Jan. 1, 1952 S. P. CAULEY 2,581,238

VAPORIZING VERTICAL POT TYPE OIL BURNER

Filed Aug. 8, 1946 2 SHEETS—SHEET 1

Fig. 1

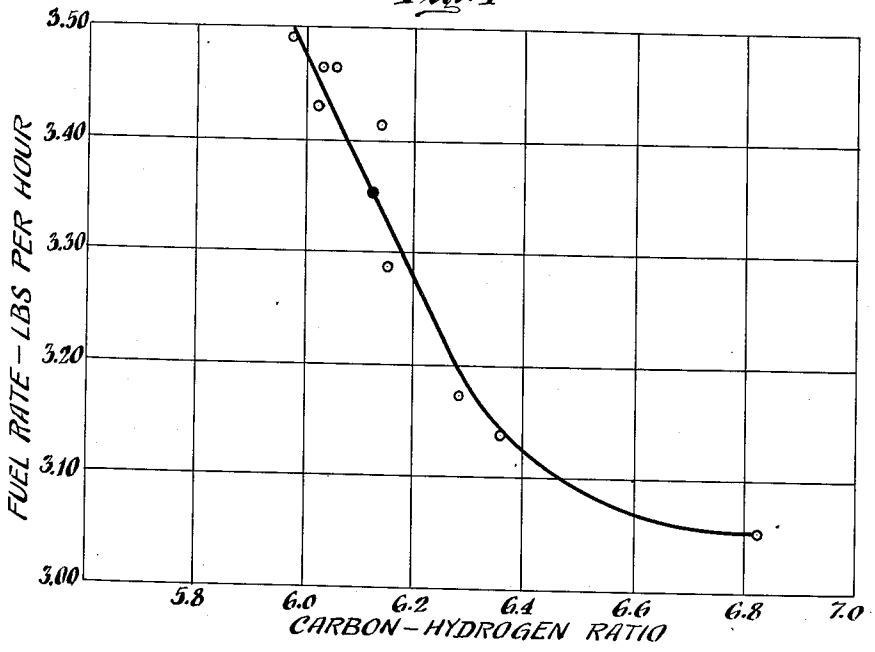
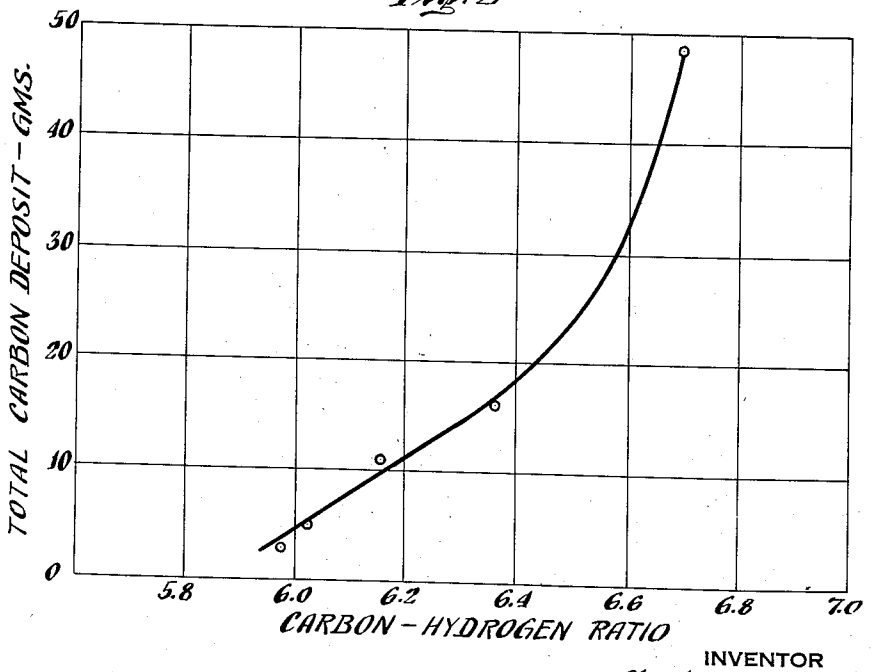


Fig. 2



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VAPORIZING VERTICAL POT TYPE OIL BURNER

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Fig. 3

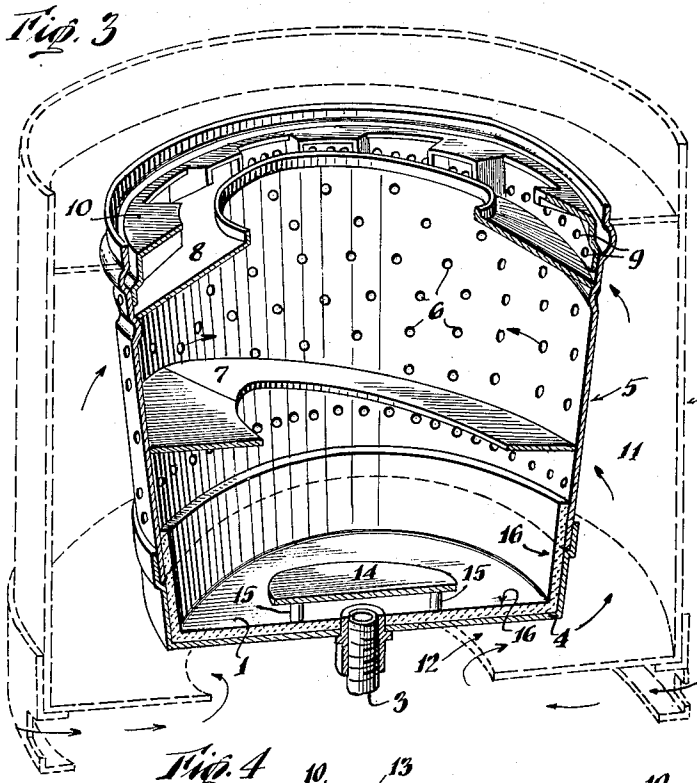


Fig. 8

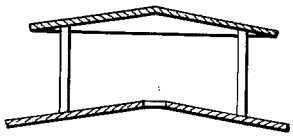


Fig. 9

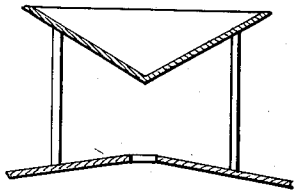


Fig. 4

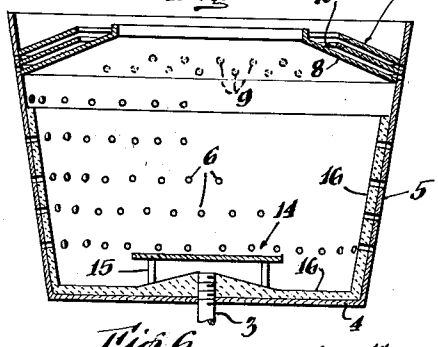


Fig. 5

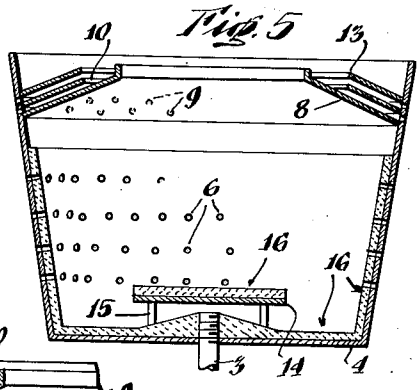


Fig. 6

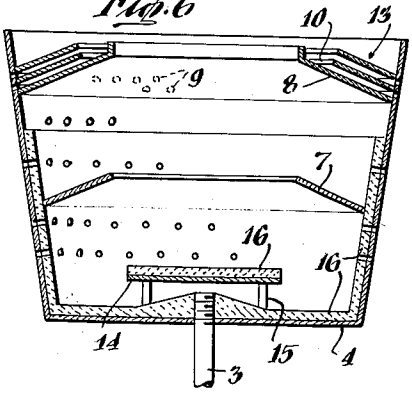
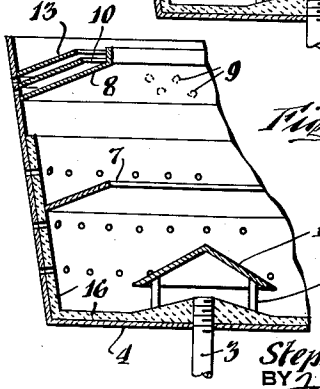


Fig. 7



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VAPORIZING VERTICAL POT TYPE OIL BURNER

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Application August 8, 1946, Serial No. 689,240

4 Claims. (Cl. 158—91)

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The present invention relates to vaporizing type liquid hydrocarbon fuel burners and, more particularly, to burners of this class which depend entirely upon the heat of combustion of the oil being burned for vaporizing the oil to be burned. These burners may be conveniently classified into the following general types:

1. Vertical pot type
2. Horizontal type
   a. Retort
   b. Pot
3. Sleeve type

The present commercially available vaporizing type burners are of all-metal construction and have common operating characteristics in that they normally require virgin distillate fuels in order to give satisfatocry performance, satisfactory performance being judged by their ability to deliver rated heat output without the formation of objectionable amounts of soot or hard carbonaceous deposits.

As previously mentioned, all of these commercially available burners have combustion characteristics which make it necessary to use distillate fuel oils that are essentially paraffinic in their composition. Attempts to use less paraffinic oils, such as those derived from commerical cracking operations for the production of motor fuels, result in the production of excessive soot and hard carbonaceous deposits in the burner. These deposits interfere with the entrance of primary air required for combustion and the flow of oil into the burner.

The above mentioned critical nature of the vaporizing burner in regard to the type of fuel required presents a serious problem in connection with the conservation of natural petroleum resources. There are several millions of this type of burner in use within the United States of America and approximately 500,000 to 700,000 additional new units are normally manufactured each year. The problem of continuing the supply of paraffinic distillate oils for these burners is recognized as being quite serious. Studies to determine the amounts of by-product distillate fuel oils from motor fuel cracking processes, that might be blended with paraffinic stocks for their use, have emphasized the critical nature of this type of burner. An example of this is illustrated in the Figures 1 and 2. In these figures the relative paraffinicity of the fuels tested is shown by the property of carbon-hydrogen ratio. This property gives the weight ratio of the carbon and hydrogen contents of a fuel. The lowest carbon/hydrogen ratio represents the most paraffinic type fuel. Reduced paraffinicity is characterized by increasing C/H ratios. The test data were obtained using a conventional vertical vaporizing type burner under the same draft conditions.

Figure 1 shows that the rate at which oils may

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be burned (indicating the relative amounts of heat released) at the maximum tolerable soot or smoke concentration is quite sensitive to the carbon-hydrogen ratios of fuels tested. The ICHAM smoke point referred to in the drawing is a measurement of the amount of light transmission that may be obtained, under specified conditions of test, through a glass rod that has been inserted in the flue gas passageway of the burner. A 6 per cent ICHAM smoke point indicates only a 6 per cent light transmission under the test conditions and roughly corresponds to the concentration at which smoke becomes visible to the human eye.

Figure 2 shows the weights of hard carbonaceous deposits produced when burning the same volume of fuels having different carbon-hydrogen ratios under the same conditions of test. As in Figure 1, it may be noted that the carbonaceous depositing tendencies of fuels, when used in this commercially available vaporizing type of burner, are also critical to carbon-hydrogen ratio.

It has been recognized by the manufacturers of this type of burner that the present commercially available designs must be modified to permit the use of catalytically cracked fuel. This is evident from a report of an address given at a recent meeting of the Cleveland Engineering Society and published in the February 6, 1946, issue of National Petroleum News (page 34).

During a discussion following presentation of the paper it was brought out that whatever course the future deisgn of pot type burners may take, no concern need be felt over the supply of thermal cracked fuel. But it was conceded that the day will come when "cat" crackers will crowd out the old thermal cracking plants, and a point will be reached where it will be necessary to switch over to the "cat" cracked product entirely, rather than attempt to sell two kinds of fuel oil.

For all of these reasons the oil burner designers were urged to develop equipment to use the "cat" cracked fuel. The speaker hoped that some clue to the right solution might arise out of a recent series of burning tests conducted by the American Society for Testing Materials.

While previous attempts to improve burners of this type to reduce or eliminate excessive deposition of carbon in the air inlets and elsewhere have been based upon the assumption that the presence of excessive deposits of carbon was evidence of insufficient air for complete combustion or inadequate mixing of sufficient air with the oil vapors, it has now been found that the unsatisfactory excessive deposits of carbon when burning fuels of reduced paraffinicity in this type of burner is not correlated as closely with the adequacy of the air supply as with other phenomena. It has been found that burners of the vaporizing type which when operating on

fuels of reduced paraffinicity may be modified in structure in a manner which in no way appears to affect the amount of air supplied to the burner but does result in the reduction of the amount of carbon deposited from fuels of reduced paraffinicity to a remarkable extent. Thus, the problem of providing an adequate supply of fuel for this class of liquid hydrocarbon burner in the face of decreasing supplies of fuel of high paraffinicity has been solved. The burners of modified structure operate on fuels of low paraffinicity under substantially the same draft usually with less smoke and at at least as high a capacity as that with which the unmodified burner operates on fuel of high paraffinicity.

It is an object of the present invention to provide a modified vaporizing type burner in which liquid hydrocarbon fuels of relatively low paraffinicity or relatively high carbon to hydrogen ratio can be burned under conditions which would produce excessive deposits of carbon were the fuel to be burned in a conventional burner of this class. It is another object of the present invention to provide movable elements which may be inserted in appropriate positions in the conventional structure of a manufactured burner to modify the structure thereof in accordance with the principles of the present invention to provide improved operating conditions resulting in the reduction of the amount of carbon deposited when burning fuels of low paraffinicity, i. e. of relatively high C/H ratios.

It is a further object of the present invention to provide a vaporizing type burner having a vaporizing chamber in which the liquid fuel is vaporized in which those portions of the vaporizing chamber which are in contact with the liquid fuel or vapors thereof before ignition are provided with non-metallic surfaces.

The present invention also has as an object to provide a vaporizing type burner having a shield interposed between the source of radiant energy and the oil to be vaporized, said shield to be of such size and so constructed and arranged as to reduce the amount of heat absorbed by the fuel to be vaporized and the vapors produced that cracking of the oil is reduced to a substantial degree before ignition and burning of the oil occurs.

It is also within the scope of the objects of this invention to provide an improvement in the operation of burners of this class whereby liquid hydrocarbon fuels of relatively low paraffinicity can be burned without the production of excessive amounts of carbon and obstruction thereby of air inlets.

Other objects and advantages will become apparent from the following description taken in conjunction with the drawings in which

Figure 1 is a graph showing the relation between the carbon-hydrogen ratio of fuels and the rate at which liquid hydrocarbon fuels may be burned at maximum tolerable soot or smoke concentration,

Figure 2 is a graph showing the relation between the weights of hard carbonaceous deposits produced and the carbon-hydrogen ratio of fuels when the same volume of each of several fuels is burned in the same burner under substantially the same test conditions,

Figure 3 is a vertical section through the lower portion of a conventional pot type vaporizing burner modified in accordance with the principles of the present invention,

Figure 4 is a more or less diagrammatic representation of a vertical cross-section through the lower portion of a conventional pot type vaporizing burner modified in accordance with the principles of the present invention, in which the non-catalytic coating of the inner surface of the bottom of the pot is built up around the fuel inlet means to insure drainage of the fuel away from the fuel inlet,

Figure 5 is a more or less diagrammatic representation of a vertical cross-section through the lower portion of a conventional pot type vaporizing burner modified in accordance with the principles of the present invention wherein the upper surface of the baffle or shield is provided with a coating of insulating material,

Figure 6 is a more or less diagrammatic representation of a vertical cross-section through the lower portion of a conventional pot type vaporizing burner modified in accordance with the principles of the present invention in which the conventional low-flame ring has been replaced with a low-flame ring all parts of which are in the same plane,

Figure 7 is a more or less diagrammatic representation of a vertical cross-section through the lower portion of a conventional pot type vaporizing burner modified in accordance with the principles of the present invention in which the flat shield or baffle of the modifications depicted in Figures 3 through 6 is replaced by a conical shield, and

Figures 8 and 9 are illustrative of further modifications of the conical shield illustrated in Figure 7.

It has been found that substantial improvement in combustion characteristics of commercially available vaporizing types of burners, which results in their ability to satisfactorily burn fuels having increased carbon-hydrogen ratios, may be obtained through two factors. The first is that if distillate fuel oils are vaporized while in contact with a non-catalytic non-metallic, instead of a metallic catalytic, surface, less soot and hard carbonaceous deposits will be obtained during combustion. This is due to the elimination of the catalytic effect of metals upon the carbonization of hydrocarbons.

The second is elimination or control of direct radiant heat absorption from the burner flame by the oil at the point of vaporization. The effect of this is to reduce excessive heat absorption by the oil being vaporized which may cause excessive thermal decomposition or carbonization of the fuel during vaporization.

It is proposed that the metallic surface in contact with oil during vaporization in vaporizing types of burners be eliminated by covering or replacing this area with a suitable refractory type of material. An alternative is to provide the metallic surface with a non-metallic heat resistant non-catalytic coating, for example, by siliconizing the metal surface. This improvement applies to all of the vaporizing types of burners discussed.

Other types of vaporizing burners may have materially improved combustion by elimination of direct radiant heat absorption by the oil during vaporization.

It is proposed to control the amount of radiant heat absorption, by the oil while being vaporized, by a shield or baffle interposed between the source of radiant heat and the oil at the point of vaporization. The method of shielding used in each type of burner will vary because of their differences in construction but, in general, the shield

should cover 60 per cent of the total surface area of the pool of oil to be burned.

In the vertical type of vaporizing oil burner the shield may be a circular disc or discs. It may have a flat surface or may be concave or convex depending upon the type of oil which is to be used. If highly aromatic fuels are to be used, the shield should preferably be in t' shape of a cone without a bottom. This shape will allow for a longer period of interaction between the hydrocarbon vapors and oxygen prior to subjection of the mixture to absorption of direct radiant heat from the flame. An illustration of this shield shape is shown in Figure 7. For less aromatic types of fuels the cone apex angle may increase or may become inverted as shown in Figures 8 and 9.

The height of the shield or its distance from the point of vaporization will also depend upon the construction of the burner in which it is used and the type of fuel being burned. Generally with aromatic fuels the shield should be placed at a greater distance from the point of vaporization than when using less aromatic fuels. This in effect provides a control over the amount of radiant heat absorption, by the oil. The edge of the shield preferably should be below the lowest primary air inlet holes in the vertical type of vaporizing burner. This allows the mixing of oil vapors and air prior to absorption of radiant heat and combustion.

In order that those skilled in the art may appreciate the magnitude of the change in the capability of a burner of the class described, the data of two comparative tests on a relatively high carbon-hydrogen ratio fuel are tabulated hereinafter.

The fuel had the following characteristics:

Gravity, °API	32.5
Distillation—	
I. B. P., °F	376
10%	428
20%	441
30%	452
40%	460
50%	467
60%	477
70%	488
80%	501
90%	520
E. P. °F	576
Recovery, percent	99.0
Residue, percent	1.0
Aniline point, °F	122.4
Carbon residue on 10% bottoms, percent	0.11
Sulfur, percent	0.07
Carbon-hydrogen ratio (estimated)	6.48

A conventional vertical vaporizing type 10 inch burner rated at 50,000 B. t. u. per hour available heat output was used. The burner was operated at a draft of 0.08 inch of water to determine if the burner would deliver the rated heat output under rating conditions required by the Bureau of Fire Underwriters. The rating conditions of the Bureau are that the smoke rating at a draft of 0.08 inch water shall not be lower than 6 per cent as measured by the ICHAM glass rod procedure. It was found upon burning approximately 50 gallons of oil that the maximum heat output under these conditions was 45,600 B. t. u. per hour. Furthermore, it was found that it was necessary to reduce the oil input at intervals to retain the 6 per cent smoke limit. This is an indication that the excessive soot (carbon) formed was interfering with the entrance of primary air to the burner.

A comparative test was then run using the same burner after improving it in accordance with the principles of the present invention. That is to say, a steel disc, 0.125 inch thick, eight inches in diameter and having its surface sloping radially at an angle of about 5 per cent from the horizontal was mounted on three supports equally spaced near the edge of the disc. The height of the supports was 2.5 inches. The height of the disc or baffle was such that, when the supports rested on the bottom of the vaporizing chamber of the burner, the edge of the baffle was below the lowest row of primary air inlet holes. The metal surface of the bottom of the vaporizing chamber was covered with a common refractory type of material such as fireclay in such a manner that the oil would be in contact only with the refractory during vaporization.

After improvement of the burner in the above manner a test run was made using the same oil and the same draft as was used in testing the unmodified burner. However, it was possible to maintain an ICHAM smoke measurement of 87 to 100 per cent. In other words, with the improved burner there was almost perfect elimination of smoke as determined by this method. Furthermore, in a continuous burning test it was not necessary to reduce the fuel input rate during the entire test period as was necessary when operating the prior art burner on the same fuel under the same draft conditions.

	Prior art vaporizing type burner	Improved vaporizing type burner
Oil rate pounds per hour	3.11	3.4
Total burning time (hours)	103.	109.2
Grams of Carbon Deposit per pound of oil burned		
Bottom Carbon	0.23	0.15
Side Carbon	0.18	
Draft, inch of water	0.05	
Carbon Dioxide per cent of Flue Gas	0.08	0.08
Per cent Excess Air	12.1	13.0
Flue Gas Temperature, °F	23.0	14.0
Efficiency, Per Cent	830	845
Smoke rate (ICHAM) as per cent light transmitted	76	76
Heat output, B. t. u./hour	5+	27
	45,600	50,000

Certain of the foregoing data should be emphasized. For example, in the modified burner only about 65 per cent as much carbon was deposited per pound of oil input as was deposited in the unmodified burner. In other words, the total amount of carbon deposited was about 35 per cent less than that deposited in the unmodified burner. The reduced carbon deposit was obtained with conditions under which the excess air was reduced 40 per cent and the smoke rating was improved by about 540 per cent. All of these improved results were obtained without the sacrifice of any efficiency or output of heat.

Other tests were conducted using other oils typical of which is one having the following characteristics:

Gravity, °API	29.4
Distillation—	
I. B. P., °F	423
10%	447
50%	479
90%	528
E. P., °F	584
Carbon residue 10% bottoms, per cent	0.07
Carbon-hydrogen ratio	7.24

This oil was burned in the burner improved as described hereinbefore under the conditions and with the results tabulated hereinafter:

Oil rate pounds per hour	3.4
Total burning time, hours	97.4
Grams of carbon deposit per pound of oil burned	0.333
Draft, inch of water	0.08
Carbon dioxide per cent of flue gas	14.0
Per cent excess air	15.0
Flue gas temperature, °F	895
Efficiency, per cent	76
Smoke rate (ICHAM) as per cent light transmitted	68
Heat output, B. t. u. per hour	50,000

It will be noted that the foregoing data were obtained on a relatively heavy oil usually considered as unsuitable fuel for this class of burner. Nevertheless, the burner improved in accordance with the principles of this invention operated in a highly satisfactory manner.

The foregoing discussion of the highly satisfactory results obtained when burning fuels usually considered unsatisfactory for use in this class of burners leads to a description of the improved burner in conjunction with the drawings. As noted hereinbefore, the drawings of Figure 3 illustrates that type of the class of vaporizing liquid fuel burners which depend entirely upon the heat of combustion of the oil being burned to vaporize the oil to be burned which is known as the "vertical pot" type modified in accordance with the principles of the present invention to provide a non-catalytic surface on those portions of the pot the surfaces of which are in contact with unvaporized oil or unignited oil vapors, a baffle or shield between the pool of unburned oil and the source of radiant heat and to provide a fuel inlet means located at the approximate center of the bottom of the pot in place of an inlet at the periphery of the pot. The general construction of this type of the general class of vaporizing burners is too well known to require detailed description herein. It is considered sufficient to state that the commercially available "vertical pot" type burner comprises in general a cylindrical metal vessel with an oil inlet at the periphery of the bottom and a plurality of spaced apart air ports or inlets in the vertical portion of the pot. These ports or inlets are usually present as rows of which the lowest is spaced a short distance above the bottom of the pot. An annular flange rigidly or removably mounted on the upper part of the wall of the pot serves as a flame ring at which point the flue burns with a visible flame. This structure is illustrated in its fundamental elements in U. S. Patents Nos. 1,660,857 and 2,393,233.

The firebox or pot 1 is constructed of suitable sheet metal such as iron or steel and is surrounded by and enclosed within a drum 2 of similar material suitably ornamented. Drum 2 usually extends beyond the upper edge of pot 1 to provide heat exchange between the products of combustion and the air surrounding the heater. Liquid fuel such as kerosene or relatively light distillates having distillation end points below about 650 degrees Fahrenheit and of suitable flashpoint is delivered to the periphery of pot 1 through inlet 3. The fuel spreads upon the base 4 of pot 1 and forms a pool which covers an area of base 4 dependent upon the difference between the rate at which the fuel is burned and the rate at which the fuel is fed to pot 1. Since the pot 1 is of generally well known construction, enumeration of the parts need only be sufficiently detailed to permit appreciation of the modifications comprehended by the principles of the present invention. Therefore, it will suffice to point out that the walls 5 of the pot usually are inclined from the vertical and provided with air inlets 6 through which the primary air is admitted to support the initial combustion of the fuel. In order to provide better operational conditions, a low flame ring or center baffle 7 is provided. Above the uppermost row of primary air inlets a high flame ring or top baffle 8 is provided. In order to ensure better mixing of secondary air entering the pot through ports 9 a secondary air mixing baffle 10 is located immediately above and contiguous to baffle 8. The chimney effect of the pot 1 draws air into the air space 11 through main base inlet 12. From air space 11 the air is drawn into the interior of pot 1 through primary inlets 6 and secondary inlets 9. The conventional, unmodified vertical pot type burner, the essential parts of which have been enumerated in the foregoing, can be modified in accordance with the principles of the present invention by providing a bottom shield or baffle 14 supported by legs 15 or in any other suitable manner to place the baffle or shield 14 between the first row of primary air inlets 6 and the unburned oil. In addition the base 4 and the walls of pot 1 are provided with a non-metallic, non-catalytic coating 16, illustrated as being of a refractory material such as fire-clay or the like, although a siliconized surface is satisfactory.

When fuel such as that for which certain physical and chemical characteristics have been given hereinbefore is burned in a conventional, unmodified burner about 0.23 gram total carbon is deposited per pound of oil burned. About 78 per cent of the total carbon deposits settles on the bottom of the pot and about 22 per cent on the walls.

The effect of heavy ends on the deposition of carbon in the unmodified burner can be determined by comparison of pertinent values for different oils. The fuels described in the following table were burned as indicated in a conventional, unmodified vertical pot type burner of the vaporizing type, a modification in accordance with the principles of the present invention is illustrated in Figure 3.

Table I

Fuel	A	B	C	D
IBP	449	423	376	435
517±11° F ..... per cent	10	90	90	50
EP	633	584	576	636
Aniline Pt., ° F	155.5	116.2	122.4	115.0
Corrected C/H Ratio	6.62	7.24	6.94	7.56
Diesel Index	52.4	34.2	41.1	29.8
Mole Wt	225	185	180	209

Run No	D-1			D-8	D-19
Fuel Rate, lbs./hr	2.72	2.15	0.050	3.11	2.16
Stack Draft, Inches Water	0.044	0.031	0.055	0.080	0.063
Pot Draft, Inches Water	0.059	0.031	0.055	0.097	0.078
Per cent CO_2 in dry flue gas	-----	-----	-----	12.0	9.4
Per cent Excess Air	-----	-----	-----	27	67
ICHAM, Per Cent Trans	51	21	5	5	34
Total Carbon Deposit, g./lb. oil	-----	-----	-----	0.23	1.90
Bottom Carbon, g./lb. oil	-----	-----	-----	0.18	0.45
Bottom Carbon, Per Cent Total	-----	-----	-----	78	23
Side Carbon, g./lb. oil	-----	-----	-----	0.05	1.45
Side Carbon, Per Cent Total	-----	-----	-----	22	77

Those skilled in the art will recognize that fuel A is a fuel of relatively high paraffinicity. It will also be observed that only about 10 per cent of fuel A is distilled off at 517 ± 11 degrees Fahrenheit and that the carbon-hydrogen ratio is the lowest of the four fuels.

For the purposes of the comparative tests to be discussed hereinafter, the attention of those skilled in the art is directed to fuels C and D. It will be observed that at 517 ± 11 degrees Fahrenheit, 90 per cent of fuel C has distilled whereas only 50 per cent of fuel D has distilled at that temperature range. It will also be noted the carbon-hydrogen ratio for fuel D is appreciably higher than that of fuel C.

Turning to the characteristics of these fuels, it will be noted (1) that although approximately eight times as much carbon was deposited by fuel D, the percentage of light transmission in the ICHAM test was much higher; (2) that with fuel C most of the carbon was deposited on the bottom of pot 1, whereas with fuel D most of the carbon was deposited on the sides. This is an important characteristic since the carbon deposited on the side walls (side carbon) tends to obstruct the primary air inlets and increase the amount of carbon and smoke. Thus, it would appear that when a more aromatic fuel with heavier ends is burned in an unmodified conventional vertical pot type burner, the total carbon deposited per pound of oil burned is increased about eight-fold and that most of the carbon is deposited on the side walls of the pot 1.

A further modification of the conventional vertical pot type burner provides the following changes of the structure illustrated in Figure 3. A sealing ring is superposed on the secondary air mixing baffle 10. The sealing ring is in the form of an annulus and serves to confine the secondary air, to increase the velocity of the secondary air and to concentrate the secondary air at the base of the flame formed at the inner periphery of top baffle 8.

Illustrative of the effect of these modifications are the comparative data on fuel C provided in Table II.

Table II

Run No.	D-8	D-9	
Fuel	C	C	C
IBP, ° F	376		
517±11° F.....per cent	90		
EP, ° F	576		
Aniline pt., ° F	122.4		
Corrected C/H Ratio	6.94		
Fuel Rate, lbs./hr.	[1] 3.11	[2] 3.28	[1] 3.34
Stack Draft, Inches Water	0.080	0.080	0.080
Pot Draft, Inches Water	0.097	0.097	0.097
Per Cent CO_2 dry flue gas	12.0	12.8	13.0
Per Cent Excess Air	27	20	18
ICHAM, Per Cent Trans.	5	32	6
Total Carbon, g./lb. oil	0.23	0.15	

[1] Maximum.
[2] Average.

These data show that as a result of the changes in burner structure noted hereinbefore the total carbon deposited from a fuel 90 per cent of which distills at 517±11 degrees Fahrenheit is reduced about 45 per cent.

By burning fuel B in a modified burner such as illustrated in Figure 4 the effect of eliminating the pool in the center of the base 4 of pot 1 and the elimination of the center baffle or low flame ring 7 is determined.

Table III

Run No.	D-9		D-10	
Fuel	C		B	
IBP, ° F	376		423	
517±11° F.....per cent	90		90	
EP, ° F	576		584	
Aniline Pt., ° F	122.4		116.2	
Corrected C/H Ratio	6.94		7.24	
Fuel Rate, lbs./hr.	[1] 3.28	[2] 3.34	[1] 3.25	[2] 3.50
Stack Draft, inches water	0.080	0.080	0.080	0.080
Pot Draft, inches water	0.097	0.097	0.097	0.097
Per Cent CO_2 dry flue gas	12.8	13.0	12.8	14.1
Per Cent Excess Air	27	18	22	11
ICHAM, Per Cent Trans.	32	6	72	6
Total Carbon, g./lb. oil	0.15	-------	0.33	-------
Bottom Carbon, g./lb. oil	-------	-------	0.14	-------
Bottom Carbon/Total Carbon per cent	-------	-------	42	-------
Side Carbon, g./lb. oil	-------	-------	0.19	-------
Side Carbon/Total Carbon..per cent	-------	-------	58	-------

[1] Average.
[2] Maximum.

Since with fuel C burned in an unmodified burner having a center baffle only 0.15 gram of total carbon was deposited per pound of oil burned, it would appear that elimination of the center baffle increases the total amount of carbon deposited probably due to poor burner characteristics of low fuel input. However, this comparison does provide a means for comparing the effect of a fuel such as fuel D having a heavy end.

When fuel D is burned in a pot modified in the manner illustrated in Figure 4 the following comparable data are obtained:

Table IV

Run No.	D-10		D-11	
Fuel	B		D	
Corrected C/H Ratio	7.24		7.56	
Aniline Pt., ° F	116.2		115	
Fuel Rate, lbs./hr.	[1] 3.25	[2] 3.50	[1] 3.33	[2] 3.37
Stack Draft, inches water	0.080	0.080	0.080	0.080
Pot Draft, inches water	0.097	0.097	0.097	0.097
Per Cent CO_2 in dry flue gas	12.8	14.1	13.1	13.2
Per Cent Excess Air	22	11	20	19
ICHAM, Per Cent Trans.	72	6	25	6
Total Carbon, g./lb. oil	0.33	-------	0.71	-------
Bottom Carbon, g./lb. oil	0.14	-------	0.51	-------
Bottom Carbon/ Total Carbon.....per cent	42	-------	72	-------
Side Carbon, g./lb. oil	0.19	-------	0.20	-------
Side Carbon/Total Carbon..per cent	58	-------	28	-------

[1] Average.
[2] Maximum.

It will be observed that an increase in the heavy ends of the fuel produced increased the total amount of carbon deposited of the order of 2.1 times. It will also be observed that the carbon was deposited primarily on the bottom of pot 1 with only about 28 per cent of the total carbon deposited on the sides. To correlate these results with the effect of burner modifications the data listed in Table I under fuel D, run No. D-19 is compared in Table V:

Table V

Run No.	D-19 [1]	D-11
Fuel	D	D
Fuel Rate, lbs./hr.	2.16	3.33
Stack Draft, inches water	0.063	0.080
Pot Draft, inches water	0.078	0.097
Per cent CO_2 in dry flue gas	9.4	13.1
Per Cent Excess Air	67	20
ICHAM Per Cent Trans.	34	25
Total Carbon Deposit, g./lb. oil	1.90	0.71
Bottom Carbon, g./lb. oil	0.45	0.51
Bottom Carbon/Total Carbon.....per cent	24	72
Side Carbon, g./lb. oil	1.45	0.20
Side Carbon/Total Carbon.....per cent	76	28

[1] Unmodified.

Those skilled in the art will observe that not only has the total amount of carbon been reduced by about 63 per cent but, in addition, in the modified form of the burner three-quarters of the carbon is deposited on the bottom whereas in the unmodified form three-quarters of the carbon is deposited on the side walls. It will also be noted that the improved conditions were obtained at a fuel rate 1.5 times that of the control (D–19).

Changing the bottom shield from a plane to a cone but making no other changes in the modification illustrated in Figure 4 produces the results indicated by the following comparable data.

Table VI

Run No.	D–11 (plane)	D–12 (cone)
Fuel	D	D
ICHAM, Per Cent Trans.	25	11
Total Carbon, g./lb. oil	0.71	0.45
Bottom Carbon, g./lb. oil	0.51	0.29
Bottom Carbon/Total Carbon, per cent	72	64
Side Carbon, g./lb. oil	0.20	0.16
Side Carbon/Total Carbon, per cent	28	36

Changing the uninsulated cone-shaped bottom shield of run D–12 to an insulated cone-shaped bottom shield produces the results indicated by the comparable data of Table VII.

Table VII

Run No.	D–12 [1]	D–13 [2]
Fuel	D	D
ICHAM, Per Cent Trans.	11	26
Total Carbon, g./lb. oil	0.45	0.88
Bottom Carbon, g./lb. oil	0.29	0.20
Bottom Carbon/Total Carbon, per cent	64	23
Side Carbon, g./lb. oil	0.16	0.68
Side Carbon/Total Carbon, per cent	36	77

[1] Cone.
[2] Insulated cone.

It is manifest that while the total amount of carbon deposited has increased about 100 per cent, the distribution of the deposit has been changed radically. Thus, the bottom carbon of D–13 (insulated hollow cone) represents 23 per cent of the total carbon in contrast to 64 per cent in D–12 (non-insulated hollow cone) and the side carbon represents a proportional increase.

Changing the bottom shield from an insulated hollow cone-shaped structure to an insulated plane produces a reduction in total carbon of about 75 per cent but the carbon distribution is substantially the same, as the data in Table VIII show.

Table VIII

Run No.	D–13 [1]	D–14 [2]
Fuel	D	D
ICHAM, Per Cent Trans.	26	17
Total Carbon, g./lb. oil	0.88	0.25
Bottom Carbon, g./lb. oil	0.20	0.05
Bottom Carbon/Total Carbon, per cent	23	20
Side Carbon, g./lb. oil	0.68	0.20
Side Carbon/Total Carbon, per cent	77	80

[1] Insulated cone.
[2] Insulated plane.

However, it is to be noted that the D–14 modification of the burner performs poorly at low fuel rates due to the absence of a center baffle which provides a base for the low fuel rate flame.

When the D–14 modification of the burner is provided with a center baffle the total amount of carbon deposited is increased to 3.8 times as much and the distribution of the deposit changed to an appreciable degree as the data in Table IX illustrate.

Table IX

Run No.	D–14 [1]	D–15 [2]
Fuel	D	D
ICHAM, Per Cent Trans.	17	98
Total Carbon, g./lb. oil	0.25	0.95
Bottom Carbon, g./lb. oil	0.05	0.43
Bottom Carbon/Total Carbon, per cent	20	45
Side Carbon, g./lb. oil	0.20	0.52
Side Carbon/Total Carbon, per cent	80	55

[1] Insulated plane; no center baffle.
[2] Insulated plane; center baffle.

It will also be noted that the ICHAM is very nearly six times as great as in the absence of a center baffle.

While it is evident from the foregoing description of various embodiments of the present invention that the characteristicts of the vaporizing type burner can be improved for the purpose of satisfactorily burning fuel containing an appreciable amount of "cat" cracked fuel, i. e. fuels of high C/H ratio, nevertheless for improved operational characteristics from all viewpoints the embodiment illustrated by Figure 6 is preferred.

In all of the Figures 3 to 7 the same or similar parts are designated by the same numeral. Thus, for example, the fire pot is designated as 1, the base thereof as 4, the walls as 5 and the oil inlet as 3. The primary air inlets are designated as 6, the center baffle as 7, the secondary air mixing baffle as 8 and the secondary air inlets as 9. The top shield is numbered 10 and the sealing ring as 13. Each bottom shield comprises the shield 14 and the supports or legs 15. The non-metallic, non-catalytic coating is designated 16 as is the similar coating of the shield when so coated.

While the present invention has been illustrated in terms of new construction, the provision of bottom shields and fire pot linings per se are also contemplated. Thus, while new burners may be constructed along the lines illustrated hereinbefore, the present invention also includes the construction of refractory linings and bottom shields for insertion in presently existing and operating burners either to improve the prior art burners or as replacement parts.

Figures 8 and 9 are illustrative of variations of the type of bottom shield. The major difference between each of these and the others and that illustrated in Figures 4 to 7, both inclusive, is the width of the apex angle of the shield. Of course, it will be observed that in Figure 9 the cone is inverted. It also is to be noted that the shields may be insulated or provided with a non-catalytic surface on the under-side.

I claim:

1. In a vaporizing type oil burner of the vertical pot type wherein vaporization of the oil to be burned is dependent substantially wholly upon heat derived from the combustion of oil being burned comprising a burner pot having a plurality of air inlet apertures located at various levels in the wall thereof, a low flame ring positioned above the lowermost of said air inlet apertures, a high flame ring positioned below the uppermost of said air inlet apertures, a notched baffle ring positioned above the uppermost of said air inlet apertures, and means for supplying a liquid fuel to the lower portion of the pot, the improvement which comprises a

sealing ring positioned immediately above said notched baffle ring, a non-catalytic, refractory coating on the surfaces of said pot with which unvaporized oil is in contact, liquid fuel inlet means positioned substantially at the center of the bottom of said pot, a horizontally disposed shield having its center in the projected vertical axis of said fuel inlet means, and means for supporting said shield in spaced relation with the bottom of said pot and below the lowermost of said air inlet apertures.

2. In a vaporizing type oil burner of the vertical pot type wherein vaporization of the oil to be burned is dependent substantially wholly upon heat derived from the combustion of oil being burned comprising a burner pot having a plurality of air inlet apertures located at various levels in the wall thereof, and means for supplying a liquid fuel to the lower portion of the pot, the improvement which comprises the combination of a non-catalytic, refractory coating on the surfaces of said pot with which unvaporized oil is in contact, liquid fuel inlet means positioned substantially at the center of the bottom of said pot, a horizontally disposed shield having its center in the projected vertical axis of said fuel inlet means, and means for supporting said shield in spaced relation with the bottom of said pot and below the lowermost of said air inlet apertures.

3. In a vaporizing type oil burner of the vertical pot type wherein vaporization of the oil to be burned is dependent substantially wholly upon heat derived from the combustion of oil being burned comprising a burner pot having a plurality of air inlet apertures located at various levels in the wall thereof, and means for supplying a liquid fuel to the lower portion of the pot, the improvement which comprises the combination of a non-catalytic, refractory coating on the surfaces of said pot with which unvaporized oil is in contact, liquid fuel inlet means positioned substantially at the center of the bottom of said pot, a horizontally disposed shield having its center in the projected vertical axis of said fuel inlet means, said shield comprising a disk of refractory material, and means for supporting said shield in

spaced relation with the bottom of said pot and below the lowermost of said air inlet apertures.

4. In a vaporizing type oil burner of the vertical pot type wherein vaporization of the oil to be burned is dependent substantially wholly upon heat derived from the combustion of oil being burned comprising a burner pot having a plurality of air inlet apertures located at various levels in the wall thereof, and means for supplying a liquid fuel to the lower portion of the pot, the improvement which comprises the combination of a non-catalytic, refractory coating on the surfaces of said pot with which unvaporized oil is in contact, liquid fuel inlet means positioned substantially at the center of the bottom of said pot, a conical shield having its center in the projected vertical axis of said fuel inlet means, and means for supporting said shield in spaced relation with the bottom of said pot and with the base of said cone below the lowermost of said air inlet apertures.

STEPHEN P. CAULEY.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
623,012	Grimm	Apr. 11, 1899
892,706	Blubaugh	July 7, 1908
1,633,549	Little	June 21, 1927
1,840,137	Sturgis	Jan. 5, 1932
1,848,206	Sherman	Mar. 8, 1932
1,927,434	Cole et al.	Sept. 19, 1933
1,950,161	Bock	Mar. 6, 1934
2,065,265	Bock	Dec. 22, 1936
2,218,154	Ramsey	Oct. 15, 1940
2,311,469	Pruitt	Feb. 16, 1943
2,326,221	Hill	Aug. 10, 1943
2,361,912	Breese	Nov. 7, 1944
2,363,192	Miller	Nov. 21, 1944
2,375,347	Castle et al.	May 8, 1945

FOREIGN PATENTS

Number	Country	Date
816,124	France	Apr. 26, 1937