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PROCESS AND APPARATUS FOR CONTROLLING HEAT AND COMBUSTION IN POT-TYPE HYDROCARBON FUEL BURNERS

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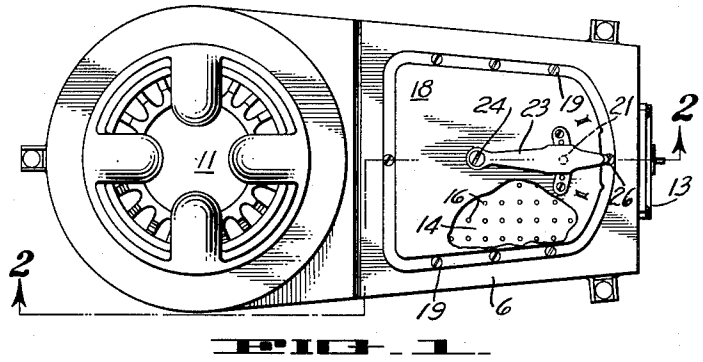


FIG. 1

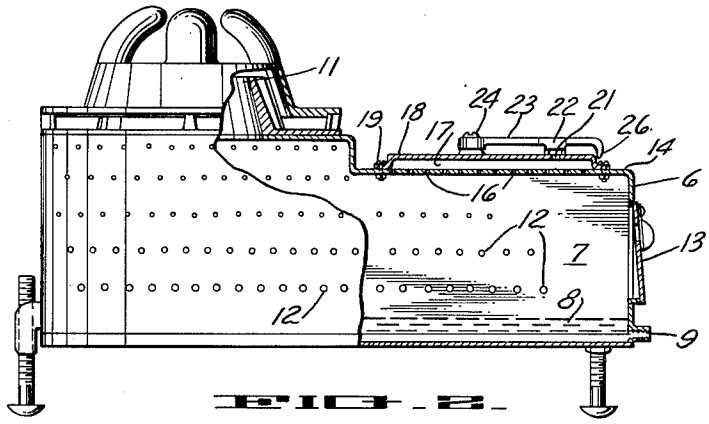


FIG. 2

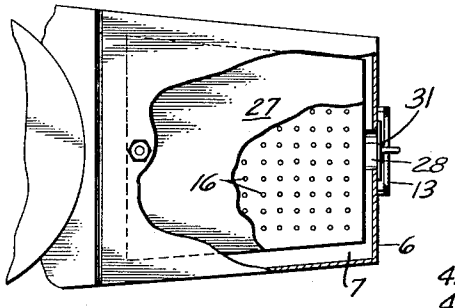


FIG. 3

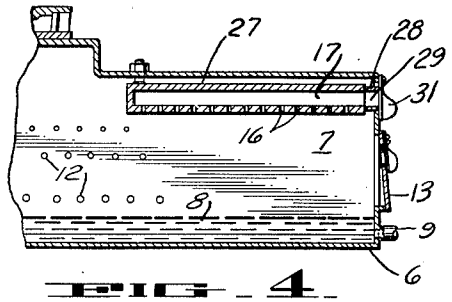


FIG. 4

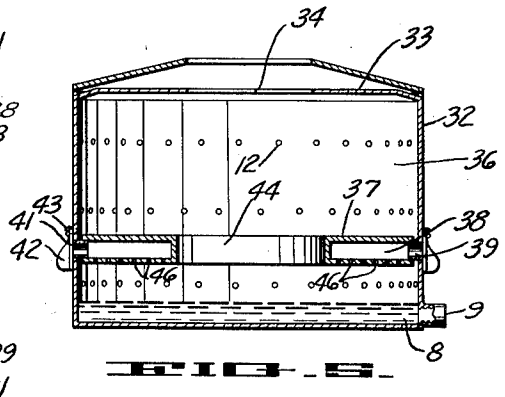


FIG. 5

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## PROCESS AND APPARATUS FOR CONTROLLING HEAT AND COMBUSTION IN POT-TYPE HYDROCARBON FUEL BURNERS

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8 Claims. (Cl. 158—91)

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This invention relates to the regulation of burners of the type in which the hydrocarbons are generally vaporized and mixed with air in a fuel generating chamber and then burned at a throat or outlet leading from the chamber where secondary air is supplied, the heat of the burning fuel at the throat serving to radiate heat to the hydrocarbons so as to vaporize the same for admixture with primary air supplied to the chamber.

Distillates of the types presently most generally available are products of modern catalytic cracking processes and are those which remain after the major portions of the more volatile fractions of the crude oil have been extracted. As a result of this, the so-called burner oils now require greatly increased temperatures to transform them to the vaporous condition necessary to insure complete and efficient combustion of the fuel. The conventional burner is generally incapable of developing, in the burner flame, a temperature sufficiently high to thoroughly volatilize the catalytic-process distillates with the result that the burner operates not only at reduced efficiency so as to create an excessive amount of smoke and soot deposit, but promotes surging or periodic burning back into the vaporizing area of the fuel generating chamber.

An object of the invention is to provide an improved process and apparatus for effecting efficient combustion of, and for deriving a maximum amount of heat from characteristically refractory burner fuels such as the high boiling-point distillates obtained as products in the catalytic refining of crude oil.

Another object of the invention is to provide, in connection with a burner having a throat at which may burn a principal flame resulting from an ignited admixture of air and hydrocarbon fuel vapor generated in a vaporizing chamber containing a body of liquid fuel exposed to thermal radiation from the principal flame, a means independent of said thermal radiation which will increase the temperature within the vaporizing chamber greatly in excess of that capable of being produced by the principal flame alone so as to create a highly combustible mixture of vapor and air in the chamber and, at the same time, which will inhibit premature ignition of the highly combustible mass of vaporized fuel and air prior to the latter coming within normal ignition range of the principal flame.

A further object of the invention is to provide, in a burner of the character described, apparatus which will institute a regenerative action in

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the burner vaporizing chamber whereby a portion of the fuel vapor created in the chamber by thermal radiation from the principal flame is utilized for creating supplemental direct and radiated heat so as to greatly increase vaporization in the chamber thereby enriching the vaporous fuel supply of the principal flame and correspondingly increasing the flame heat so as to augment the normal vaporization caused by the principal flame and to increase the density of fuel vapor available and utilized for creating the aforesaid direct and radiated heat.

A further object of the invention is to provide an improved burner of the class described which is characterized by the production of a quieter fire, which indicated more efficient combustion by the deposit of less soot than ordinarily accumulates in burners of similar types, and which is less susceptible to the condition known as surging wherein the flame burning exteriorly of the generator or fuel vaporizing chamber recedes to burn persistently within the chamber with an accompanying severe loss in combustion efficiency.

Still another object of the invention is to provide heat control apparatus which may be readily attached to and incorporated in most types of conventional hydrocarbon fuel burners of the character referred to without necessitating extensive structural changes in the latter.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of the preferred form of the invention which is illustrated in the drawing accompanying and forming part of the specification. It is to be understood, however, that variations in the showing made by the said drawings and description may be adopted within the scope of the invention as set forth in the claims.

Referring to the drawings:

Figure 1 is a top plan view of an oil burner equipped with the improved heat control apparatus of my invention. Portions of the view are broken away so as to more clearly disclose the internal structure.

Figure 2 is a vertical sectional view taken in the plane indicated by the line 2—2 of Figure 1.

Figure 3 is a top plan view of the burner showing a modified form of heat control apparatus embodied therein.

Figure 4 is a side elevational view of the structure of Figure 3 with a portion of the burner broken away so as to more clearly show the heat control apparatus, the latter being shown in vertical section.

Figure 5 is a vertical sectional view of a cylindrical type of burner housing showing a ring type air heating device of my invention included therein.

In the drawings I have shown a burner of the fuel evaporation class such as disclosed in my prior Patent No. 2,109,946 and comprising as illustrated in Figures 1 and 2, housing 6 defining a generating or vaporizing chamber 7 at the bottom portion of which a pool 8 of liquid hydrocarbon fuel is arranged to be created, the fuel being admitted from a suitable source of supply, and at a pre-regulated rate, through an inlet 9 provided in the housing. The upper portion of the housing is provided with an opening or burner throat 11; and a plurality of apertures 12, pierced through the housing side walls, serve to admit primary combustion-supporting air to the chamber 7. In some burners of this type, ignition is instituted by introducing a flaming wad of paper or the like into the chamber 7 through an inspection door such as shown at 13 so as to raise the oil in the pool 8 to ignition temperature whereupon the rising vapors will combine with air admitted through the apertures 12 and, becoming ignited, will issue as a flame from the burner throat 11. Other burners are equipped with electrically energized glow devices or oil-fired pilot flames for initiating vaporization and combustion of the fuel. When the usual fuels having the relatively high proportion of readily vaporizable combustible fractions such as previously readily obtainable, was utilized for the operation of the typical burner thus described, the action of the burner flame established at the throat was to effect vaporization of the oil by thermal radiation from such flame and by heat conducted through the housing to the pool 8.

To permit, in such typical or other burners, use of catalytic distillates as the oil burner fuel instead of the fuel with the high percentage of the combustible fractions aforesaid, I provide for utilization with the burner, a novel means and process which involves in the preferred embodiments of the invention, the projection directly into the vaporization chamber of numerous tongues or jets of flame consisting of volatile components of the fuel vapor in the vaporizing chamber and highly heated air drawn from a restricted air chamber. This burning creates a controlled high temperature in the vaporizing chamber so as to greatly increase the rate of vaporization but without increasing the combustion of the mixture in the vaporizing zone of the chamber. The aforesaid burning action may be provided for by a wide variety of mechanical arrangements, several of which are here explained.

In each of the arrangements here illustrated, an air heating chamber is provided in association with the vaporizing chamber and communicates therewith through a plurality of small perforations contained in a wall or other element separating the chambers from each other.

As shown in Figures 1 and 2, as an example, the top wall member 14 of the housing 6 is provided with a comparatively large number of small apertures 16 each of which is about .086 inch in diameter, which form passages to the vaporization chamber 7 from an air heating chamber 17 disposed above the housing 6 and formed by a recessed cap member 18, the latter overlying the apertures 16 and sealed to the top wall member 14 in any suitable manner such as by screws 19. The cap member 18 is imperforate except for an aperture 21 (or a plurality if desired) in the top



thereof which may be partially or fully opened by a shutter valve 22 superposed thereover and preferably forming part of an arm 23 which is mounted by a screw 24 or the like to swing over the cap member. The shutter valve forms the common control means for regulating the supply of air to all of the apertures 16. A downturned end portion 26 of the arm is adapted, preferably, to frictionally engage a portion of the cap member or burner housing so that an adjustably fixed regulation of the uncovered area of the aperture 21 may be secured. Instead of being on the top wall 14, the chamber 17 may, as shown in Figures 3 to 5 of the drawings, be provided in a separate housing 27 positioned at any suitable location directly within the vaporization chamber 7. In such case, as in the embodiment shown in Figures 3 and 4, the housing 27 may be supported by means including a tubular arm 28 extending from the housing and passing through an aperture provided therefore in a wall member of the main burner housing 6. The arm 28 has a longitudinal passage 29 therein which carries air from exteriorly of the burner into the air heating chamber 17 and a shutter valve 31 is provided and adopted for operation similar to the valve 22.

For the purpose of explanation reference will be made to the embodiment of the invention shown in Figures 1 and 2. When the burner has been ignited for a short time, the jet flames at the apertures 16, will, as the result of the heat rising therefrom and conducted through the burner top wall 14, highly heat the air contained in the chamber 17, which air when passing through the apertures 16 will readily mix with fuel vapor in the uppermost portion of the vaporization chamber and thus effect continued propagation of the jet flames The jet flames are very blue in color and are comparatively short, extending approximately no more than about ¼ of an inch downwardly into the vaporization chamber.

In the operation of the burner of my invention, and as a very important feature thereof, the cross-sectional area of the aperture 21 to the chamber 17 is less than the combined cross-sectional area of the apertures 16, thus restricting the flow and reducing the velocity of the air from chamber 17 to the vaporizing chamber. In other words the flow from the apertures 16 into the vaporizing chamber will be restricted and at a much lower velocity than the air entering the vaporizing chamber through the apertures 12. The very low velocity of the air passing from the chamber 17 through the jet apertures 16 accounts for the shortness of the jet flames and the restricted volume of the air is sufficient only to support the desired combustion for the production of the aforesaid very blue flames. As will be understood, when the burner is operating and combustion is taking place at the throat 11, a considerable draft is induced in the vaporization chamber so that the pressure therein will be less than that of the pressure in chamber 17, and consequently there will be a flow of air from chamber 17 into the vaporizing chamber.

Operation of the burner in this manner, even for a very short time, increases the temperature of the vaporizing chamber and of the flame burning at the throat 11 by several hundred degrees Fahrenheit over that normally procurable in conventional types of burners. This intense heat generated by the flames burning at the apertures 16, in cooperation with the heat generated from the main flame, burning at the orifice 11, is radiated through the mass of comparatively

heavy fuel vapor to finally permeate the portions of the pool of liquid fuel. In this manner the heavier air-borne components of the fuel mixture in the generating chamber will be broken down to more nearly approach a gaseous phase, and the body of the liquid fuel will become so thoroughly and highly heated that it is very rapidly and completely vaporized. It will thus be evident that with the higher temperatures obtainable in the burner of my invention, the complete volatilization of the average catalytic-process distillates may be readily effected.

As the result of the thermal radiation from both the main burner flame and the numerous jet flames, a temperature will be attained in the vaporizing chamber which is considerably above the flash points of the fluid contents therein both in its liquid and vaporous phases. It will thus be evident that in a conventional burner and under ordinary conditions, such a temperature would result in the ignition and combustion of said contents in the chamber and produce the objectionable condition known in the art as "surging." It is a peculiar phenomenon of the present invention that notwithstanding the highly heated and vaporized condition of the fuel, the combustion thereof in the vaporizing zone of the chamber will be inhibited until it reaches the zone of the burner throat.

Exactly what occurs in the vaporizing or generator chamber is not entirely clear for the reason that several actions may take place which prevent said combustion with resultant surging. It may well be that the continuous generation of carbon dioxide and other products of combustion from the small blue flames steadily burning from the heat control chamber, thins out and modifies the oil and vapor mixture to the extent that combustion in the vaporizing zone of the burner is prevented. It is also possible that the heat control arrangement of my invention causes a chemical reaction to take place within the burner chamber which produces a burning mixture quite different from the mixture ordinarily formed in the conventional burner, and that this mixture, so formed under higher temperatures and with the added products of combustion from the multiplicity of small blue flames contains a high proportion of alcoholic vapors.

I have found that burners, when equipped with the heat control arrangement of my invention have a much smoother and quieter fire. Also, as previously explained, not only does the aforesaid arrangement eliminate the periodic surging, but no carbon will accumulate within the generator chamber even when burning the heavy catalytic oils.

I have also found in testing the burner of my invention that when better grades of fuel are used, most satisfactory fuel vaporization and burner performance will be obtained when the jet flames are located at the lower surface of the chamber top wall **14**. However when lower grade fuels are used, which have smaller amounts of the low-boiling point fractions, it has been found better to bring the jet flames into closer proximity with the surface of the oil pool. This may be accomplished, by positioning the auxiliary housing **27** in the vaporization chamber at such a location that the jet flames are sufficiently close to the oil pool to insure thorough heating thereof and to effect substantially complete reduction of the liquid thereof to the vaporous phase. Thus in Figure 5 is shown a burner of common form having a cylindrical housing **32** provided



in its top wall **33** with a burner orifice **34** disposed substantially centrally above the fuel vapor generation chamber **36**, an air heater housing **37** being provided with the chamber **36**, which is hollow to define an air chamber **38** connected by means of one of more tubes **39** with the burner housing **32**. The tubes **39**, besides serving as supports for the air heater housing, provide ducts **41** through which outside air may enter the chamber **38**, the exterior ends of the ducts being capable of fractional or complete exposure by means of shutter valves **42** cooperating therewith and mounted for pivotal movement by means of screws **43** or the like on the burner housing **32**. In the drawing I have shown the air heater housing as a disk-shaped body which occupies substantially the entire cross-sectional area of the chamber **36** with the exception of a central portion thereof defined by an opening **44** extending vertically through the air heater housing **37** and positioned substantially directly below the burner orifice **34**. The underside of the housing **37** is provided with a large number of small holes **46** entering the chamber **38** and at which the jet flames described above may burn to heat the vapor content of the chamber and to project heat downwardly toward the surface of the oil pool. If desired holes **46** may also be provided at the chamber **38**. Thus the combustion gases and the highly heated fuel vapor may pass upwardly through the opening **44** and thence directly through the burner orifice **34**. It will of course be obvious that instead of the ring-shaped disk housing shown in Figure 5, I may choose to employ a solid disk type of housing which may be positioned and sized to underlie the burner orifice with the gas and vapor passage defined by a peripheral gap between the margin of the disk and the adjacent wall surface of the burner housing **32**. Thus the gases and vapor generated will be caused to rise in the peripheral zone of the generator chamber **36** and will be caused, by the housing top wall **33**, to move convergently toward and through the burner orifice **34**. In either case, a desired turbulence in the fluid contents of the generator chamber is effected which, together with the high air temperature and combustion inhibiting action produced by the jet flames will produce greatly improved combustion in the main flame burning at the burner orifice and greatly increase the capacity of the burner.

I claim:

1. In a natural draft burner for hydrocarbon fuel having a housing with a horizontally elongated chamber into which may be admitted, respectively, fuel to be vaporized and primary air to be combined with vaporized fuel to form a combustible mixture, and said housing being further provided with a burner throat overlying the chamber adjacent one end thereof and through which the fuel mixture may flow and in which said fuel mixture may burn as a flame issuing from the housing, to radiate heat into the chamber to contribute toward vaporization of fuel therein and to induce a draft of air into the chamber to form with the fuel vapor a combustion propagating component of said fuel mixture, pre-ignition means overlying the chamber adjacent the other end thereof and including means to introduce a separate flow of air into the chamber over substantially the remaining portion of the chamber to combine with vaporized fuel therein and to form a separate fuel mixture ignitable to burn within and to separately radi-

ate heat into the chamber to further contribute to said fuel vaporization, and means for controlling admission of said separate flow of air, said separate air flow means being in direct vertical flow communication with the fuel in said remaining portion of the chamber whereby the burning thereat will radiate heat directly toward said fuel.

2. In a natural draft burner for hydrocarbon fuel having a housing with a horizontally elongated chamber into which may be admitted, respectively, fuel to be vaporized and air to be combined with vaporized fuel to form a combustible mixture, and said housing being further provided with a burner throat overlying one portion of said chamber through which the fuel mixture may flow and in which said fuel mixture may burn as a flame issuing from the housing, to radiate heat into the chamber to contribute toward vaporization of fuel therein and to induce a draft of air into the chamber to form with the fuel vapor a combustion propagating component of said fuel mixture, a housing member associated with said burner housing and defining an air chamber elongated in the direction of elongation of the burner chamber and contiguously related to and overlying substantially the entire remaining portion of said burner chamber, means to introduce a controlled flow of air into said air chamber, and means including a plurality of jet openings positioned over the full length of the air chamber to conduct air from said air chamber into said burner chamber to be mixed with fuel vapor in the latter and ignitable to burn as flames from said jet openings in proximity to said air chamber and exposed within said burner chamber, said flames being separate from said throat flame and disposed over the fuel in said remaining chamber portion whereby the heat from said flames will be radiated directly toward the fuel located under said air chamber.

3. An oil burner comprising a housing providing a horizontally elongated oil-vaporizing and air-mixing chamber, means providing a pool of oil along the bottom of the chamber, said housing having a burner throat at the top thereof overlying one portion of the exposed surface of said pool, said housing also having openings in its sides for admitting primary air to the chamber over substantially the entire surface of said pool, means supplying secondary air to said throat, a casing providing an air chamber along the upper portion of said first chamber and having a plurality of jet openings in the bottom thereof overlying the other portion of the surface of said pool, said jet openings being disposed at a level lower than said secondary air means and arranged to propagate flames therefrom to radiate heat directly toward said other portion of the pool surface, and means for controlling the supply of air to said casing.

4. An oil burner having a housing provided with an oil-vaporizing and air-mixing chamber, means providing a pool of oil along the bottom of said chamber, said housing having a burner throat at an upper portion thereof overlying one portion of the exposed surface of said pool, said housing also having openings in the side thereof for admitting primary air to the chamber over substantially the entire surface of the pool, means supplying secondary air to said burner throat, a casing providing an air chamber substantially at the top of said first chamber and having a plurality of jet openings providing communication between said chambers and positioned directly over the other portion of the surface of the pool, said jet openings being laterally offset and disposed below the level of said secondary air means, air supplying means independent of said primary air openings and said secondary air supplying means for admitting air to said casing, the effective area of the air supplying means for said casing being less than the total cross-sectional area of said jet openings.

5. An oil burner comprising a housing having side, top and bottom walls defining a horizontally elongated oil vaporizing chamber, said top wall having a burner throat therein adjacent one end of said chamber, said side walls being perforated to admit primary air to the chamber substantially throughout the length thereof and having a substantially imperforate portion adjacent the top thereof near the other end of the chamber, secondary air supply means at said throat to provide with said primary air and oil vapor a combustible mixture to burn at said throat and thereby radiate heat in the chamber to vaporize the oil therein and induce a draft from said perforations to said throat, a casing providing an air chamber adjacent the top and said last mentioned end of the vaporizing chamber and having a bottom wall with air discharge openings in the zone of said imperforate side wall portion, and air supply means to said casing.

6. An oil burner comprising a housing having top and bottom walls and elongated opposing side walls and front and rear side walls defining an elongated oil-vaporizing and air mixing chamber, means adjacent said rear side wall and cooperating with the top wall of the housing to form a burner throat for the chamber, said elongated and rear side walls having openings therein for admission of primary air to the chamber, said side walls having a substantially imperforate portion adjacent the top wall and front side wall, means providing a pool of oil substantially over the entire length of the bottom wall, a casing positioned within the chamber opposite and between said imperforate portions and entirely removed from under the throat, said casing having top, side and bottom walls defining an air chamber, the top wall of said casing being substantially imperforate and said bottom wall of the casing being formed with jet openings, and means securing said casing to the front wall of the housing and providing a passage for air to said casing chamber from exterior of the housing.

7. The process of vaporizing oil and mixing the same with air in a horizontally elongated chamber for discharging and burning in a throat at the top and adjacent one end of the chamber, which comprises the introduction of a thin film of oil across the entire bottom surface of said chamber, admitting primary air to said chamber along substantially the entire length thereof and closely adjacent to the surface of the oil, supplying secondary air for admixture with the air and oil mixture discharging at the throat, the amount of said primary air and oil in the chamber being such that a combustible mixture will be provided with said secondary air and burned at said throat, supplying jets of air independent of said primary and secondary air to the mixture in the chamber along the upper portion thereof laterally remote from said throat, selectively controlling the amount of said air jets, said amount being sufficient to provide a zone of limited combustion in proximity to the supply of air for said jets for preheating said supply prior

to the introduction of said jets in the chamber and for increasing the vaporization of the oil in the chamber.

8. The process of vaporizing oil and mixing the same with air in a horizontally elongated chamber for discharging and burning in a throat at the top and adjacent one end of the chamber, which comprises the introduction of a thin film of oil across the entire bottom surface of said chamber, admitting primary air to said chamber along substantially the entire length thereof and closely adjacent to the surface of the oil, without effecting burning of said primary air in said chamber adjacent the admission thereof, supplying secondary air for admixture with the air and oil mixture discharging at the throat, the amount of said primary air and oil in the chamber being such that a combustible mixture will be provided with said secondary air and burned at said throat, supplying jets of air independent of said primary and secondary air to the mixture in the chamber along the upper portion thereof laterally remote from said throat and at an entering velocity substantially less than the primary air velocity, selectively controlling the quantity of said air jets, said amount being sufficient to provide short streaks of blue flame in proximity to the supply of air for said jets for pre-heating said supply prior to the introduction of said jets in the chamber and for increasing the vaporization of the oil in the chamber subjacent said jets.



HARRY C. LITTLE.

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