

[54] TWO-STAGE VAPORIZING FUEL OIL
BURNER

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[51] Int. Cl. **F23d 1/44**
[58] Field of Search..... **431/236, 237, 245,**
431/211, DIG. 65, DIG. 67, 234, 235

[56] **References Cited**
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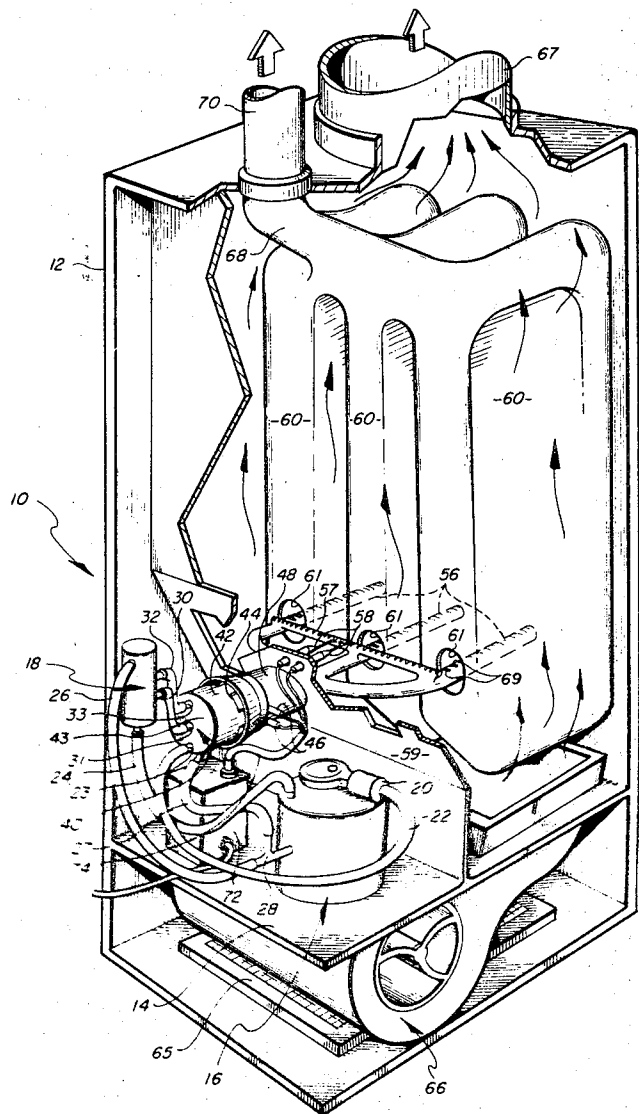
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[57] **ABSTRACT**

The device achieves vaporization of liquid fuel such as fuel oil in the "free stream" by burning a small percentage of the fuel on the fringes of a spray of atomized droplets. A small pilot flame is maintained within a housing and is supplied by one of a pair of atomizers to vaporize fuel being injected into the same housing from the second atomizer. The heated chamber within the housing thus vaporizes all of the fuel. Both atomizers induce sufficient air through aspiration ports in the housing to premix fuel and air. The fuel ejected from the pilot atomizer experiences a reduction of droplet size through use of a long cone which deflects and collects a portion of the fuel spray. The gaseous fuel is subsequently burned in a primary combustion chamber downstream of the vaporization housing.

14 Claims, 6 Drawing Figures



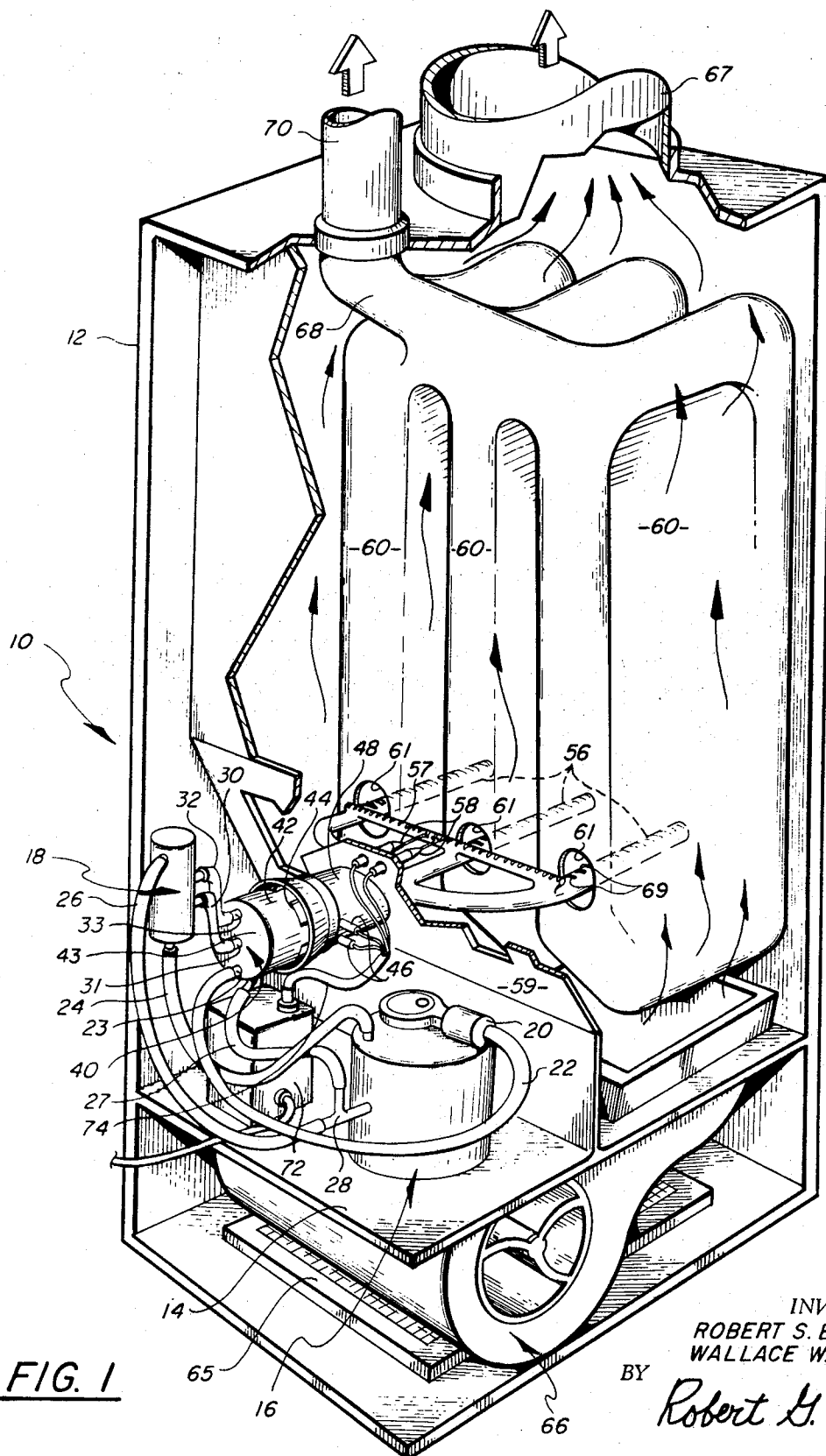


FIG. 1

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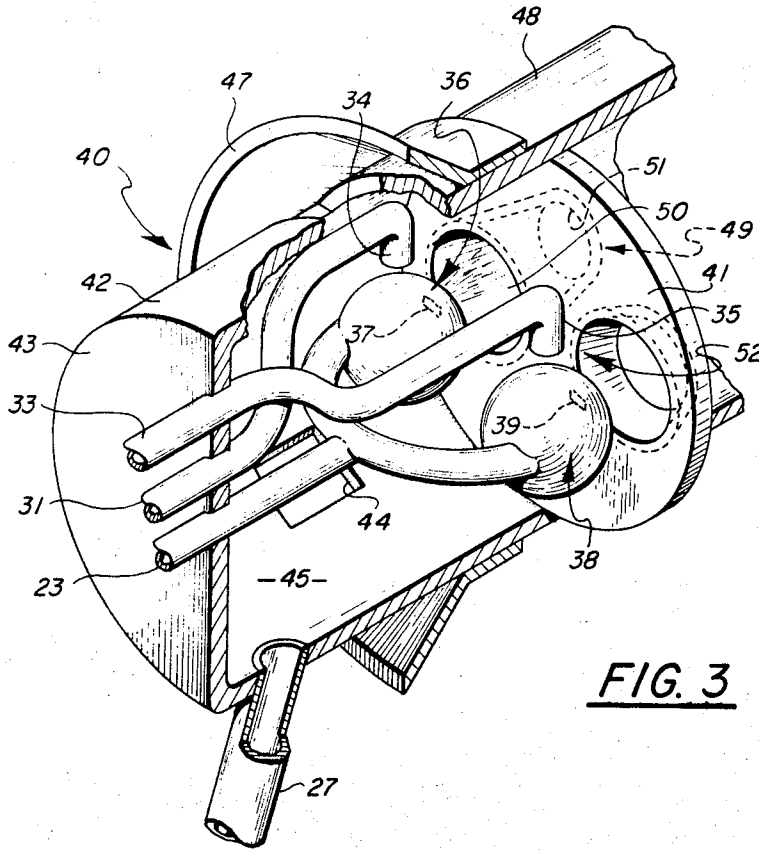
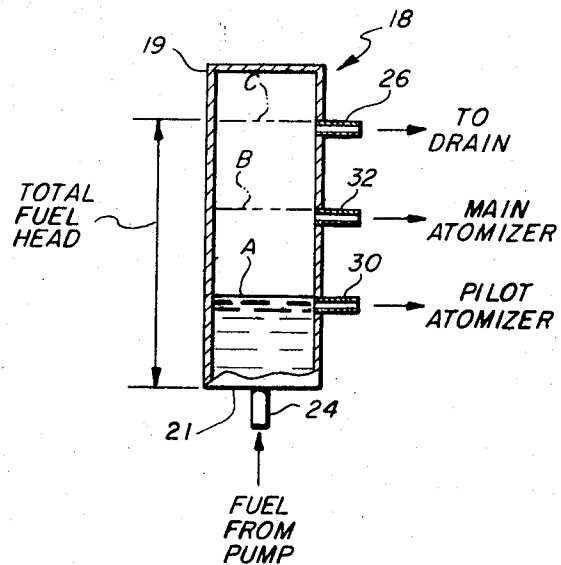


FIG. 3

FIG. 2



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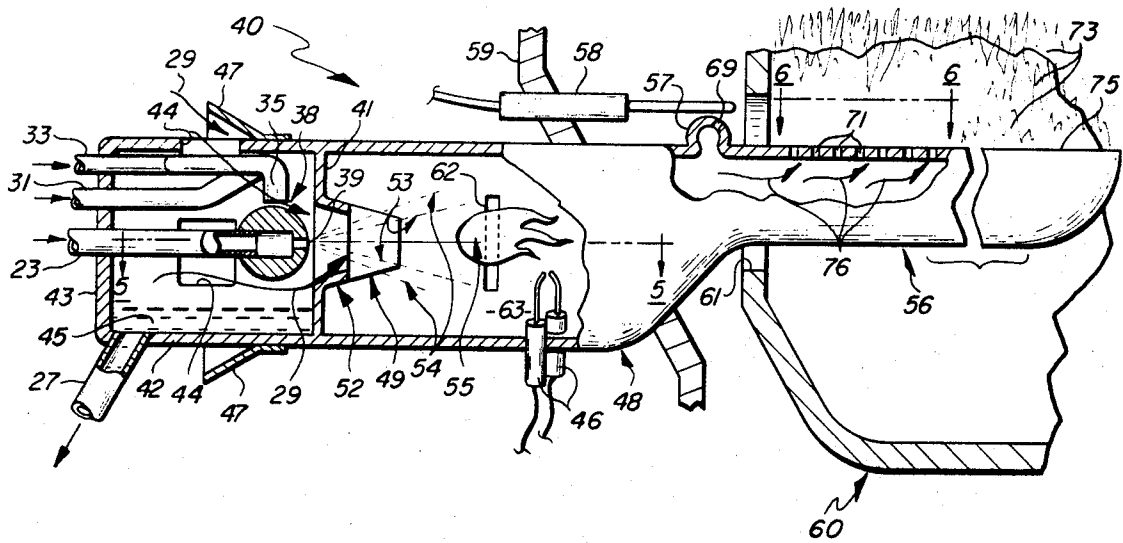


FIG. 4

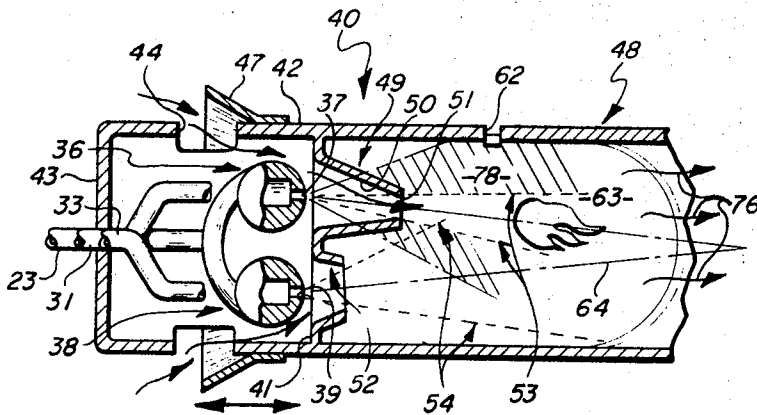


FIG. 5

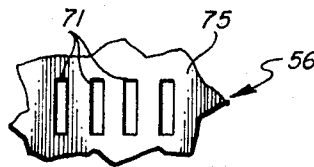


FIG. 6

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TWO-STAGE VAPORIZING FUEL OIL BURNER

CROSS-REFERENCE TO RELATED APPLICATION

This application is related to a commonly assigned application entitled Vaporizing Fuel Oil Burner Ser. No. 162,076 by J. A. Hagel et al., filed concurrently herewith.

BACKGROUND OF THE INVENTION

1. Field of the Invention

Efficient vaporization or gasification of a liquid fuel such as fuel oil prior to combustion is a significant step toward the use of liquid fuels in normal gaseous fuel combustion appliances such as warm air fuel oil furnaces.

The prior art discloses oil vaporizing systems that rely on high temperatures and, to a degree, on the heat of the walls of the combustion chamber to boil and to gasify fuel oil for more efficient burning.

2. Description of the Prior Art

Basically, two types of fuel oil burning systems make up the state of the art. Better than 90 percent of the fuel oil burners in domestic use to date utilize a high pressure nozzle that injects fuel through a relatively small aperture in a nozzle. Approximately 100 lbs of pressure forces fuel oil out of the nozzle and no air is brought in with the fuel oil. Air is pumped into the combustion chamber through a separate entrance. The combustion chamber, however, must be very hot to accomplish the foregoing vaporization process because of the relatively large droplet size of the fuel being injected from the foregoing fuel oil dispenser. Temperatures in the range of from 1500° to 2000°F within the combustion chamber are necessary in order to vaporize fuel oil dispensed by this device. It is essential that special stress-resisting materials be utilized in fabricating the combustion chamber due to the high temperatures to which the chamber walls are subjected.

A small percentage of domestic dwellings have fuel oil furnaces that incorporate an air atomization, low pressure fuel oil burner system. This device siphons fuel oil into an air stream which sprays into a combustion chamber by flowing air under pressure past an opening surrounded by fuel oil. A relatively large opening is necessary in the nozzle to allow air under relatively low pressure to siphon the fuel oil into a combustion chamber for subsequent burning.

The air atomization fuel oil burner just described requires a minimum of about 1 pound of air for every pound of fuel dispersed therefrom. This atomization air is mixed homogeneously with the relatively small fuel droplets resulting in a mixture too rich in fuel to burn. Consequently, vaporization must be accomplished by using a hot surface or by mixing additional air with the fuel. The former process results in layers of carbon deposits on the vaporizer chamber walls, and the latter technique results in excessive vaporizer chamber temperatures.

Other types of fuel oil burners are disclosed in the prior art; however, these innovations primarily concern themselves with the shape of the combustion chamber and the means by which air is introduced within the chamber to enhance fuel-air mixing. Various rotational forces are generated to encourage fuel-air mixing within the combustion chamber.

U.S. Pat. Nos. 3,421,692, 3,421,699 and 3,425,058 to Babington et al basically disclose a means to atomize

liquid by depositing a liquid film on and over a hollow curved surface or sphere and breaking up the resultant highly stressed thin film of liquid by directing a stream of air under pressure through the plenum defined by the sphere and out through a small aperture or apertures therein. A multiplicity of very fine droplets in a relatively narrow size range are directed from the sphere. U.S. Pat. No. 3,425,058 discloses a fuel burner wherein fine droplets are sprayed into a combustion chamber. The atomized fuel oil is subsequently ignited, thereby providing a source of heat for a warm air furnace or the like. The basic principle of the Babington atomizer disclosed in the patent is utilized in the present invention. The Babington et al atomizer has the advantage of providing a very fine droplet spray pattern which, in itself, enhances the burning properties of, for example, liquid fuel oil being ejected from the surface of the sphere. However, when fuel oil is used as the ignitable liquid, it is still in a liquid state after it is ejected within a combustion chamber and must be vaporized before it may be ignited.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a method to vaporize the miniscule droplets formed by an atomizer so that the vaporized fuel will act as a gas and can be consumed accordingly.

More specifically, it is an object of this invention to enhance vaporization of atomized fuel oil sprayed from a main atomizer by first providing a pilot flame supplied by a separate atomizer and air aspiration ports in a chamber housing, wherein the pilot flame heats up the housing and induces air through the aspiration ports prior to sequentially introducing fuel oil droplets from the main atomizer so that the air-fuel mix is gasified and directed through a vapor distributor toward a primary combustion chamber.

The device achieves fuel oil vaporization in a "free stream" by burning a small percentage of the fuel droplets on the fringes of an atomized fuel spray. The amount of fuel burned depends on the type of fuel used and the temperature required to achieve vaporization. No. 2 fuel oil, for example, requires a temperature of about 700°F for complete vaporization. Combustion of about 2 to 5 percent of the fuel is sufficient to achieve complete gasification of the commonly used liquid fuels. A mixture of fuel and air for such a small fuel quantity would, however, exceed the fuel-rich limit for combustion. The device limits the quantity of fuel consumed in the vaporization process by introducing the air on the boundary of the fuel spray.

The device is comprised of a pair of fuel oil atomizers of the type disclosed in the Babington et al. patents, supra, one to supply fuel for a pilot flame and the other to supply fuel to be vaporized by the pilot flame and passed to a main combustion chamber for consumption therein. The atomizers are contained within an end of a vapor distribution housing. The housing is basically a vapor distributor which is connected to at least one primary gas burner element, the element containing a multiplicity of ports which open into a primary combustion chamber. The atomizers are adapted to spray through a specially designed baffle plate. The first aperture opposite the atomizer supplying fuel for the pilot flame is the larger opening of an elongated cone extending downstream or away from the atomizer, the smaller opening of the cone being furthest from the at-

omizer. The purpose of the elongated cone is to allow only those fuel oil droplets of the smallest size to escape through the smaller opening of the cone. The rest of the droplets are captured by the inner wall of the cone-shaped chamber and thereby prevented from entering the vapor distribution housing. Between the end of the housing and the baffle plate is one or more air-aspiration ports positioned in the housing to admit ambient air into the interior of a chamber defined by the end of the housing and the baffle plate. The air is subsequently directed around the atomizers and through the apertures in the baffle plate into the interior of the vapor distribution housing, thereby mixing with the fringe of atomized fuel from the pilot atomizer. Electrodes are cantilevered into the vapor distribution housing upstream of the baffle plate to intercept the narrow region of atomized fuel droplets from the pilot atomizer and to ignite and maintain ignition of a small pilot flame. Since boundary air on the fringe of the narrow cone of fuel droplets provides sufficient air to overcome the fuel-rich mixture and form a combustible mixture, a pilot flame is maintained that consumes only a very small portion of the atomized fuel injected into the vapor distribution chamber. The pilot flame heats up the inside chamber of the vapor distribution housing, which in turn induces more air through the aspiration ports, around the atomizer spheres and through the apertures in the baffle plate. The heated chamber defined by the housing then vaporizes fuel droplets being subsequently injected into the housing through the larger second aperture in the baffle plate from the second or main fuel oil atomizer. The vaporized fuel-air mixture is then directed down the vapor distribution housing and into the burner element, the element defining a multiplicity of ports leading into a primary combustion chamber. The gasified fuel oil is subsequently ignited in the main combustion chamber by a second pair of electrodes, thus the overall system provides heat in much the same manner as burning natural gas. The oil burner then produces a clean and well distributed flame within the main combustion chamber.

The small pilot flame necessary to vaporize the incoming fuel droplets operates in a temperature range low enough so that exotic or expensive materials are unnecessary in fabricating the vapor distributor housing.

The temperature ranges under specified conditions in the pilot flame area are in the neighborhood of 700° to 800°F, which is adequate to vaporize liquid fuel oil droplets when the Babington atomizer is utilized. As heretofore described, conventional gun type burners generate much higher temperatures to vaporize fuel oil, hence more expensive and heavier materials are required to withstand the stresses induced by the burner.

Accordingly, an advantage over the prior art is the elimination of exotic, heavy and expensive heat-resisting materials that are necessary to fabricate conventional oil burners.

Another advantage is the ability to vaporize fuel oil completely so that it acts as a natural gas, providing a clean, non-polluting type of flame.

Still another advantage is the ability of the apparatus of the present invention to retrofit within conventional warm air gas furnaces, thereby taking advantage of the unique aspect of the fuel oil vaporizing principles herein described.

The above noted objects and advantages of the present invention will be more fully understood upon a study of the following detailed description in conjunction with the detailed drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a typical furnace with the side and front panels removed and a portion of the inner panel cut away to illustrate how the various components cooperate with one another;

FIG. 2 is a partially cutaway, side elevational view of a fuel supply reservoir illustrating the sequential means by which the fuel is supplied to the fuel oil atomizers;

FIG. 3 is a partially cutaway perspective view of the horizontal fuel oil burner element illustrating the two fuel oil atomizers and their various feed pipes;

FIG. 4 is a side elevational view of the horizontal fuel oil burner connected to the furnace panel, the end of the burner being extended within a main combustion chamber;

FIG. 5 is a view taken along lines 5—5 of FIG. 4, illustrating the two intercepting or impinging patterns of atomized fuel within the vapor distribution housing; and

FIG. 6 is a view taken along lines 6—6 of FIG. 4, showing the individual vapor distribution slots along the top of the burner element.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Turning now to FIG. 1, the fuel oil furnace generally designated as 10 consists of a housing 12, having a base communicating with fresh air through a hole therein and a support platform 14 which is raised above the base of the furnace. The platform 14 supports a recirculating fuel lift pump generally designated as 16. The fuel lift pump may be of the type disclosed and claimed in commonly assigned application Ser. No. 888,245, filed Dec. 29, 1969, entitled Liquid Supply Pump, by Velie et al. The fuel lift pump contains, on its uppermost surface, an air pump 20 which is driven by a motor contained within the fuel pump 16. A fuel pump feed line enters the fuel lift pump 16 from a fuel oil tank located externally of the furnace (not shown). The platform 14 also supports a furnace control module 72 to which is attached a system electrical control harness 74 which leads to two pairs of electrodes which will be explained herebelow. A bulkhead or panel 59 supports a horizontal fuel oil burner generally designated as 40. The burner 40 comprises a housing 42, which supports at an end 43 of the housing a pair of fuel inlets 31 and 33, which are connected to a fuel supply reservoir generally designated as 18, by lines 30 and 32. The fuel supply reservoir is connected to the fuel lift recirculation pump 16 by conduit 24. The purpose for the fuel supply reservoir will be further explained with reference to FIG. 2. Immediately below the fuel inlets 31 and 33 is an air inlet 23 connected to conduit 22, leading from the air pump 20 and connected to fuel recirculation pump 16, driven by a motor within the pump. Extending from the bottom of the housing 40 is a fuel drain 27 which is connected to a T-fitting 28, leading into the fuel recirculation pump 16. Additionally, a fuel drain conduit 26 is connected to the T-fitting 28 and leads to the top of the fuel reservoir 18. The two lines 26 and 27 thus provide a means for a fuel overflow to be recirculated back to the fuel lift pump. The return

fuel can then be recirculated by the lift pump back to the atomizer unit contained within the housing.

Connected to housing 40 are, for example, three horizontal burner elements generally designated as 56, shown partially in dotted line, extending into three rectangularly-shaped, heat transferring, combustion chambers 60. The horizontal fuel elements protrude into each of the combustion chambers 60 through openings 61 provided in the lower front section of the combustion chambers, the opening 61 being oversized with relation to the burner elements 56 to allow ambient air to gain access to the interior of the combustion chamber thereby providing air for combustion of gaseous fuel oil. Across the top of the individual fuel elements 56 is a pilot vapor distribution tube 57, the interior of which communicates with the interior of each of the horizontal burner elements. Thus, the vaporized fuel is admitted to the interior of pilot 57 and exits through a multiplicity of apertures 69. Extending through bulkhead or panel 59 is a pair of electrodes 58, the tips of which extend above the pilot vapor distributor tube 57 to provide a source of ignition for igniting the escaping fuel oil vapor from each of the horizontal elements 56. Another pair of electrodes 46 extend into housing 42, thereby intercepting the narrow spray pattern from the atomizer pilot fuel supply, thus providing a source of ignition for a pilot flame whose operation will be described in detail below. Between the end 43 of housing 42 and a baffle plate 41 (FIG. 3) is one or more apertures 44 in the housing to admit ambient air into the interior of the housing to enhance the fuel vaporization process.

Fresh air is conventionally admitted to the interior of the oil-fired furnace through an air filter screen 65 which is intermediate the base of the furnace and the fresh air blower 66. Fresh air is forced by the blower into the interior of the furnace 10 and out past the individual combustion chambers 60 so as to exchange heat from the combustion chambers to the fresh air. The fresh air is warmed and directed out through duct 67 to be distributed therefrom to the interior of, for example, a home dwelling. Each of the individual combustion chambers 60 are in communication with each other through a common manifold 68 at the top of each of the chambers which leads into a single flue exhaust pipe 70 through which the combustion products are directed to the atmosphere.

Turning now to FIG. 2, the sequencing fuel supply reservoir 18 for the atomizers consists of a tank 19 which is in flow communication with the fuel lift recirculation pump 16 through conduit 24. The tank 19, being cylindrical in shape, is oriented substantially vertically. On a level nearest the base 21 of tank 19 is located a supply line 30 which supplies fuel oil to the pilot atomizer within housing 42. Above the pilot atomizer on still another plane is the main atomizer fuel supply line 32. The main atomizer feed line leads to the main fuel feed pipe 33 for the main atomizer in housing 42. A third outlet supply line 26 positioned nearest the top of tank 19 returns fuel through T-fitting 28 back to the fuel lift recirculation pump 16.

The purpose of the sequencing fuel supply reservoir is to first supply fuel oil to the pilot atomizer within the horizontal fuel burner 40 prior to admitting fuel to the main atomizer through supply line 32. As can be seen, as the liquid rises in tank 19, liquid is exposed to supply line 30 which feeds fuel oil to the pilot atomizer, thus

the pilot atomizer begins to spray fuel oil into the fuel oil burner. The fuel is subsequently ignited by electrodes 46 (shown in FIG. 1), thus providing a pilot flame which acts to heat up the interior of the horizontal fuel oil burner prior to the injection of the main atomized fuel droplets from the main atomizer. As the fuel rises within tank 19, the pilot atomizer first is actuated and while the pilot atomizer warms up the housing 42 of the horizontal fuel oil burner 40, the fuel in tank 19 continues to rise until it reaches the main atomizer level or port 32, whereupon the fuel is then admitted to the main atomizer thereby injecting fuel droplets within the previously heated chamber. The pilot flame serves to vaporize the main fuel emanating from the main atomizer. The fuel head within tank 19 can be determined by positioning the drain port 26 some predetermined distance above the two ports 30 and 32, thereby providing means to control the total fuel head subjected to the atomizers.

Turning now to FIG. 3, the perspective view shows the end of the horizontal fuel burner element 40. The dual atomizers generally designated as 36 and 38 can be clearly seen in this view, the two atomizers being fed by conduits 31 and 33 which, as heretofore explained, connect to the fuel supply reservoir 18. A baffle plate 41 is positioned radially with respect to the axially aligned housing 42, the baffle plate containing a pair of apertures 49 and 52. The aperture 49 opposite the pilot atomizer 36 is defined within an open-ended hollow restrictor body or cone which extends downstream or away from the pilot atomizer into the vapor distribution housing 48. The narrowest end of cone 51 is the opening furthest from the pilot atomizer, the other end of the cone 50 being adjacent the atomizer. The opening 52, adjacent the main atomizer 38 is much larger to allow more atomized droplets to be admitted there-through. Between end 43 and the baffle plate 41 is a series of apertures 44 in the housing 42 to allow ambient air to enter the chamber generally designated as 45 within ends 43 and baffle 41. The ambient air enters the vapor distribution chamber 48, past the two atomizer heads 36 and 38 through openings 49 and 52 thus providing an envelope of boundary air around the atomizers. The size of the openings 44 in the housing may be controlled by movable shroud 47, the shroud being slidable in an axial direction over the housing 42. Drain port or line 27 leads back to the fuel lift recirculation pump as previously described.

In operation, referring to both FIGS. 2 and 3, as the fuel rises within tank 19, fuel is admitted to the pilot atomizer through fuel inlet 31, exits nozzle 34, admitting fuel oil to the surface of atomizer 36. A small slot 37 (shown in dotted line) in the atomizer ball 36 is positioned opposite the aperture 49 in the baffle plate so as to direct the fuel droplets therethrough. Air from the air pump is admitted to the interior of air inlet 23 from air pump 20 which commonly pumps air through the interiors of both of the atomizers 36 and 38, the air escaping through slots 37 and 39 respectively. The air serves to break up the highly stressed thin film of liquid that is spread over the pilot atomizer sphere 36. The atomizer directs miniscule fuel oil droplets into the cone shaped aperture. Only a portion of the total droplets sprayed from the surface of the ball exit through small opening 51 into the interior of the vapor distribution housing 48. The electrodes (shown as 46 in FIG. 1) then ignite the fuel oil droplets from the pilot atomizer.

Subsequently the fuel oil level in tank 19 rises to the main atomizer feed line 32, which directs fuel oil to inlet 33, through nozzle 35 onto the main atomizer element 38. Air entering sphere 38 breaks up the film of liquid over atomizer 38 thereby directing the fuel through aperture 52 in baffle 41. Thus it can be seen that the fuel oil is first directed to the pilot atomizer 36 for preheating of chamber 48, followed by sequential admission of the main spray of fuel oil droplets from the main atomizer 38. The pilot combustion process vaporizes the fuel oil from the main atomizer for consumption within the main combustion chambers 60. When the pilot atomizer is in operation, the ignited spray pattern aspirates air through ports 44, past the spheres 36 and 38, and through the openings 49 and 52, into the chamber or vapor distribution housing 48.

Turning now to FIGS. 4 and 5, the housing 42 is attached to bulkhead 59, thus supporting the fuel burner adjacent the combustion chamber section 69. The burner rod element 56 is shown which extends into the interior of the primary combustion chambers 60 through opening 61. The element 56 has along its top surface 75, a series of equidistantly spaced slots 71 oriented traverse to the axis of the burner rod which admits vaporized fuel oil to the interior of the combustion chamber 60. The two atomizer fuel feed lines 31 and 33 are anchored to base plate 43 of housing 42. The drain line 27 is in communication with chamber 45 to collect and return fuel oil to the fuel recirculation pump. The shroud 47, as heretofore described, can be translated over the openings 44 to regulate the amount of aspirating air admitted to the interior of the burner element 40.

Turning now to FIG. 5, this view clearly shows the spray patterns emanating from atomizers 36 and 38 within the vapor distribution housing 48. The sequencing fuel supply reservoir 18 admits liquid fuel oil through conduit 31 onto the pilot atomizer 36 prior to admitting liquid to the conduit 33 feeding main atomizer 38.

It should be pointed out here that the objective of the present invention is to achieve vaporization of fuel oil droplets in a free stream by burning a small percentage of fuel on the fringes of a fuel spray. It has been found that combustion of about 2 to 5 percent of the fuel is sufficient to achieve complete gasification of the commonly used liquid fuel oils. A homogeneous mixture of fuel and air for such a small fuel quantity would normally exceed the rich limit for combustion. Therefore a means to limit the amount of fuel consumed in the vaporization process must be provided to stay within the limits of combustion. The elongated cone or open-ended hollow restrictor body 49, fixed to baffle plate 41, operates to limit the amount of fuel oil droplets that are being ejected into the interior volume 63 for the pilot flame operation. As the pneumatic pressure breaks up the fuel droplets on the sphere, thereby injecting the droplets into the cone, it can be seen that the normal spray pattern is generally relatively wide, as indicated by the outer shaded area 78 extending away from the apertures 37. The inner walls 50 of the cone 49 serve to trap the larger droplets that are sprayed from the surface of the ball 36, while the smaller droplets are allowed to escape through opening 51 of the cone. Thus, it can be seen that the cross-hatched area 78, normally filled with fuel droplets, never enters volume 63. Only the very smallest of the fuel droplets are

admitted to chamber 63 for pilot flame operation. The percentage of atomized droplets consumed by the pilot flame is between 5 and 8 percent of the fuel droplets ejected from the atomizer. The electrodes 46 (FIG. 4) provide a constant source of ignition for the pilot flame 55. By trapping most of the droplets emanating from sphere 36, the proper mixture of air and fuel oil is provided to create the right conditions to maintain a pilot flame. The flame serves to heat up the interior of volume 63 as heretofore explained. The aspirated air through openings 44 is introduced as boundary air surrounding the fuel spray from the atomizers. The pilot flame is ignited and maintained. A short time interval elapses before the liquid level within tank 19 reaches fuel outlet 32. The main atomizer then begins to eject fuel oil droplets into the heated zone or volume 63. As indicated in the drawings, it should be noted that the center lines 64 of the two spray patterns intersect interiorly of the housing 42 so as to assure that the majority of fuel oil droplets are kept away from the interior walls of the housing. It should be further noted that the slot 37 in sphere 36 is smaller than slot 39 in sphere 38 so that the amount of droplets being sprayed from the main atomizer 38 is greater than the amount being directed from sphere 36. To further clarify the invention, the area of fuel droplets emanating from atomizer 36 is defined by area 53, while the area of fuel droplets from main atomizer 38 is defined as 54. It can be readily seen that the spray pattern is much wider from atomizer 38 than it is from atomizer 36.

It has been found though experimentation that a No. 2 grade of fuel oil is preferred. In order to vaporize 100 percent of the fuel droplets being atomized, a minimum temperature must be maintained within the vapor distribution chamber 48 of approximately 700°F. Therefore, an ideal temperature within the vapor distribution chamber 48 would be approximately 800°F. Again, this temperature is well below the 1500° to 2000°F range necessary in conventional oil burners. The air being admitted to the interiors of the atomizers and out through slots 37 and 39 is in the neighborhood of 0.5 to 0.6 lbs. per hour at 6 to 8 psig air inlet pressure. All these parameters are based on a burner housing dimension of approximately 1-½ inches in diameter. When this overall size is utilized, the size of the air aspiration port 44 may be between 1 and 2 square inches relative to the 1-½ inch diameter of housing 42. Additionally, a vent hole or slot 62 is provided adjacent the pilot flame 55 of approximately 0.2 square inches that is provided in the vapor distribution chamber 48 to assure stability of the pilot flame. Without the vent hole or slot 62, the burning gases tend to oscillate within volume 63. The slot 62 dampens out the oscillating effect, thereby preventing resonance within the vapor distribution housing which might tend to snuff out the pilot flame.

Clean burning with an output of approximately 70,000 BTU/hr. has been achieved based on an oil burner having the same general dimensions just described. Additionally, CO₂ levels are relatively low (5 to 10 percent). Lower overall combustion temperatures decrease nitrous oxide emissions into the atmosphere, therefore the combustion parameters of the present invention contribute very little to this type of pollution.

Referring again to FIG. 4, there can be a number of burner rod elements 56 (three are shown in FIG. 1) which connect to the end of the vapor distribution

housing 48 and terminate within the combustion chamber 60. A connecting pilot vapor distributor conduit 57 directs vaporized fuel out of the burner rods 56. Thus, when the electrodes 58, anchored to plate 59, are activated, the pilot tube 57 serves to transfer flame to all the rod burner elements. The vaporized atomized fuel oil droplets (designated as 76) traverse the interior of the rod elements and escape through the plurality of apertures 71 in the rods. Ignition then takes place in volume 73 within the combustion chambers 60, thereby heating up the interior of the chambers.

FIG. 6 is a fragmentary view of the top surface of the rod element 56 showing the elongated equidistantly-spaced slots 71 in the rod burners.

The basic fuel oil burner can operate from one quarter gallon an hour to .7 gallon per hour of fuel oil and the device will work equally well with a No. 1 grade of fuel oil which is relatively light, up to and including fuel oil designated as No. 4 which is relatively heavy. Fuel oil is defined as any liquid or liquefiable petroleum product used for the generation of heat or power. No. 1 and No. 2 fuel oils are liquid. The former is used in vaporizing or pot type burners and has a boiling range of about 400° to 625°F. No. 2 is less volatile and is used in domestic heaters not requiring a No. 1 grade of fuel oil. No. 4 oil is liquid at room temperature, but is very viscous. It is usually used in industrial furnaces with no preheating facilities. The Babington atomizer is relatively non-clogging and since the fuel runs over the outer sphere 36 and 38 and the air exiting through the apertures 37 and 39 breaks up the film of oil over the sphere, there is very little chance of clogging the apertures because of the higher pressure within the interior of the spheres 36 and 38. Thus, the atomizer fuel oil burner is non-critical as to the grade of fuel oil burned.

It should be noted that any atomizer exhibiting fuel dispensing properties similar to the atomizer shown in the Babington et al patent could be utilized to take advantage of the unique aspects of the present invention.

The controls of the furnace are conventional in that the temperature of the furnace can be automatically controlled by providing automatic on and off devices to turn on and shut off the furnace dependent upon a temperature variant.

We claim:

1. A liquid fuel burner device comprising:

a pilot flame fuel atomizer and a main fuel atomizer; fuel supply means to sequentially supply fuel first to said pilot flame fuel atomizer and then to both said pilot flame fuel atomizer and said main fuel atomizer;

a housing means for receiving and burning a portion of the atomized fuel from said pilot flame fuel atomizer;

first ignition means to ignite said portion of atomized fuel from said pilot flame fuel atomizer to provide a pilot flame in said housing means to heat up said housing means prior to injection of fuel from said main fuel atomizer,

means to direct fuel from said main fuel atomizer to said housing means, said pilot flame serving to vaporize the unburned atomized fuel from said pilot flame fuel atomizer and from said main fuel atomizer in said housing means; and

means downstream from said pilot flame for receiving and burning the vaporized fuel from said housing means.

2. The burner device of claim 1, wherein said pilot atomizer and said main atomizer are connected to and positioned within an end of said housing means, said atomizers being contained within a chamber defined by the end of the housing and a baffle plate attached within said housing, said baffle plate having a pair of apertures therethrough, the pilot fuel atomizer and the main fuel atomizer being adapted to spray fuel through each of said apertures in said baffle plate into the interior of said housing.

3. The burner device of claim 1 wherein the center lines of both spray patterns from said pilot atomizer and said main atomizer within said housing are directed inwardly away from the inner walls of said housing.

4. A liquid fuel burner device comprising:

a pilot flame fuel atomizer and a main fuel atomizer; fuel supply means to sequentially supply fuel first to said pilot flame fuel atomizer and then to both said pilot flame fuel atomizer and said main fuel atomizer;

a housing means for receiving and burning a portion of the atomized fuel from said pilot flame fuel atomizer;

first ignition means to ignite said portion of atomized fuel from said pilot flame fuel atomizer to provide a pilot flame in said housing means to heat up said housing means prior to injection of fuel from said main fuel atomizer, said pilot flame serving to vaporize the unburned atomized fuel from said pilot flame fuel atomizer and from said main fuel atomizer;

burner element means for receiving said vaporized fuel and distributing said fuel exteriorly of said element; and

second ignition means to ignite the vaporized fuel which is distributed exteriorly of said burner element means.

5. The burner device of claim 4 further including a combustion chamber housing having a port therein for receiving said burner element means and in which said second ignition means ignites said vaporized fuel which is distributed exteriorly of said burner element means within the interior of said combustion chamber housing.

6. The burner device of claim 5 further comprising a blower means positioned exteriorly of and adjacent to said combustion chamber housing, said blower directing air past the exterior walls of said combustion chamber whereby heat is transferred from the exterior combustion chamber walls to said air.

7. The burner device of claim 6 wherein said pilot flame fuel atomizer and main fuel atomizer are of the type which utilize air under pressure to atomize liquid fuel therefrom.

8. The burner device of claim 7 further including air pump means for supplying said air under pressure to said pilot flame fuel atomizer and main fuel atomizer.

9. A liquid fuel burner device comprising:

a substantially horizontally oriented elongated housing having a first and second end;

a pilot fuel atomizer and a main fuel atomizer positioned within said first end of said housing;

a baffle plate attached within said housing downstream of said atomizers, said baffle plate having at least first and second apertures, said first aperture leading into the larger end of an open-ended hollow restrictor body having convergent walls which

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is positioned such that the convergent walls of said hollow restrictor body serve to collect those fuel droplets sprayed from said pilot atomizer that impinge on the inner converging walls of said restrictor body thereby restricting the amount of fuel droplets that escape through the narrowest opening of said restrictor body downstream of said pilot atomizer, said main atomizer being positioned adjacent said second aperture, the fuel droplets from the main atomizer being directed through said second aperture;

a substantially vertically oriented fuel supply tank to sequentially supply fuel to each of said atomizers, said tank having a fuel inlet at the bottom end, a pilot atomizer feed line on a first plane above the bottom and a main atomizer feed line on a second plane above said atomizer feed line whereby, as the liquid level rises in the tank, the pilot feed line directs fuel to said pilot atomizer prior to admittance of fuel to the main atomizer;

at least one air aspiration port in said housing between said first end of the housing and the baffle plate, said air aspiration port serving to admit air into said housing, said air being directed around each of said atomizers and through said apertures in said baffle plate;

a chamber means defined by said housing downstream of said baffle plate for receiving and burning a portion of the atomized fuel from said pilot atomizer to heat up said chamber prior to injection of fuel from said main atomizer;

first ignition means positioned interiorly of the housing downstream of said baffle plate, said ignition means being adapted to ignite a portion of the atomized fuel oil droplets from said pilot atomizer thereby providing a pilot flame in said chamber means, said flame serving to vaporize the unburned fuel droplets from said pilot atomizer and from said main atomizer;

said housing further defining an aperture therein ad-

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acent said pilot flame to stabilize said flame;

at least one hollow burner element means connected to said second end of said housing, said burner element means having a plurality of equidistantly spaced slots transverse to the axis of said burner element, said slots serving to distribute said vaporized fuel exteriorly of said element; and

second ignition means exteriorly of said burner element means to ignite said vaporized fuel thereby providing the primary source of flame for said oil burner.

10. The burner device of claim 9 wherein the pilot fuel atomizer and the main fuel atomizer are of the type which include a plenum including a curved apertured surface, means for supplying air under pressure to the interior of the plenum and means for supplying fuel to be burned to the curved surface of the plenum at a point spaced from the aperture therein whereby the fuel flows in the form of a highly stressed thin film thereover, the air emitting through the aperture in said surface atomizing fuel in a fog-like mist.

11. The burner device of claim 10 further including fuel oil collection means in said first end of said housing, said collection means serving to collect unatomized fuel oil.

12. The burner device of claim 11 further including fuel pump recirculation means and means to direct said unatomized fuel oil in said collection means to said fuel pump recirculation means.

13. The burner device of claim 12 further including air pump means, said air pump means serving to pump air to said atomizer means.

14. The burner device of claim 13 wherein the open-ended hollow restrictor body is a cone that is part of said baffle plate and extends away from said pilot atomizer so as to collect those fuel droplets sprayed from said pilot atomizer that impinge the inner wall of said cone.

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