent the flame from flaring out to any appreciable extent at the tips and thus confine it into as thin a sheet as possible. The portion of waste combustion gases not recirculated by the blower pass into the preheating chamber 8 and thence up the smokestack 9. The draft made by the circulating blower 10 and the positioning of the passageway 7 at the bottom of the furnace also forces the flame downward preventing contact with the top furnace wall.

Oil to be heated or cracked is introduced via inlet 18 and circulated through the preheating coil 19 positioned in the preheating chamber 8 where it absorbs the heat from the waste combustion gases. The oil is then passed through the top coil 20, coil 22 and then through the banks of tubes 23, 24 and 25 in the order named. The tubes 23 and 24 receive direct radiant heat from one side of the sheet of flame while the backs of these tubes, not "seen" by the flame, receive heat reflected from the furnace walls. The bank of tubes 25 receives direct radiant heat from the sides of the two sheets of flame.

It is thus seen that the oil is circulated through coils and tubes positioned in zones of gradually increasing temperature.

If desired, the operation may be such that the oil to be cracked is gradually preheated to a cracking temperature before reaching the central bank of tubes and the cracking completed in said bank where the temperature in the furnace is the hottest or the oil may be circulated in such manner that a soaking period of substantially constant temperature is provided before the oil is passed out of the system.

The above description and operation is, of course, merely illustrative of the generic invention. Other gases, such as air, may be circulated as the protective medium for the tubes. The amount of waste furnace gases recirculated over the tubes may be varied depending upon the results desired. The coils and tubes may be arranged differently in the furnace depending upon the operation desired. Other refinements and other improvements may be made as anyone skilled in the art will readily understand.

The above description is not limiting but is to be taken as merely illustrative of the best mode of utilizing the invention, which we claim:

1. A method of heating surfaces of oil containers which comprises placing said oil containers intermediate sheets of hot combustion gases and heating the surfaces of said oil containers substantially solely by radiation from said sheets.

2. In a furnace, a plurality of tubes to be heated, a plurality of burners positioned one above the other, a plurality of ducts positioned one above the other intermediate said burners and said tubes and means for circulating waste furnace gases through said ducts.

3. In an oil heating furnace, the combination of tubes to be heated, a plurality of burners positioned one above the other for generating a sheet

of hot combustion gases, a plurality of ducts positioned one above the other parallel to said burners and intermediate said burners and said tubes and means for circulating waste furnace gases through said ducts.

4. In an oil cracking still, the combination of tubes to be heated, burners positioned one above the other on each side of said tubes for introducing sheets of hot combustion gases adjacent said tubes, ducts positioned one above the other and intermediate said burners and said tubes, and means for circulating waste combustion gases into said ducts.

5. In an oil cracking device, a furnace, tubes in said furnace, a plurality of burners adapted to generate a sheet of hot combustion gases in said furnace and adjacent said tubes, means for causing a downward draft in said furnace, ducts in said furnace positioned between said burners and said tubes and means for introducing waste combustion gases into said ducts.

6. A method of heating surfaces of oil containers which comprises placing said oil containers intermediate sheets of hot combustion gases, circulating waste combustion gases intermediate said sheets of hot combustion gases and said oil containers and heating the surfaces of said oil containers by radiation from said sheets of hot combustion gases.

7. A method of heating oil containers which comprises placing said oil containers intermediate sheets of hot combustion gases and circulating blankets of waste combustion gases intermediate said sheets and said oil containers to establish a pressure gradient away from said oil containers and towards said sheets to prevent said hot combustion gases from "licking" the surfaces of said oil containers.

8. In an oil cracking still, the combination of tubes to be heated, burners positioned one above the other on each side of said tubes for introducing sheets of hot combustion gases, ducts positioned one above the other intermediate said burners and said tubes and means for circulating waste combustion gases through said ducts.

9. In an oil cracking still, the combination of tubes to be heated, burners positioned one above the other on each side of said tubes for introducing sheets of hot combustion gases, ducts positioned in line one above the other parallel to said burners and intermediate said burners and said tubes and means for circulating waste combustion gases through said ducts.

10. In an oil cracking device, a furnace, tubes in said furnace, burners positioned one above the other on each side of said tubes for introducing sheets of hot combustion gases in said furnace adjacent said tubes, ducts positioned one above the other intermediate said tubes and means for circulating waste combustion gases through said ducts.

11. In an oil cracking device, a furnace, tubes in said furnace, burners positioned one above the other on each side of said tubes for introducing sheets of hot combustion gases in said furnace adjacent said tubes, tubes positioned adjacent the roof of said furnace, means for causing a downward draft in said furnace, ducts positioned one above the other intermediate said burners and said tubes and means for circulating waste combustion gases through said ducts.

12. In an oil cracking device, a furnace, tubes positioned adjacent each side wall of said furnace, a central bank of tubes positioned intermediate said side wall tubes, tubes positioned adjacent

the roof of said furnace, burners positioned one above the other intermediate said central bank of tubes and said side wall tubes for introducing sheets of hot combustion gases in said furnace adjacent said tubes, means for causing a downward draft in said furnace, ducts positioned one above the other on each side of said burners and means for circulating waste combustion gases through said ducts.

13. In a furnace, oil containers to be heated, means to generate a plurality of broad, thin, incandescent flames, means to direct said individual flames to merge and present a substantially continuous sheet of flame substantially as thin as the individual flames and of relatively great superficial area in relation to the volume of gases in said sheet of flame, said oil containers being so arranged as to be heated substantially solely by radiation from said sheet of flame, the heated surface of the container being spaced from the sheet of flame a sufficient distance to substantially prevent contact of the flame with said surface.

14. In a furnace, oil containers to be heated, means to generate a plurality of broad, thin, incandescent flames, means to direct said individual flames to merge and present a substantially continuous sheet of flame substantially as thin as the individual flames and of relatively great superficial area in relation to the volume of gases in said sheet of flame, means for interposing a blanket of gases transparent to radiant heat intermediate said sheet of flame and said oil containers, said oil containers being so arranged as to be heated substantially solely by radiation from said sheet of flame.

15. In a furnace, oil containers to be heated, means to generate a plurality of broad thin incandescent flames, means to direct said individual flames to merge and present a substantially continuous sheet of flame substantially as thin as the individual flames and of relatively great superficial area in relation to the volume of gases in said sheet of flame, means for circulating waste combustion gases intermediate said sheet of flame and said oil containers to prevent said sheet of flame from contacting said oil containers, said oil containers being so arranged as to be heated substantially solely by radiation from said sheet of flame.

16. In combination a furnace, a plurality of tubes to be heated in said furnace, a plurality of burners in alignment and having nozzle orifices which will give a flame having a broad, thin character, the burners being so spaced that the individual flames issuing therefrom merge to generate a substantially continuous sheet of flame substantially as thin as the individual flames and of relatively great superficial area in relation to the volume of gases, the burners being spaced from the said tubes so that the sheet of flame is substantially parallel with the plane of said tubes, a plurality of ducts in alignment parallel to said burners between said burners and said tubes and adapted to establish a blanket of gases substantially parallel to said sheet of flame and means for circulating gases through said ducts.

17. A method of heating surfaces of oil containers which comprises generating a plurality of broad, thin, individual, incandescent flames from a plurality of points in alignment, causing said flames to merge to form a broad, continuous sheet of flame substantially as thin as the individual flames and of relatively great superficial

area in relation to the volume of gases in said sheet, and heating said surface substantially solely by radiation from said sheet while the surface is spaced a sufficient distance from said sheet to substantially prevent contact of the sheet with said surface.

18. A method of heating surfaces of oil containers which comprises generating a plurality of broad, thin, individual, incandescent flames from a plurality of points in alignment, causing said flames to merge to form a broad, continuous sheet of flame substantially as thin as the individual flames and of relatively great superficial area in relation to the volume of gases in said sheet, interposing a blanket of non-combustible gases transparent to radiant heat between said sheet and said surface, and heating said surface substantially solely by radiation from said sheet.

19. A method of heating surfaces of oil containers which comprises generating a plurality of broad, thin, individual, incandescent flames from a plurality of points in alignment, causing said flames to merge to form a broad, continuous sheet of flame substantially as thin as the individual flames and of relatively great superficial area in relation to the volume of gases in said sheet, interposing a blanket of waste combustion gases transparent to radiant heat between said sheet and said surface, the waste combustion gases being under pressure sufficient to prevent said sheet from contacting said surface, and heating said surface substantially solely by radiation from said sheet.

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