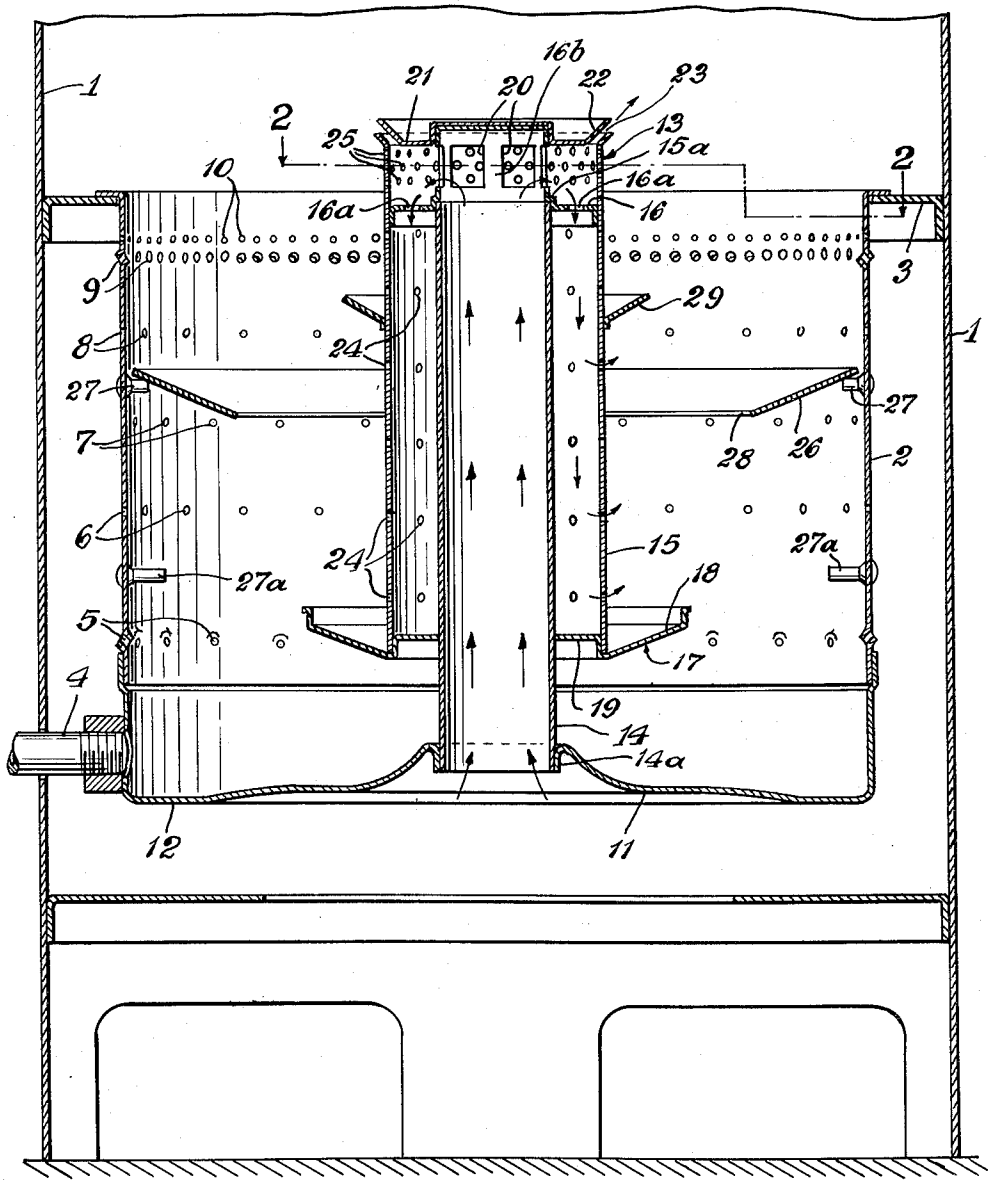
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BURNER UNITS AND METHODS

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Fig. 1



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BURNER UNITS AND METHODS

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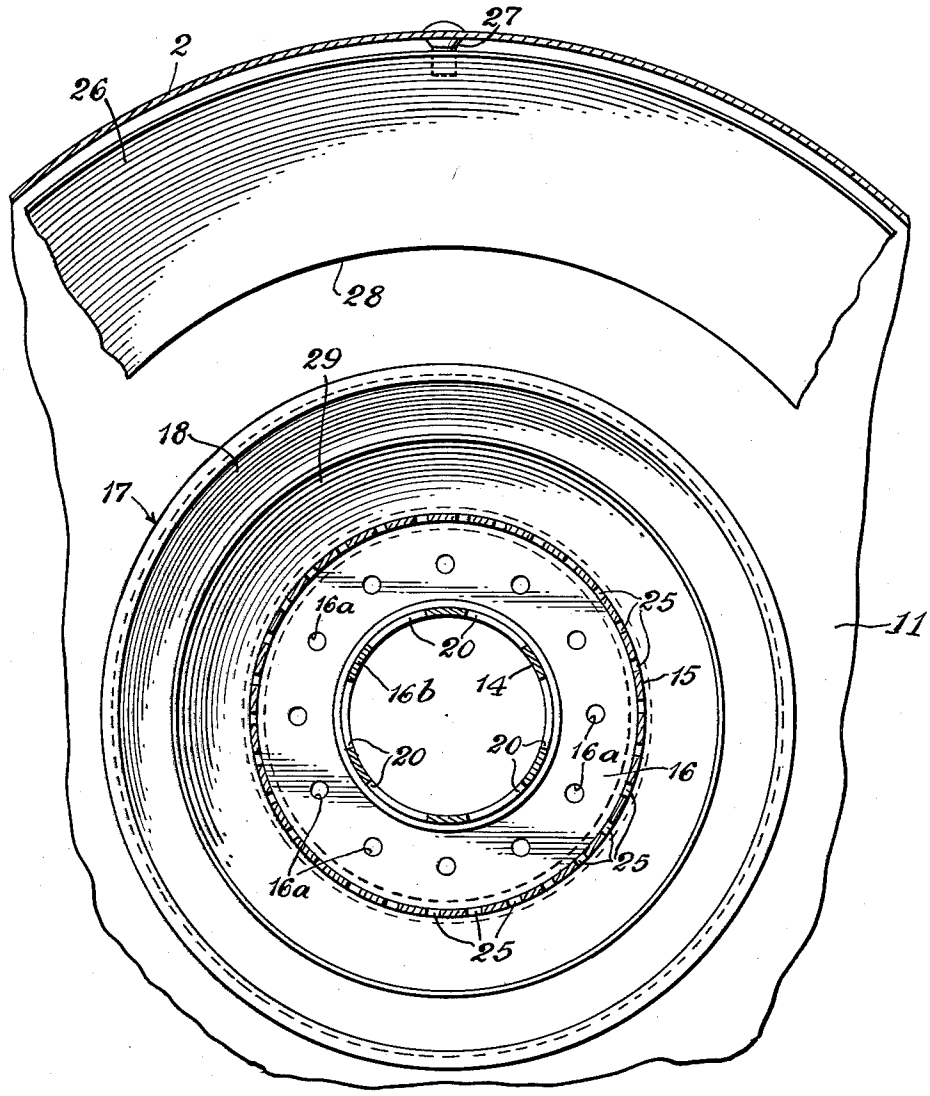


Fig. 2

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BURNER UNITS AND METHODS

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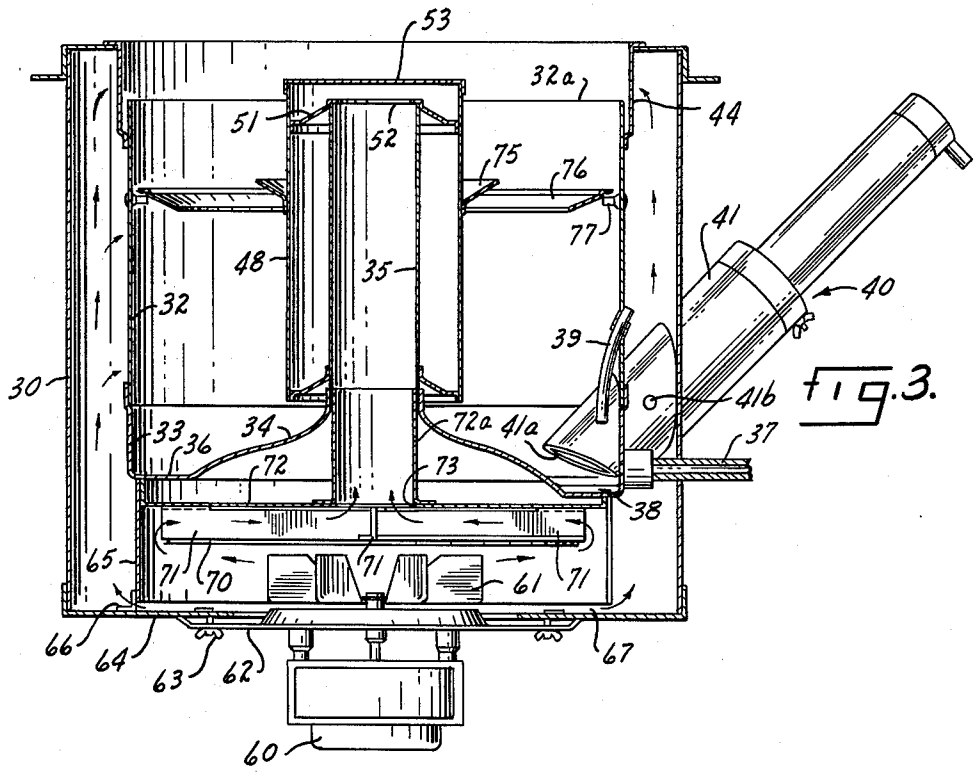
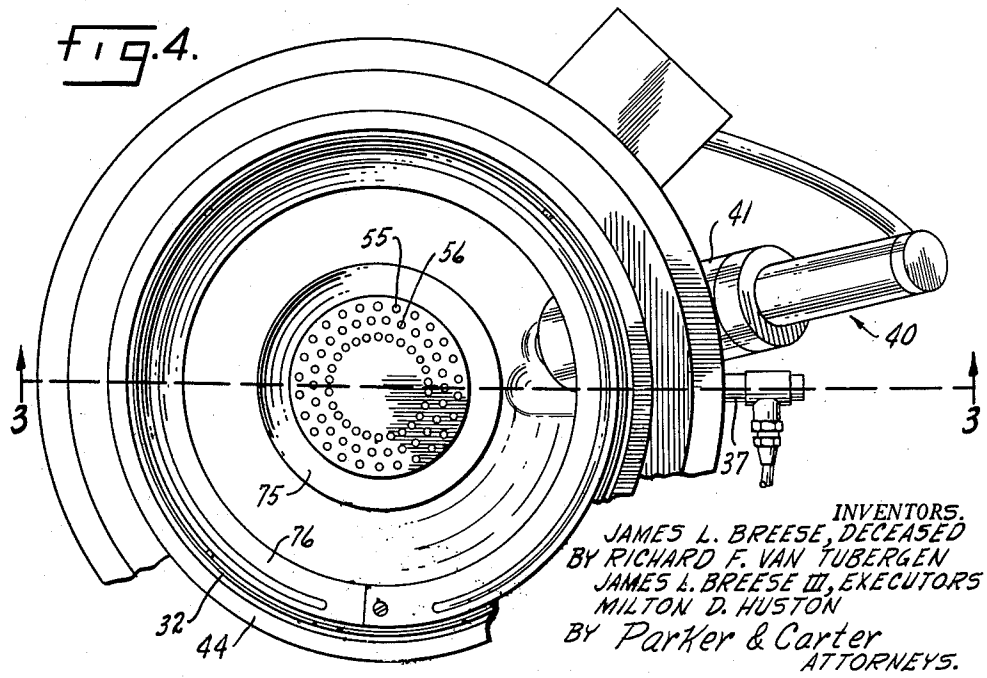


Fig. 3.

Fig. 4.



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BURNER UNITS AND METHODS

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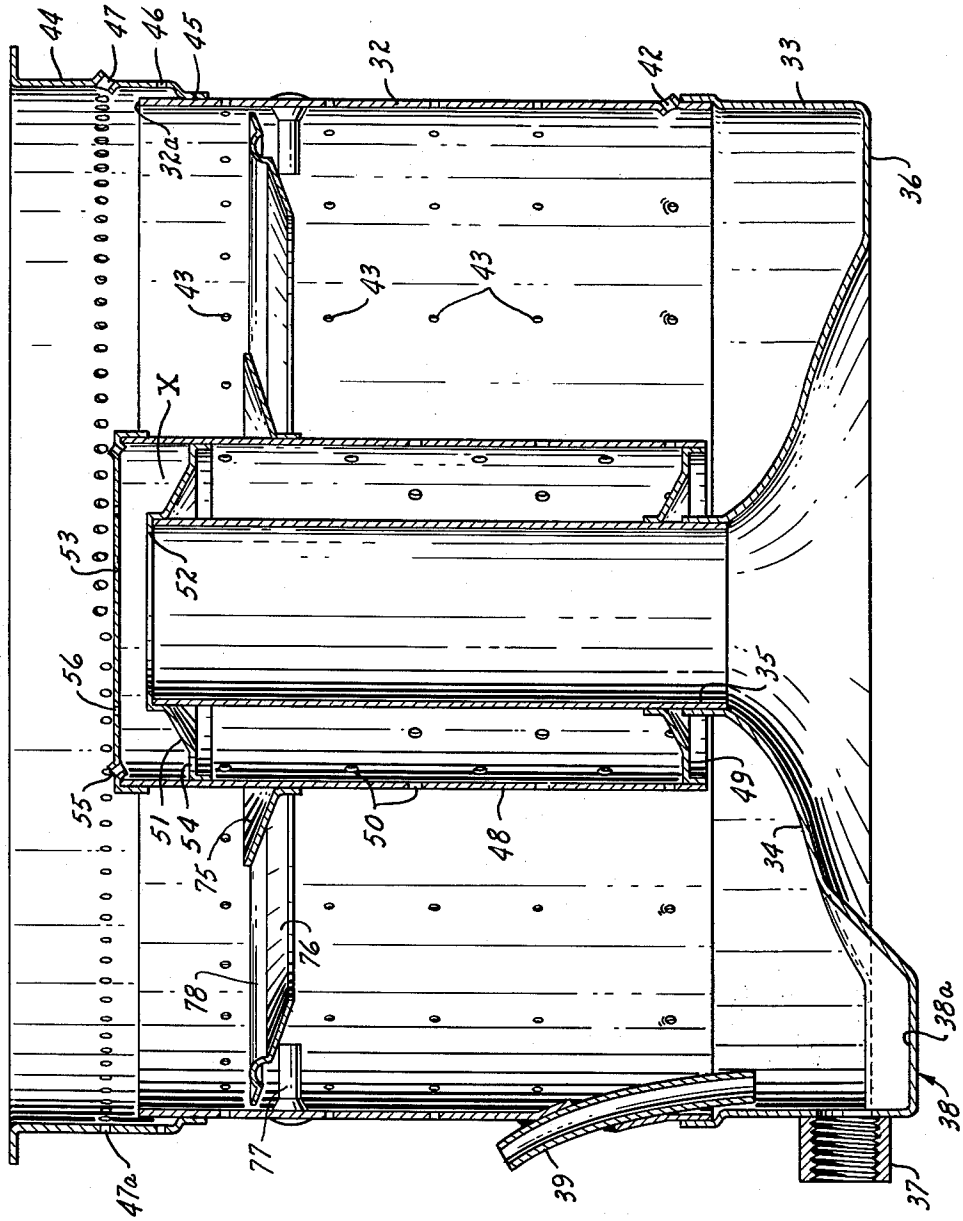


FIG. 5.

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BURNER UNITS AND METHODS

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Fig. 6.

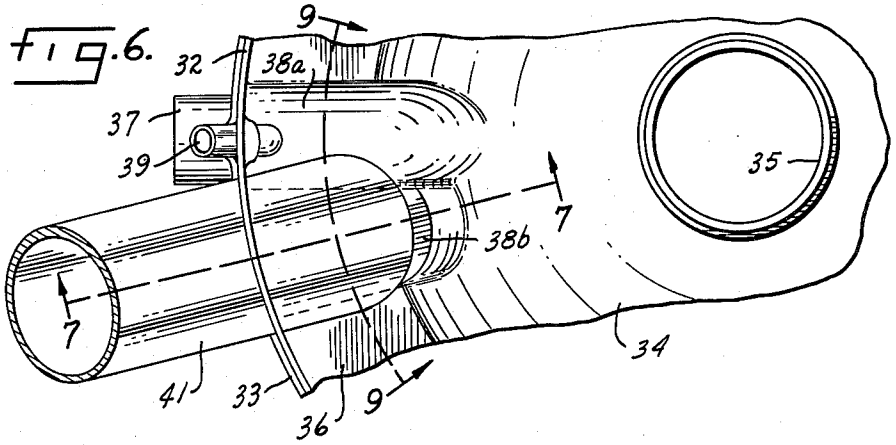
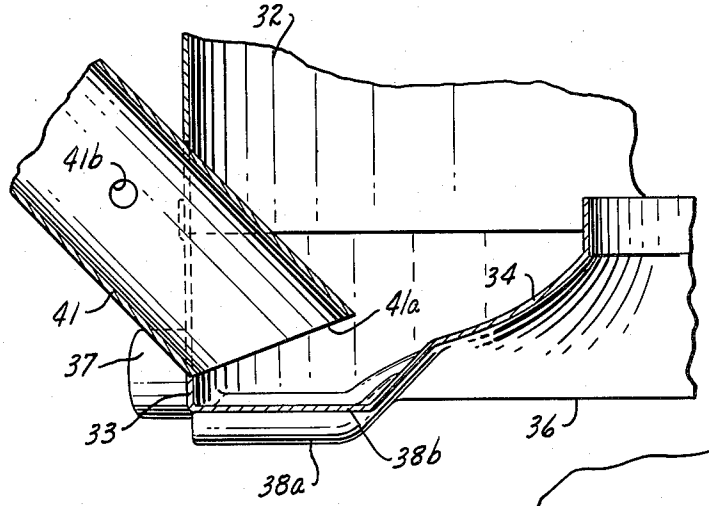


Fig. 7.



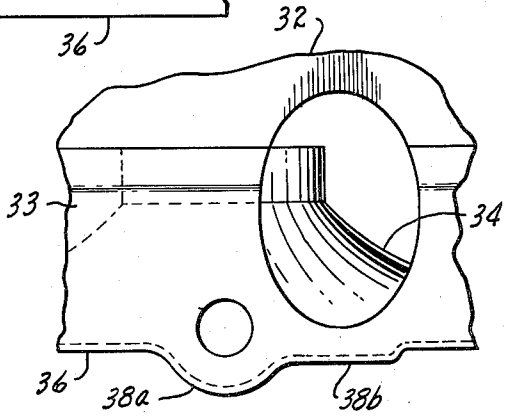
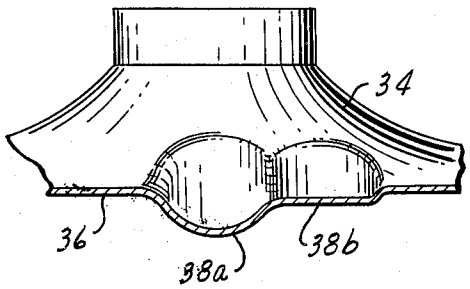


Fig. 8.

Fig. 9.



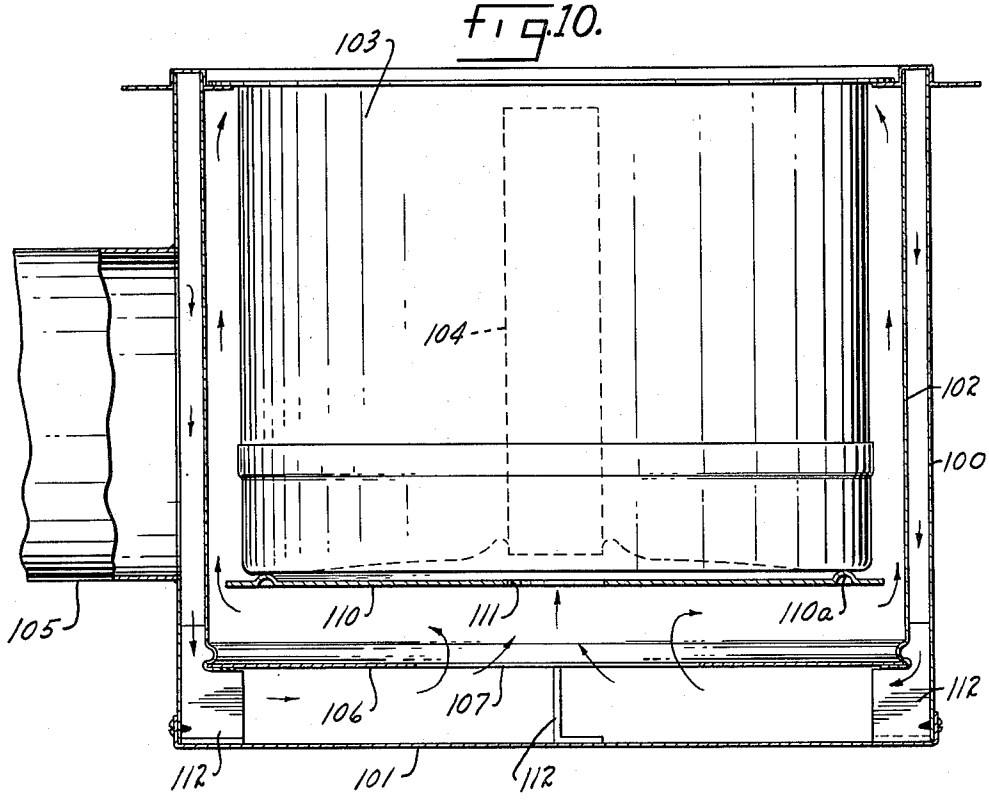
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BURNER UNITS AND METHODS

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Fig. 10.



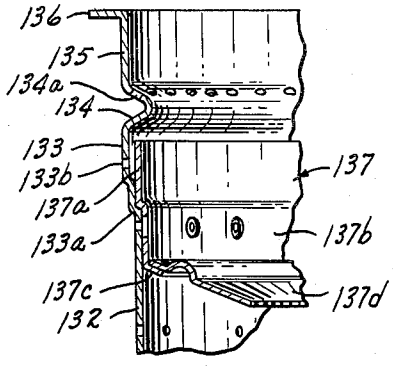
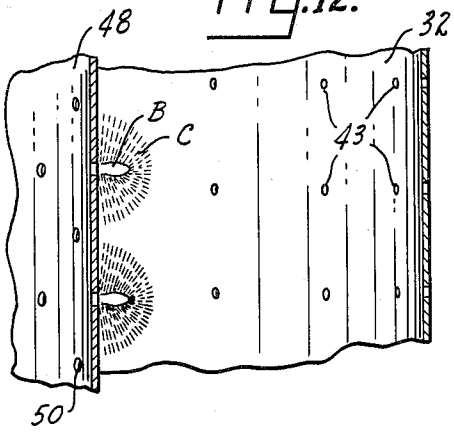


Fig. 11.

Fig. 12.



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BURNER UNITS AND METHODS

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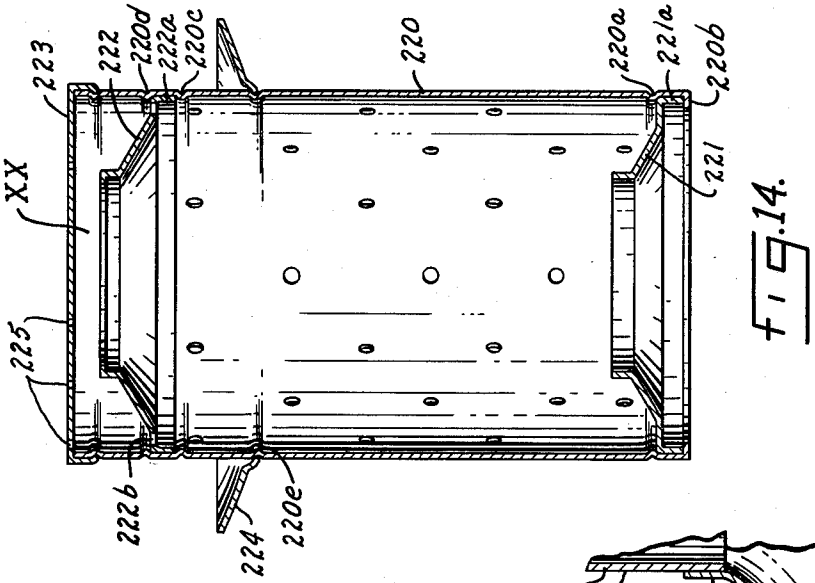


FIG. 14.

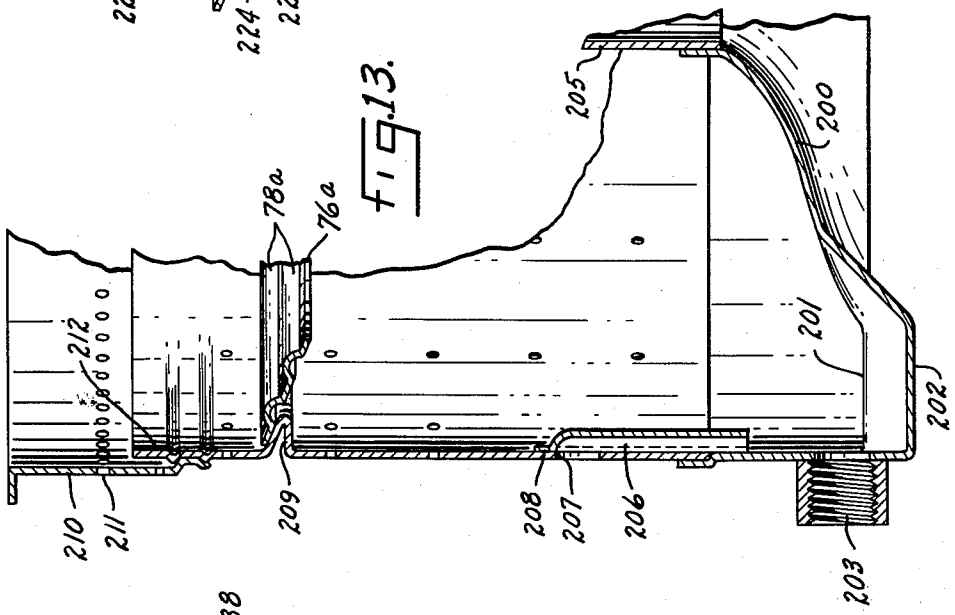


FIG. 13.

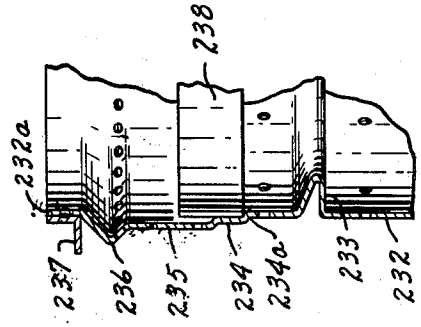


FIG. 15.

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United States Patent Office 3,017,925 Patented Jan. 23, 1962

3,017,925

BURNER UNITS AND METHODS

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Filed Aug. 28, 1959, Ser. No. 838,818
11 Claims. (Cl. 158—91)

The present invention is directed to vaporizing pot type liquid fuel burners. One purpose of the invention is the provision of a vaporizing burner pot for liquid hydrocarbon fuels which operates with maximum efficiency.

Another purpose is the provision of an improved burner pot which is quieter and more stable in operation than conventional burner pots.

Another purpose is the provision of an improved burner pot which operates efficiently with catalytic blends of hydrocarbon fuels and which lessens the tendency of these fuels to crack and produce large amounts of free carbon.

Another purpose is the provision of an improved burner pot which operates over a large range of capacities without producing large amounts of free carbon.

Another purpose is to provide an improved method for burning liquid hydrocarbons in a pot type burner.

Another purpose is to provide an improved means of and method for heating a rich mixture of vaporized hydrocarbon and air prior to the combustion of the final mixture.

Another purpose is to provide improved means for vaporizing the liquid hydrocarbon in a pot type burner without cracking.

Another purpose is to provide an improved pot bottom for pot type liquid hydrocarbon burners.

Another purpose is to provide improved air diffuser means for a pot type liquid hydrocarbon burner.

Another purpose is to provide improved baffling means for a pot type liquid hydrocarbon burner.

Another purpose is to provide improved ignition and air supply means for the initiation of combustion in a liquid fuel pot type burner.

Another purpose is to provide a burner producing a flame having a relatively small vertical extension as compared to flames of existing pot type burners of like size, whereby a heater or stove element of a substantially lower vertical clearance may be employed.

Another purpose is to provide an improved air diffuser for pot type burners.

Another purpose is to provide improved means for supplying secondary air to pot type burners.

Another purpose is to provide a composite pot having a relatively small amount of heat resistant material employed only where heat conditions make its use advantageous.

Other purposes will appear from time to time in the course of the ensuing specification and claims.

The present application is a continuation-in-part of application Serial No. 545,594, filed on November 8, 1955, for "Pot Type Burner with Spiralling Combustion and Central Air Tube," now abandoned.

The invention is illustrated more or less diagrammatically in the accompanying drawings wherein:

FIGURE 1 is an assembly view, in section, of the improved burner pot forming the present invention;

FIGURE 2 is a sectional view of the assembly shown in FIGURE 1 looking in the direction of the arrows 2—2 of FIGURE 1;

FIGURE 3 is a vertical axial section through a variant form of burner, with parts in elevation, the section being taken on the line 3—3 of FIGURE 4;

FIGURE 4 is a partial plan view of the structure of FIGURE 3;

FIGURE 5 is a vertical axial section, on an enlarged scale, of the pot shown in FIGURE 3;

FIGURE 6 is a partial top plan view of the lower part of the structure of FIGURE 5;

FIGURE 7 is a section on the line 7—7 of FIGURE 6;

FIGURE 8 is a side elevation of the structure of FIGURE 6, with parts removed;

FIGURE 9 is a section on the line 9—9 of FIGURE 6;

FIGURE 10 is a vertical axial section, with parts in side elevation, of a variant form of burner;

FIGURE 11 is a partial vertical radial section of a variant pot detail;

FIGURE 12 is a diagrammatic illustration of the combustion taking place about the below described air diffuser structure;

FIGURE 13 is a partial radial vertical section of a variant form of pot;

FIGURE 14 is an axial section through an air diffuser structure as used in the pot of FIGURE 13; and

FIGURE 15 is a partial vertical axial section illustrating the variant formation of the pot side wall.

Like elements are designated by like characters throughout the specification and drawings.

Referring generally now to the drawings, and in the first instance to FIGURE 1, there is illustrated a heater casing 1 within which is supported a burner pot 2. The burner pot 2 may rest, at its upper end, on a partition ring 3. The upper portion of the casing is subjected to a draft. Under some circumstances, a fan unit or other source of air pressure may be employed to force air into the interior of the casing. A fuel inlet pipe 4 is fitted to the lower portion of the pot. It should be understood that suitable fuel control means (not shown) will be employed in conjunction with the fuel inlet 4 for delivering a liquid hydrocarbon fuel to the interior of the pot.

The side wall of the burner pot 2 is provided with several rows or levels of air inlet apertures 5, 6, 7, 8, 9 and 10 which are adapted to admit primary and secondary air to the interior of the burner pot. The row of air inlet apertures 9 which is next below the uppermost row may be inwardly and upwardly directed as appears in FIGURE 1. The lowermost row of air inlet apertures 5 is preferably directed downwardly and more or less tangentially. The lowermost row 5 is so directed that air delivered through these apertures is directed downwardly toward the bottom of the pot and is also directed on tangential lines with respect to the vertical axis of the pot. At high fire the apertures 5, 6, 7 and 8 supply primary air, and 9 and 10 secondary air.

It should be noted that in FIGURE 1 the bottom of the pot 11 is illustrated as domed upwardly so that liquid fuel delivered through the inlet 4 initially flows around the outer edge of the pot bottom as at 12. In the embodiment shown the outer portion of the pot bottom is relatively flat, whereas the medial portion of the bottom is domed upwardly. In effect, a fuel receiving trough is provided which extends circumferentially around the pot and which is located adjacent the pot side wall. Thus fuel admitted to the trough is, to a substantial degree, heated by heat conducted downwardly by the pot side wall 2 when combustion is taking place at and above the top of the pot. The below described air diffuser structure also conducts heat to the trough.

According to the invention, an air diffusing tube assembly, designated generally at 13, is supported in the center of the pot. This assembly includes an inner air supply tube 14 which is inserted in the pot bottom and is in communication with the air space beneath the bottom of the pot. The tube 14 makes a snug fit with a down-

wardly turned rim 14*a* which surrounds a central aperture in the upwardly domed portion of the pot. It may be welded to the rim 14*a*. A primary purpose of the air diffuser, as will later appear, is to heat the rich incombustible mixture which rises in the pot.

The assembly 13 includes an outer tube or air diffuser housing 15 which is spaced from the wall of the inner tube 14 to define an air chamber therebetween. The outer tube 15 may be supported in the position shown by being affixed to an upper partition member 16 which has a shoulder 15*a* resting on the upper edge of the tube 14 at a level adjacent the upper portion of the burner pot. The member 16 is provided with a plurality of apertures 16*a* to allow air to pass to the space between 14 and 15. The apertures 16*a* are proportioned to maintain the air within the diffuser housing 15 at a relatively low pressure. A lower member 17, in the form of a baffle, may be affixed to the lower portion of the tube 15. The member 17 may include an upwardly directed outer portion 18 and an inner portion 19 which forms a partition between the inner tube 14 and outer tube 15, thus closing off the space between the tube 14 and tube 15 to the bottom of the pot.

The partition 16 includes a portion 16*b* extending upwardly from shoulder 15*a*. Portion 16*b* has a plurality of circumferentially spaced openings 20 so that air passing upwardly through the tube 14 may pass outwardly into the space between the portion 16*b* and the tube 15. A cap 21 is fitted over the upper end of the portion 16*b* and includes an outer edge portion that is upwardly inclined as at 22 and which overlies the upper edge of the tube 15. It should be noted that the upper edge of the tube 15 is similarly inclined and spaced from the edge 22 so as to define a circumferentially extending, and upwardly and outwardly directed air passage 23.

The diffuser housing 15 is provided with a plurality of vertically spaced rows of apertures 24 which are adapted to deliver air, from the space within the housing 15, and below the partition 16, to the interior of the pot, at a relatively low pressure. The upper portion of the housing 15, above the partition 16, is provided with a plurality of closely spaced rows of air apertures 25. During use air flows upwardly through the central air tube 14 and flows outwardly at relatively high pressure through the apertures 25. Part of this air flows downwardly into the expansion chamber defined between the inner tube 14 and outer tube 15 where it passes outwardly at a relatively lower pressure through the apertures 24. In practice, the parts and apertures are so proportioned that the air admitted through the pot side wall, at high pressure through the air inlets 5, 6, 7, 8 and 9, and the air admitted outwardly through the air apertures 25, is at the same pressure.

In practice, high pressure air through the apertures 5, 6, 7 and 8 mixes with the vaporized hydrocarbon to produce a primary mixture. As will later be described, low pressure air from the apertures 24 maintains localized combustion which serves to heat the rising mixture. High pressure air through the apertures 9 and 10 provides the secondary air for producing the finally combustible mixture. And high pressure air from the diffuser housing above the partition 16 serves to complete and clean the combustion. In practice, the low pressure jets thus admitted provide a supply of air for a strictly localized combustion diagrammatically shown in FIGURE 12, and below described in greater detail. Thus, whereas the primary air admitted through apertures 5, 6, 7 and 8 enters and forms part of a rich and incombustible mixture of air and vaporized fuel, the low pressure jets admitted through the apertures 24 support localized pinpoints of flame which are scattered across the surface of the outer air diffuser sleeve 15, and serve to heat the rich incombustible mixture as it rises in the pot, this heating having, in practice, a catalytic action.

An inverted conic baffle 26 is shown as supported on rivets 27 affixed to the pot wall. The baffle 26 has a central opening 28 through which the air diffuser assembly extends. The baffle 26 is shown with its lower rim generally aligned with the third row of air inlet apertures 7. Rivets 27*a* may be used to support a lower pilot ring, if one is desired.

Another relatively small baffle member 29 may be affixed to the outer tube 15 at a level above the baffle 26 and at a level below the row of apertures 9. In effect, the baffles 17, 26 and 29 are interposed between the combustion taking place at and above the secondary air inlets 9 and the liquid fuel admitted to the circumferential trough 12. This liquid fuel is thus shielded from direct radiation of heat from the flame by the baffling shown in FIGURE 1, or by other suitable baffling, such as is shown, for example, in FIGURES 3 and 5. The liquid hydrocarbon in the trough 12 does not "see" the flame. The baffling can, of course, be varied, and the design of baffling shown is not critical.

FIGURES 3 and following illustrate a variant form of burner and pot which, however, has the same general function and mode of operation as that of FIGURES 1 and 2. Considering first FIGURES 3, 4 and 5, the burner includes an outer jacket 30 within which is suitably supported a burner pot having a side wall 32 and a bottom section 33 with an upwardly domed inner portion 34 which is upwardly continued at its center by the axial air tube 35. It will be clear that, as in the form of FIGURES 1 and 2, the pot structure defines a circumferential trough 36 which is adjacent the pot side wall. The fuel inlet pipe 37 delivers fuel to the trough 36, being aligned with a sump, generally indicated at 38, which constitutes a local deepening of the circumferential trough 36. Aligned above the sump 38 is a starting air inlet pipe 39 which is in communication with the space between the outer housing or jacket 30 and the pot side wall 32. 40 indicates, generally, a starter assembly which is shown as including an inclined tube 41 which extends through a suitable aperture in the pot side wall and which has an inner end 41*a* which overlies the sump 38 or a lateral extension thereof, as will later be described in detail. 41*b* is an air inlet. With reference, for example, to the structure as shown in FIGURES 5 to 9, inclusive, the fuel inlet fitting 37 is aligned with the deepest sump portion 38*a*. Thus the fitting actually extends below the normal bottom level or surface 36 of the circumferential trough. This, in connection with the contour of the trough itself and the upwardly domed bottom, insures that a minimum volume of liquid fuel can enter the pot bottom if, for example, the fire is extinguished. The normal controls employed will halt the delivery of liquid fuel if the level of fuel within the pot rises as high as the top of the inlet fitting 37. This provides a relatively small maximum possible volume of liquid fuel in the pot bottom. The starting pipe or air supply means 39 is located immediately above the sump portion 38. The air inlet passage thus provided is positioned and sized to work automatically, with no closure needed and no control means. It provides an air jet of starting air directly over the sump portion into which the liquid fuel flows through the fitting 37. At the starting stage combustion takes place immediately above the surface of the oil in the sump, causing a rapid initial vaporization. The ratio between the inflow of air and the vaporized hydrocarbon becomes favorable for a non-combustion stage, as the volume of vaporized liquid fuel increases. In other words, at the immediate starting period the air supply through the inlet 39 is secondary air, the primary air being suitably supplied through the starter assembly 40, which overlies the lateral shallower sump extension 38*b*. The details of this supply of primary air for the starting assembly are not shown, since that assembly does not form part of the present invention. Following the rapid vaporization of an increasing volume of the hydrocarbon, the air delivered through the tube 39 then becomes primary air and merely mixes with

the rich mixture. At high fire it is just a small fraction of the primary air supply, and combustion no longer takes place near or immediately above the sump **38**. On the contrary, the rich mixture rises in the pot and does not become combustible, at the high fire stage, until it receives its secondary air through such inlets as, for example, **47** or **47***a*.

In the pot proper, as shown on a somewhat larger scale in FIGURE 5, it will be noted that the pot side wall **32** is provided with a lower row of primary air inlet apertures **42** which may advantageously be downwardly turned, and somewhat inclined from the radial, in order to impart a swirling movement to the air admitted therethrough. **43** indicates additional rows of primary air inlets which are spaced circumferentially about the pot side wall at various distances from the ends of the pot. The pot side wall **32** is shown as terminating with a circumferential lip **32***a*. An upper pot section, generally indicated as **44**, may be welded or otherwise secured to it as at **45**. This separation is advantageous, since the strip or ring **44**, which is subjected to maximum heat, may be made of stainless steel or other suitable heat resisting metal. Air is admitted through apertures **46** to the space about the pot side wall **32** and below the lip **32***a*. This results in the generally vertical direction of a stream or screen of air.

Referring, for example, to FIGURE 5, the pot side wall **32** is secured to the bottom **33** and constitutes, so far as heat conduction is concerned, a homogeneous unit. The pot is completed by the outer member or ring **44** which is welded or otherwise firmly secured to the pot side wall as at **45**. The apertures **46** deliver air inwardly against the upper outer part of the pot side wall section **32**. In effect an expansion chamber is provided and the jets of air impinge on the pot wall, and the result is the upward delivery below the secondary air inlets **47** of low velocity air. This low velocity air is delivered at the base of the jets flowing from the inlets **47** or **47***a*. It will be understood that these secondary air inlets may be upset or upwardly inclined by distortion of the metal, as shown at **47**, or they may constitute merely punching of the metal, as at **47***a*. It will be understood that, normally, the secondary air inlets of a particular pot will all be inclined, as at **47**, or will all be straight punched, as at **47***a*. The point of importance is that, no matter how the secondary air jets are delivered, the upward delivery at relatively slow velocity of the air which enters through the inlets **46** stabilizes the flame and prevents any vibration or flutter. A slow speed supply of air, at all times well below the speed of flame propagation, is thus provided, and the flame from the secondary air jets burns right back to the surface of the member **44**. The flame front is thus stationary and is located at the pot side wall, at the slot defined between the lip **32***a* and the upper outer pot member **44**.

Mounted about the diffuser pipe **35** is the diffuser sleeve or housing proper **48**. It is spaced outwardly from the sleeve **35**, for example, by a bottom closure element **49**. It is provided with a plurality of air outlets **50** through which air flows outwardly into the interior of the pot and into the mixture of primary air and vaporized fuel. The top supporting partition **51** centers and supports the upper end of the diffuser sleeve **48**, and rests removably on the upper edge of the pipe **35**. It is suitably apertured, as at **52**, to permit air to flow upwardly and outwardly from the upper end of the tube **35**. The diffuser sleeve **48** has a top closure **53** which defines a plenum chamber above the support or partition **51**, this plenum chamber being indicated at X. The aperture **52** is of such size that the air within the plenum chamber will be generally at the same pressure as the air delivered to the space within the outer housing **30** of FIGURE 3 and the pot side wall **32**. The partition **51**, however, is provided with apertures, as at **54**, which maintain the air in the space between the pipe **35** and the sleeve **48**, and below the partition **51**, at a somewhat lower pressure. Thus the air which escapes through the outlets **50** is at lower pressure than the air delivered through the primary air inlets **42** and **43**, and is at a lower pressure than the air delivered outwardly through the closure cap **53** through such apertures as those shown at **55** and **56**. Thus, as in the corresponding structure of FIGURE 1, air at relatively high pressure is delivered from the plenum chamber X upwardly and outwardly into the rising mixture or into the combustion already taking place, whereas air at low pressure is admitted through the diffuser wall or sleeve **48**. This low pressure air supports the localized pinpoints of flame illustrated diagrammatically in FIGURE 12, and heats and has a catalytic effect on the rising mixture.

With reference to the supply of air for combustion, there is illustrated in FIGURE 3 a motor **60** rotating the axially located fan **61**. The fan assembly may be mounted in any suitable base **62** removably secured, as by securing means **63**, to the bottom member **64** of the outer housing **30**. **65** indicates a circumferential baffle against which air is delivered by the fan **61**. The baffle may be mounted, for example, on suitable brackets **66** which leave a bottom space **67** through which the air, after its speed has been broken by the circumferential baffle **65**, is allowed to flow into the space between the outer sleeve or housing **30** and the pot side wall **32**. To the extent that this air is spiralled by the fast action, it increases the tendency to an inclined delivery through the inlets **42**, which will cause a spiralling rotation of the air delivered into the lower part of the pot. The apertures **42** are shown, for example, in FIGURE 5. Positioned above the fan is a generally plane, horiztonal baffle **70** which may be supported upon a plurality of generally radial supports **71** which space the baffle **70** from the upper plate **72** with its axial air inlet **73**. Thus some of the air delivered by the fan is directed inwardly by the supports **71** and passes upwardly through the air inlet **73** for delivery through the tube **35**. However, the supports **71** break up the spiralling of the air, and the baffles or plates **70** and **72** prevent any direct impingement on the bottom dome **34** or against the bottom wall of the pot, which might otherwise cause undesired cooling of the pot bottom. The upper plate **72** is shown with an upper tubular extension **72***a*, so no air wipes the pot bottom.

It will be realized that a wide variety of baffling within the pot may be practical. In the form of FIGURES 1 and 2 two baffles are employed, extending outwardly from the diffuser sleeve **15**, and a single baffle is employed, as at **26**, extending inwardly from the pot side wall, these baffles being in staggered relationship. In the form of FIGURE 5 only two baffles are employed, an upwardly and outwardly inclined baffle **75** on the diffuser wall **48** and a downwardly and inwardly extending conic baffle **76**, shown as mounted on pins **77** on the pot side wall. The baffle **76**, for strength and stability, is circumferentially channeled or beaded, as at **78**. In FIGURE 13 a baffle **76***a* is shown, with two beads **78***a*. The ring **76** may be made solid, or may be divided for an overlap. If desired, as in larger burners, two or more of the beads or concavo-convex strengthening ribs **78** may be employed. In the form of FIGURE 5 the baffles **75** and **76** are at the same level as an indication of the wide variety of shape and location of baffle which is acceptable. They perform, however, generally the same function as the baffles of FIGURE 1, in that they partially or largely shield the fuel in the trough **36** and the sump **38** from "seeing" the combustion of the fuel. Thus the liquid fuel is vaporized not so much by radiant heat as by heat conducted downwardly along the pot side wall or by the air diffuser assembly. This is not to say that no radiant heat is permitted to reach directly the liquid fuel. It is, however, of substantial advantage to limit, if not to prevent, the subjection of the liquid fuel to radiant heat, thus preventing cracking of the fuel.

Referring to FIGURE 10, a somewhat different pot structure is illustrated, in which an outer sleeve **100**, with its lower wall **101**, defines a space within which a circumferential, generally cylindrical, intermediate baffle **102** is positioned. Spaced inwardly from the baffle **102** is the burner pot, generally indicated at **103**, and having a central air duct **104**. Since the details of pot and duct and diffuser structure have been shown, for example, in FIGURES 3, 4 and 5, they are not repeated in FIGURE 10, it being understood that the pot **103** and the duct **104** are preferably provided with air inlet and air diffuser means, generally as shown in FIGURE 5. The side wall or housing **100** is apertured to receive a duct **105**. A fan assembly, including a motor and its fan, not shown, directs air inwardly against one side of the circumferential baffle **102**. The air moves downwardly, in the direction of the arrows about the baffle **102**, and it all eventually passes upwardly through the axial air inlet **107** of the bottom baffle **106**. Some of this air moves directly upwardly into the diffuser duct or passage **104**, and some of the air passes upwardly about the pot **103**. Direct impingement against the pot bottom is prevented by the transversely extending intermediate baffle **110** with its central aperture **111**. Since the baffle **110** terminates at its outer edge somewhat within the cylindrical baffle **102** air can thus flow upwardly about the outer edge of the baffle **110** and upwardly through its central aperture **111**. If desired, radial supports **112** may be employed between the bottom plate **101** and the horizontal baffle **106**. Thus, in FIGURE 10, air, instead of being fan-directed upwardly along the axis of the pot, is directed laterally, but is so baffled that no local cooling of pot side wall or bottom takes place, and no pressure differentiation between the air delivered upwardly about the pot side wall **103**, or upwardly through the diffuser duct **104**. As will be clear from FIGURE 10, the horizontal baffle **110** is downwardly spaced below the bottom, and the air delivered by the fan does not cause such cooling of the pot bottom as would cause puddling or prevention of adequate and uniform vaporization of the liquid fuel. Means such as the circumferential bead **110***a* prevent any escape of air between baffle and pot bottom.

It will be realized that many changes may be made in size, shape, number and disposition of parts. Whereas there is shown and described several operative forms of the invention, it should be understood that these showings and descriptions should be taken as primarily illustrative or diagrammatic. For example, the details of the admission of both primary and secondary air may be widely varied. The shape of the pot or the method of making the pot may be widely varied. For example, FIGURE 11 illustrates a variation in the formation of the upper edge of the pot. In FIGURE 5, for example, the pot side wall **32** terminates in a top circumferential upper lip **32***a*, and a supplemental separate member **44**, which may be of heat resistant metal, is secured to the pot side wall **32** somewhat below the lip **32***a*. In FIGURE 11, on the contrary, the pot side wall **132** is outwardly offset, as at **133**, and inwardly offset, as at **134**, terminating in an upper cylindrical portion **135** and an outwardly extending flange **136**. A ring, generally indicated as **137**, is fitted in and supported upon the unitarily formed ledge **133***a* of the pot side wall. It includes an upper sleeve **137***a* aligned with air inlets **133***b*. Thus air is directed upwardly toward the inward offset **134**. The upper wall of the offset **134** is provided with a plurality of secondary air inlets **134***a*. The ring **137** also includes a lower portion **137***b* with an inwardly extending lip **137***c* upon which any suitable baffle ring **137***d* may be supported.

In the pot of FIGURE 13 the formation of the bottom will be understood to be substantially the same as in the structure of FIGURE 5. It includes, for example, the domed bottom portion **200** which is shaped to define a circumferential trough **201** having a localized sump **202** in line with the fuel inlet fitting **203**. Upwardly extending from the center of the domed bottom **200** is the air distributor pipe **205**. In order to deliver starting air downwardly toward the sump there is shown a sheet metal guiding or directing element **206** aligned with an aperture **207** in the pot side wall and welded as at **208** to the inner surface of the pot side wall. Likewise, in the place of the supporting pins **77** of FIGURE 5 it is preferred to roll a circumferentially inwardly extending flange **209** which may be formed when the sheet for the pot side wall is rolled. It is also found to be advantageous to employ an upper pot component **210** suitably apertured for the admission of secondary air, as at **211**, which, as shown in FIGURE 13, may be rolled into interlocking relation with the upper extension **212** of the pot side wall.

In the form of FIGURES 13 to 15, inclusive, the air diffuser unit is removably mounted on the tube **205**, and is shown as including an outer, generally cylindrical wall **220** which may be rolled into interlocking relationship with a bottom member **221** and a partition **222**. It will be observed that the lower outer flange **221***a* of the bottom **221** is rolled into place and gripped between a bead **220***a* and a bottom flange **220***b*. The outer flange **222***a* of the partition **222** is held between beads **220***c* and **220***d* of the side walls **220**. The structure is completed by a perforated top closure **23** which may be rolled into the closed position in which it is shown in FIGURE 14. Similarly, the baffle **224** may be rolled into and received in the circumferential cavity **220***e* of the wall **220**. The entire unit is thereby firmly held together in proper assembled position and may be applied to and removed as a unit from the air pipe **205**. The aperturing of the pot of FIGURE 13 and of the diffuser may be, in general, the same as that shown in FIGURE 5. However, it is preferable to have a plurality of small apertures **225** in the top plate **223** which direct air directly upwardly. It will be understood that the details of perforation may be widely varied. In this structure, as in the structure of FIGURE 5, the partition **222** passes air at high pressure into the plenum chamber XX between the members **222** and **223**. Air is allowed through the partition **222** by apertures **222***b* into the space within the wall **220** and about the air pipe **205** under conditions which maintain the air within the air diffuser structure thus formed at a substantially lower pressure than the air which is delivered into the vaporized liquid fuel through the primary and secondary air inlets of the pot side wall. This is important in connection with the maintenance of the widely scattered small heating flames or pinpoints of combustion earlier described.

Referring to FIGURE 15, we illustrate a variation in the formation of the upper edge of the pot. The pot side wall **232** is inwardly rolled, as at **233**, and outwardly offset, as at **234**, and further offset, as at **235**. Near the upper edge **232***a* the wall is outwardly rolled, as at **236**. Fastened to the upper portion **232***a*, as by welding, is an angular flange **237** for mounting the pot in the outer wall of the burner. Seated upon the out-turned portion **234***a* is a circumferential ring **238** which corresponds to the upper extension **212** of FIGURE 13.

The use and operation of the invention are as follows:

In burning liquid hydrocarbon fuels and, in particular, catalytic blends of hydrocarbon fuels, there is always a risk, for example, in pot type burners, of cracking the fuel and of producing free carbon which eventually soots up the burner, and either makes it unusable, or provides a difficult maintenance and cleaning problem. Disclosed herein is an improved structure and an improved method of liquid hydrocarbon combustion which substantially eliminates cracking. Considering, for example, the pot structure of FIGURE 5, liquid fuel is admitted to a trough **36** which extends circumferentially about the pot bottom, and which is so near to the pot side wall **32** and its downward extension **33** that the heat of combustion taking place at or above the top of the pot is eventually

conducted to the outer edge of the pot bottom, and is effective in connection with the vaporization of the liquid fuel. The axial diffuser assembly also conducts heat to the trough. In burners of the type herein shown the fuel is vaporized, during normal pot operation, by combustion taking place at or above the upper portion of the pot. In considering the pot of FIGURE 5, or the pot of FIGURE 3, in full operation, air is delivered at uniform pressure upwardly about the pot side wall and upwardly through the air diffuser duct **35**. The air which enters the pot through the apertures **42** and **43** is what is commonly called primary air. It mixes with the fuel vaporized by combustion taking place above and produces a more or less homogeneous mixture of air and of vaporized hydrocarbon. The parts are so proportioned, however, that insufficient air is admitted through the primary air inlets to provide a fully combustible mixture. This so-called rich mixture rises in the pot, and when it passes above the baffles **75** and **76** it reaches the level where it receives secondary air in substantial volume. The details of admission of the secondary air, as such, may be widely varied, but secondary air may be supplied, for example, through the inlets **47** or **47***a* of FIGURE 5 and is delivered into the rich mixture in sufficient volume and at sufficient pressure to provide a substantially homogeneous mixture of air and vaporized hydrocarbon in which the air proportion is sufficient to support full combustion. In the structure of FIGURE 5 the final and completed mixture will burn at or somewhat above the level of the lip **32***a*. Additional air may be supplied to the final mixture or to the flame, for example, through the apertures in the closure cap **53**, to make sure that all the fuel is burned.

In carrying on this method of combustion, and especially with some of the modern fuels, the problem of preventing cracking is difficult. In accordance with the present invention it has proved advantageous to protect the liquid fuel largely, or substantially, from subjection to direct radiation from the burning fuel. This protection may be provided by the baffling shown, for example, in FIGURES 1, 3 and 5. The baffles keep the liquid fuel from "seeing" the combustion taking place. However, it is important, in order to vaporize the fuel, that heat be available for adequate vaporization. Some heat is supplied by conduction downwardly through the pot wall and through the air diffuser structure. However, this heat might prove insufficient if the fan-delivered air is permitted to wipe the pot bottom and to abstract heat from it. This theft of heat from the pot bottom would tend to cause puddling or accumulation of liquid fuel, and would substantially disturb the operation of the burner. It is found that adequate baffling is effective in preventing the fan-driven air from wiping heat directly from the pot bottom. One solution, in connection with the axially located fan, is shown in FIGURE 3, with the use of the circumferential cylindrical baffle **65** on the one hand and with the use of the baffling system **70** and **72** on the other, to insure that adequate air, at a substantially even pressure, flows upwardly about the pot side wall and upwardly into the air diffuser duct, without, at the same time, wiping heat from the pot bottom. Another solution, in connection with a side located fan, is shown in FIGURE 10. In both instances a supply of air is provided both for the exterior of the pot and for the interior of the pot at uniform pressure, and without the heat loss which would be caused by a direct wiping of high velocity air across the pot bottom.

An important phase of the invention is also the heating of the rising mixture. This heating, as earlier alluded to, is obtained by the use of an air diffuser formed to maintain pinpoints of flame over a widely scattered area. These pinpoints are maintained, as diagrammatically shown in FIGURE 12, by delivery of air at relativell low pressure through the apertures **50** of the diffusing wall. In practice, these low pressure jets of air pick up the rich mixture and convert it, but only locally, into a fully combustible mixture. Each such low pressure jet, as shown at B in FIGURE 12, draws a certain amount of the rich mixture from the localized space, indicated at C in FIGURE 12. The low pressure at which the air is delivered provides isolated and widely scattered zones of localized combustion. With the diffuser wall **48** covered by these widely scattered flame pinpoints it becomes an effective heating means for heating the rising rich mixture, and actually has a catalytic effect. On the other hand, the high velocity high pressure jets of air delivered inwardly through the primary air inlets **42** and **43** merely add air to produce a rich mixture, without localized combustion. This rich mixture is heated as it rises, by the pinpoint jets above discussed. The heat speeds up the chemical changes elsewhere mentioned. It does not burn as a whole until it receives enough secondary air, for example through the apertures **47**, to be converted into a thinner and fully combustible mixture.

It is also found that in maintaining the method of combustion herein discussed it is highly advantageous to direct the lowest row of air inlet jets, as at **42** in FIGURE 5, somewhat downwardly toward the bottom. These inlets may also be turned somewhat from the radial so that the jets cause the mixture to spiral or to rotate. To some degree the same effect may be obtained by causing the air to spiral within the space surrounded by the outer housing or sleeve **30**. However, it is practical and advantageous locally to deform the pot side wall in such fashion as to cause the jets **42** to be directed at an inclination to the radial.

A further advantage of the present structure is to insure that there will be a minimum amount of fuel in the pot bottom in cases where the flame becomes extinguished and the burner is flooded. The upward doming of the bottom of the pot, and the location of the inlet or fitting **37** in line with the sump **38**, insures that if combustion ceases only enough liquid fuel can enter the pot to fill the trough **36** to a relatively low level. The controls currently used operate to cut off fuel flow when the fuel gets as high in the pot as the top of the fuel inlet.

A further advantage of the structure herein described is to prevent any difficulty with downdraft and eddy currents which tend to cause poor combustion and carbon build-up. The air diffuser structure herein shown, including, for example, its outwardly extending baffles, blocks out the central space of the pot and positively prevents any axial or near axial downdraft. The local combustion taking place at the outer surface of the diffuser sleeve **48** also promotes an upward movement of the mixture. The products of this limited combustion tend to rise and to carry with them the unburned mixture. The slight upward flow of air along the diffuser counteracts the weak eddy currents along the under side of the secondary air jets and thus prevents downward flow and carbon build-up. Thus the air diffuser or flame propagator helps the action of the pot in several different ways.

It should be kept in mind that when air is rotating rapidly in a cylinder centrifugal force tends to make it hug the outside wall, and there is little air movement or pressure at the center. According to the method and structure herein shown, the lowest row of primary air inlets **42** cause a rapid rotation of the mixture in the lower part of the pot. Hence, the importance of applying air at uniform pressure both about the exterior of the pot and upwardly through the interior of the pot, this result being obtained by the baffling structures described in connection with FIGURES 3 and 10. The baffling can, of course, be widely varied.

A further advantage of the burner structure shown herein, for example, as shown in FIGURE 5, is that it produces a flame of relatively small vertical extension. In practice, it is from ten to twelve inches lower in vertical clearance than the flame of existing pot type burners

of the same size or capacity. This is, in practice, very important, since it permits the heater or stove designer to employ a heating structure of substantially lower vertical clearance. In the past, the height of the flame has been a critical limiting fatcor, for example in floor furnaces, since, of course, it is not, in general, practical to employ heaters or stove structures in which the flame regularly impinges on the upper wall of the stove. The flame of lower height permits the heater designer considerable latitude, and enables him to design heater or stove units which can be fitted into more restricted spaces, particularly as regards vertical clearance. This is very important, for example in floor furnaces.

To summarize, liquid fuel is supplied to a circumferential trough preferably adjacent the side wall of the pot. The fuel is vaporized largely by conduction of the heat of combustion downwardly through the pot side wall or through the diffuser structure. Cracking is prevented by the baffling which shields the liquid hydrocarbon from "seeing" the flame. This loss of radiant heat otherwise available for vaporization is kept from being damaging by a careful shielding of the pot bottom from the direct effect of rapidly moving air. The rich mixture formed by the addition of air to the vaporized hydrocarbon is heated as it rises in the pot, and, at the same time, downdrafts and downward eddy currents are prevented. The rich mixture is converted first into an alcohol and then into an aldehyde, as it rises in the pot, and finally receives adequate secondary air for full combustion. These chemical changes are speeded up by the heat of the diffuser, which has practically a catalytic effect.

We claim:

1. A method of controllably vaporizing and burning liquid hydrocarbon fuels in a confined chamber which includes the steps of admitting liquid hydrocarbon fuel to a lower portion of the chamber, vaporizing and oxidizing the liquid fuel without cracking, at a temperature substantially below the final combustion temperature, by admitting primary air to the chamber in volume insufficient to form a fully combustible mixture, while protecting the rich primary mixture of air and vaporized fuel thus formed from direct subjection to the radiant heat of combustion taking place elsewhere in the burner, simultaneously heating the rising rich mixture of vaporized fuel and air by maintaining limited localized combustion jets along the path of flow of the rising mixture, the air for said combustion jets being delivered at a pressure substantially below the pressure of the primary air and inducing final combustion of the now homogeneous and heated mixture of air and fuel by the admission of secondary air to the rising mixture adjacent the upper portion of the burner.

2. The method of controllably vaporizing and burning liquid hydrocarbon fuels in a confined chamber which includes the steps of admitting liquid hydrocarbon fuel to a circumferentially extending zone in the lower portion of the chamber, such zone being radially spaced about the center of the chamber, subjecting the liquid fuel in such circumferential zone to a temperature sufficient to vaporize the liquid fuel without cracking it, supplying air to the initially vaporized hydrocarbon in a quantity less than that required for combustion, while imparting a rotary motion to said mixture of vaporized fuel and air as it moves in and upwardly from the zone of initial vaporization, thereafter continuously directing air into the mixture as it rises upwardly in the chamber, heating the rising mixture by localized areas of combustion in its path, and converting it first to an alcohol compound mixed with vaporized hydrocarbons and, thereafter, during the subjection to further air and heat to an aldehyde compound, the air used for maintaining the localized areas of combustion being delivered at substantially lower pressure than the air added to the mixture in the course of its conversion to an alcohol compound and thereafter to an aldehyde compound and supplying secondary air to the final aldehyde compound in volume sufficient to render it fully combustible and burning the mixture thus formed at and above the level of admission of such secondary air, while preventing central downdraft through the chamber and while substantially shielding the hydrocarbon in the initial circumferential zone of vaporization from seeing the combustion of the final mixture.

3. An hydroxylating pot type liquid fuel burner which includes a burner pot having a pot side wall with apertures circumferentially and vertically spaced therein for the admission of primary air to the interior of the pot, and means for delivering secondary air into the pot at a level above the uppermost row of such apertures, means for admitting liquid fuel to a depression extending circumferentially about the bottom of the pot and adjacent the pot side wall, whereby liquid fuel in such depression is subjected to heat conducted downwardly by the pot side wall, an air delivery and mixture heating assembly positioned generally along the axis of the pot and formed and adapted substantially to prevent downdraft in the pot and to conduct heat to the pot bottom, said assembly including an air admission tube and a surrounding perforated air diffuser, means for delivering air through the apertures of said diffuser and into the mixture of air and vaporized hydrocarbon rising in the pot at a pressure lower than the air pressure at which primary and secondary air is added to the mixture through the pot side wall, the air coming through the apertures in the diffuser combining with the fuel and air mixture to maintain localized combustion on the surface of the diffuser which is effective to heat the rising mixture, and baffling means for substantially shielding the liquid fuel in said circumferential zone from seeing the combustion of the final mixture taking place at and above the level of admission of air through said secondary air inlet apertures.

4. The structure of claim 3 characterized in that the air admission tube of the mixture heating assembly is in communication with the space below and about the burner pot.

5. The structure of claim 3 characterized in that the air delivery and mixture heating assembly includes means located above the level of the secondary air inlet apertures for delivering air to the mixture at substantially the same pressure as that of the primary and secondary air.

6. The structure of claim 3 characterized in that the air diffuser includes means for defining a chamber having one or more air inlet apertures in communication with the air outlet apertures through which air may pass to the interior of the pot, the area of the air outlet apertures substantially exceeding the area of the air inlet aperture or apertures.

7. The structure of claim 3 further characterized by means for delivering air to the space about the pot side wall and to the air admission tube with a minimum cooling of the pot bottom including a fan located below the pot bottom and means for rotating it, a generally horizontal baffle plate overlying the fan and located between it and the pot bottom, a circumferential air deflector in the line of delivery of the fan, passage means for permitting a flow of air about said deflector to the space about said pot wall, a second generally horizontal plate positioned between the pot bottom and the horizontal baffle plate, said plate being axially apertured in communication with said air admission tube, the space between said plates being in communication with the space within said circumferential air deflector, whereby the fan delivers air simultaneously to the space about the pot side wall and to the air admission tube.

8. The structure of claim 3 further characterized in that said baffling means includes a baffle in the form of a somewhat concavo-convex frustrum, said baffle having one or more circumferential beads extending thereabout, and means for supporting said baffle including a circumferential bead formed in the pot side wall.

9. In a pot type burner having a circumferential pot side wall apertured to permit the entry of air for combustion, a bottom element defining a circumferential trough, a sump in said trough, a fuel inlet fitting in the pot side wall at said sump extending below the normal level of the trough, an ignition assembly extending inwardly through the pot side wall and having a lower end terminating above the sump, the portion of the sump underlying the ignition assembly being somewhat shallower than the portion of the sump in radial alignment with the fuel inlet fitting, the pot bottom surrounded by the trough being upwardly domed to an elevation substantially above the plane in which the fuel inlet fitting lies, whereby a minimum volume of liquid fuel is present in the trough and pot bottom when the level of fuel in the pot bottom reaches the level of the top of the fuel inlet aperture through said fitting, and means for directing starting air downwardly toward said sump.

10. The structure of claim 9 characterized in that the means for directing starting air downwardly toward the sump is constituted by a tubular member within the pot side wall, the interior of which is in communication, through the pot side wall, with outside air, said tubular member having a lower end spaced somewhat above the level of fuel in the sump.

11. The method of controllably vaporizing and burning liquid hydrocarbon fuels in a confined chamber which includes the steps of admitting liquid hydrocarbon fuel to a circumferentially extending zone in the lower portion of the chamber, such zone being radially spaced about the center of the chamber, subjecting the liquid fuel in such circumferential zone to a temperature sufficient to vaporize the liquid fuel without cracking it, supplying air to the initially vaporized hydrocarbon in a quantity less than that required for combustion, while moving such

vaporized fuel and air in and upwardly from the zone of initial vaporization, thereafter continuously directing air into the mixture as it rises upwardly in the chamber, heating the rising mixture by localized areas of combustion in its path, and converting it first to an alcohol compound mixed with vaporized hydrocarbons and, thereafter, during the subjection to further air and heat to an aldehyde compound, the air for the localized areas of combustion being delivered at a pressure substantially below the pressure of the air supplied to the initially vaporized hydrocarbon, and supplying secondary air to the final aldehyde compound in volume sufficient to render it fully combustible and burning the mixture thus formed at and above the level of admission of such secondary air.

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