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PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements in or relating to the Supply of Liquid Fuel to, and Consumption by, Oil Burners

I, KWONG LO TSANG, a Chinese National of 16D Chatham Garden Flats, Chatham Road, Kowloon, Hong Kong do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to oil burners and is concerned with a method of supplying a liquid fuel to an oil burner, a fuel supply system for an oil burner and an oil burner having such a fuel supply system.

According to the present invention in a method of supplying a liquid fuel to an oil burner, the fuel is propelled to the burner by exerting thereon the pressure developed by a liquefied fuel gas which is allowed to vaporise at the prevailing ambient temperature, and the pressure of the vapour resulting from this vaporisation is controlled to a value below its normal vapour pressure at the prevailing ambient temperature.

Further by the present invention in a method of operating an oil burner with a normally liquid main fuel, an auxiliary fuel consisting of a liquefied gaseous fuel is allowed to vaporise at the prevailing ambient temperature and to exert its vapour pressure at this temperature upon the main fuel so as to propel the main fuel to the burner, the auxiliary fuel being used to supply sufficient heat to the burner to allow vaporisation and ignition of the main fuel therein, and the pressure of the auxiliary fuel vapour being controlled to a value below its normal vapour pressure at the prevailing ambient temperature.

A fuel supply system constituting another feature of the present invention includes a source of a normally liquid fuel constituting the main fuel of the system, a source of a liquefied gaseous fuel constituting a costlier auxiliary fuel, first conduit means for supplying the main fuel to the burner, second conduit means for supplying the auxiliary fuel to internal auxiliary combustion means for vaporising the main fuel when this is supplied to the burner inlet and heating said main fuel to the ignition point thereof, and third conduit means connecting the auxiliary fuel source to the main fuel source, valve means being provided in the third conduit means for allowing the pressure of the vapour of the auxiliary fuel to be exerted upon the main fuel, either directly or indirectly, so as to propel the main fuel through the first conduit means to the burner, and check valve means being provided in the second conduit means.

The auxiliary fuel may act directly upon the main fuel or an intervening solid or liquid barrier between the main and auxiliary fuels may prevent direct contact therebetween whilst allowing the pressure of the auxiliary fuel to be exerted upon the main fuel.

The method and apparatus of the present invention have the advantage of simplicity, low capital cost and inexpensive operation. They are particularly useful where a relatively low-cost fuel such as a normally liquid petroleum cut is readily available at the same time as a costlier liquefiable petroleum gas such as propane or butane which is commercially available in the refining of crude petroleum. By using the commercial liquid propane or butane mainly as a propellant and only to a limited extent as a fuel, for auxiliary services such as the heating of the liquid petroleum cut to ignition point in the burner, ecomonical plant operation can be maintained.

Furthermore, the system relies only on the expansion energy locked up in the auxiliary fuel while it is in its liquid state to supply the work needed for the supply of the main fuel to the burner. Both the capital cost of the pumps used in conventional fuel supply systems and their running costs are therefore avoided. Atmospheric heat is sufficient to start and to maintain operation.

[Price 4s. 6d.]

The use of the propane or butane vapour as the propellant at ordinary temperatures also ensures that the pressure throughout the system is substantially uniform and kept within safe limits. Direct contact between fuel and an oxidizing agent, as would occur in a system using compressed air as a propellant, is also avoided. Furthermore, the fuel needed for the auxiliary services is merely tapped off from the flow line for the propellant fluid so that the separate installation for this purpose in conventional plants is not needed.

Direct contact between the auxiliary and main fuels has the advantage of simplicity and the installation required is then cheaper to install. The greater capital and maintenance costs of the arrangements needed to prevent direct contact between the two fuels must, however, be balanced against the fact that the loss of the costlier auxiliary fuel by dissolution in the main fuel is then avoided.

The invention is more particularly described with reference to the accompanying drawings which illustrate several embodiments of the fuel system, by way of example, and in which

Figure 1 is a flow-sheet of one constructional form, according to the invention, of a fuel supply system for an oil burner, together with a diagrammatic view of the burner;

Figure 2 is a diagrammatic view showing two embodiments (2A and 2B) of a modification in one stage of the system shown in Figure 1, the modified stage being shown when an end condition has been reached, and

Figures 3 to 5 are similar views of further modifications of the stage shown in Figure 2.

Figure 1 shows an oil burner 1 and a fuel supply system for the burner 1. This system includes a source 2 of liquefied propane or butane gas, and a source 3 for the fuel proper.

Source 2 is constituted by two pairs of cylinders 4 and 5 containing commercial liquid propane or butane. The cylinders 4 and 5, which are provided with individual outlet valves, are connected to an automatic change-over device 6 through flow lines 7 and 8, respectively. The line 7 is connected to the device 6 through a shut-off valve 9 and the line 8 is provided with a shut-off valve 10.

A flow-line 11 connects the source 2 to the source 3 through a pressure-regulating valve 12 and a shut-off valve 13. The source 3 is constituted by a cylinder 14 provided with inlet and outlet shut-off valves 15 and 16, respectively. The cylinder 14 contains a normally liquid fuel such as a high-boiling petroleum fraction, for example gasoline, kerosene, diesel oil and fuel oil, referred to below as the " main fuel ".

A flow-line 17 connects the source 3 to the burner 1 through valves 18 and 19. The valve 18 is temperature-controller through a thermocouple or thermostat 20, provided with a sensing element 21.

A line 22 branches off from the feed line 11 for the propane or butane which constitutes an auxiliary propellant fuel as will be explained below. The line 22 is provided with a pressure-regulating valve 23.

The line 22 feeds a nozzle 54 directly within the burner 1 through a valve 25. The pressure-regulating valves 12 and 23 allow the control of the pressures in the lines 11 and 22 to values below the normal vapour pressure of the liquid propane or butane which is used. The valves 12 and 23 are set so that the pressure in the line 22 is always lower than the pressure in the line 11. A check valve 55 is disposed in the line 22 adjacent to the burner 1.

The valve 25 is temperature-controlled through a thermocouple or thermostat 27 with a sensing element 28. The line 22 also feeds a pilot burner 29 through a valve 30.

The system just described operates as follows. As shown on the drawing, the operating bank for the propane or butane gas is constituted by the pair of cylinders 4 and the cylinders 5 are the reserve bank. The cylinders 4 are shown about half-empty of liquid.

The individual outlet valves on all four cylinders are opened, together with the valves 9 and 10. In the condition illustrated, the automatic change-over device 6 is set to allow flow from the cylinders 4 and to cut off the cylinders 5. When the operating cylinders 4 are exhausted, the device 6 switches to the reserve cylinders 5 and emits a signal calling for new cylinders. In this way, the supply of auxiliary propellant fuel is always available and plant operation is not interrupted by any " run-off " of this fuel.

The pressure-regulating valve 12 is assumed to be set to below normal, allowing a pressure below the normal vapour pressure of the auxiliary fuel at ordinary room temperature to be exerted in the flow line 11. The valve 13 is opened after the cylinder valves and the shut-off valves 9 and 10 are opened, and the valve 15 is then also opened so that this pressure is exerted upon the main fuel in the cylinder 14.

The valves 16, 19 and 30 are now opened and the pilot burner 29 is lit. The valve 25 is automatically opened by the thermocouple or thermostat 27 a few seconds after the pilot burner 29 has been turned on, so that the fuel leaving the nozzle 54 is lit by the pilot burner 29 and starts to heat the burner 1.

When a selected high temperature as set in the thermocouple or thermostat 20 has been reached in the burner 1, the control valve 18 opens automatically. The main fuel in the line 17 can now flow to the burner under the pressure exerted by the auxiliary propellant fuel. The vaporised main fuel flows to a port hole (not shown) in the burner adjacent to the pilot burner 29 where it is ignited. The valve 25 is now manually closed, shutting off the nozzle 54 and the plant is allowed to run on its own.

Figure 2 shows a first modification of the

source 3. This is now constituted by three cylinders 31, 32 and 33. A valved connection 34 between the cylinders 31 and 32 is substantially in the form of an inverted U whose open ends 35 extend to locations closely adjacent to the bottoms 36 of the cylinders. Initially the cylinder 31 is filled nearly to the top with a barrier liquid 37, which is water in this example, and the cylinder 32 is filled with the main fuel. The cylinder 33 has an isolation plate 38 fixed at about mid-height and a vertical dip-tube 39 extending from above the plate 38 to a location adjacent to the bottom 36 of the cylinder 33. The cylinder 33 contains both the barrier liquid 37 and the main fuel.

The line 11 feeds the auxiliary fuel to a valved inlet 40 at the top of the cylinder 31 and to a valved inlet 41 immediately beneath the plate 38 in the cylinder 33. Valved outlets 42 and 43 at the tops of the cylinders 32 and 33, respectively, are connected to the line 17 between the source 3 and the burner 1.

The auxiliary fuel supplied to the inlets 40 and 41 acts upon the main fuel through the intervening barrier liquid 37, and pushes the main fuel through the outlets 42 and 43.

Figure 2 shows an end-stage of the source 3 when the cylinders 32 and 33 are almost completely exhausted of main fuel. At this moment, the flame in the burner 1 which is supplied by the main fuel becomes very weak or even goes out altogether, indicating that refilling or switching over to new plant is needed.

Figure 3 shows a second modification of the source 3. This is constituted by a single cylinder 44 containing the main fuel with a supernatant layer 45 of a barrier liquid which in this example is ethylamine. The line 11 is connected to a valved inlet 46 and a valved outlet 47 is connected to the line 17.

Figure 4 shows a third modification of the source 3. A cylinder 48, containing the main fuel, has a porous synthetic plastic plate 49, which constitutes a barrier between the auxiliary and main fuels, and a wire mesh screen 50 adjacent to the base 51 of the cylinder 48. The lines 11 and 17 are connected as in Figure 4. The porous plastic plate 49 is movable. It floats on the surface of the main fuel, and moves up or down as the main fuel is charged or discharged. The object of the screen 50 is merely to fix the lowest level that the porous plate 49 can reach.

Figure 5 shows a fourth modification of the source 3. The barrier within the cylinder 52 constituting the main fuel source 3 is formed in this case by a liner or diaphragm 53 of a synthetic plastic elastomeric material. The cylinder again has a wire mesh screen 50 adjacent to its base, and the lines 11 and 17 are connected up as in Figures 3 and 4.

The burner 1 may be provided with a vaporiser (not shown) but this is not essential. Thus, fuel from the source 3 may be fed to an oil burner without a vaporiser, the fuel being atomised to a form consisting of fine spray particles while passing through a nozzle of the burner and being ignited by a pilot burner such as that represented at 29.

The use of commercial liquid propane or butane has been specified above for the source 2 since it is believed that, at present, other liquefied fuel gases such as other liquefied petroleum gases cannot be used under economically practicable conditions. Accordingly, commercial liquid propane or butane is preferred for the production of the auxiliary propellant gas in the fuel system just described by way of example. However, the use of certain other liquefied fuel gases, and in particular the use of other liquefied petroleum gases, is technically feasible and is therefore not excluded.

The installation shown for the source 2 is simple and effective, allowing the use of a greater number of cylinders if desired. However, other forms of storage may be used and the auxiliary propellant gas may also be supplied directly from a source of the liquefied gas as the liquid is formed, and allowed by control means such as the simple valves illustrated in the drawings to return to the gaseous state at ambient temperature, with control to lower pressures as described.

Similarly, more elaborate storage for the main fuel than the simple cylinder 14 shown in Figure 1 may be employed. As the main fuel is used up, the cylinders or other containers may be replaced or may be refilled at site. In the case of small-scale plant, the cylinders used are simply replaced by full ones, but, in large plants, it is preferable to refill at site. A stand-by installation is also advisable so that there will not be any interruption in the fuel supply during replacement or refilling.

Although "fuel oil", also known as "reduced crude", is mentioned above, other similar cuts such as "gas oil" fractions obtained by refining crude petroleum beyond kerosene may be used as the main fuel. By "diesel oil" is meant in general a fraction boiling between kerosene and the heavier lubricating oils. Furthermore, although high-boiling, or normally liquid petroleum fractions are preferred, other normally liquid fuels such as synthetic fuels which are normally liquid at ambient temperatures may be used provided that it is possible to propel them simply by using the vapour pressure of the auxiliary gas, and to ignite them after heating to about the ignition temperature as described above.

Instead of water, various aqueous solutions may be used as the barrier liquid 37 in Figure 2. The solutions may be acid or basic, organic or inorganic, provided they are substantially inert to the auxiliary and main fuels.

Although ethylamine has been used as the layer 45 in Figure 3, various other amines having a specific gravity of 0.8 or below and a boiling point not lower than 14° C may be

used, for example ethyl-, propyl-, butyl-, and amyl-amines, butyl-di-amylamine, dibutylamine and dipropylamine. The specific gravity of the amine used should be lower than that of the main fuel. The amines are either immiscible or only very slightly miscible with petroleum products.

Synthetic plastic material with fine pores is preferably used for the plate 49 in Figure 4, but a natural or synthetic rubber with fine pores may be used instead. Similarly, the liner 53 in Figure 5 may be composed of a rubber.

It will be noted that the equipment required for the fuel supply system described above by way of example is of the simplest kind. Thus, except possibly in the arrangement of Figure 2, only very simple connections are provided for the source 3, and in all cases ordinary cylinders in the desired number may be used for the storage and supply of the main fuel. The same applies to the source 2. Similarly, the conduit system consisting of the lines 11, 17 and 22 is of a simple nature, and, apart from the pressure-regulating valves 12 and 23, the temperature control valves 18 and 25 and the check valve 55, only inexpensive shut-off valves are needed.

WHAT I CLAIM IS:—

1. A method of supplying a liquid fuel to an oil burner in which the fuel is propelled to the burner by exerting thereon the pressure developed by a liquefied fuel gas which is allowed to vaporise at the prevailing ambient temperature, and in which the pressure of the vapour resulting from this vaporisation is controlled to a value below its normal vapour pressure at the prevailing ambient temperature.

2. A method of operating an oil burner with a normally liquid, main fuel, in which method an auxiliary fuel consisting of a liquefied gaseous fuel is allowed to vaporise at the prevailing ambient temperature and to exert its vapour pressure at this temperature upon the main fuel so as to propel the main fuel to the burner, the auxiliary fuel being used to supply sufficient heat to the burner to allow vaporisation and ignition of the main fuel therein, and in which the pressure of the auxiliary fuel vapour is controlled to a value below its normal vapour pressure at the prevailing ambient temperature.

3. A method as claimed in Claim 2 in which the auxiliary fuel acts directly upon the main fuel.

4. A method as claimed in Claim 2 in which a solid body or a liquid layer is interposed between the main and auxiliary fuels so as to prevent direct contact therebetween whilst allowing the pressure of the auxiliary fuel to be exerted upon the main fuel.

5. A method as claimed in Claim 4 in which a layer of water, or of an aqueous solution which is substantially inert to the auxiliary and main fuels, is interposed between the auxiliary and main fuels.

6. A method as claimed in Claim 4 in which a layer of an amine with a specific gravity of 0.8 or below and a boiling point not lower than 14° C. is interposed between the auxiliary and main fuels.

7. A method as claimed in Claim 4 in which a plate with fine pores composed of a synthetic plastic material is interposed between the auxiliary and main fuels.

8. A method as claimed in Claim 4 in which a liner or diaphragm composed of a natural or synthetic rubber or other elastomer is interposed between the auxiliary and main fuels.

9. A method as claimed in any of Claims 2 to 8 in which the main fuel is vaporised within the burner and the auxiliary fuel heats the vaporised main fuel either from outside the burner or through combustion in heating means within the burner.

10. A method as claimed in any of Claims 2 to 8 in which the main fuel is atomised in the burner and the resulting atomised liquid is raised to a sufficiently high temperature for ignition by internal or external heating means which are fed by the auxiliary fuel.

11. A fuel supply system for an oil burner which system includes a source of a normally liquid fuel constituting the main fuel of the system, a source of a liquefied gaseous fuel constituting a costlier auxiliary fuel, first conduit means for supplying the main fuel to the burner, second conduit means for supplying the auxiliary fuel to internal auxiliary combustion means for vaporising the main fuel when this is supplied to the burner inlet and heating said main fuel to the ignition point thereof, and third conduit means connecting the auxiliary fuel source to the main fuel source, valve means being provided in the third conduit means for allowing the pressure of the vapour of the auxiliary fuel to be exerted upon the main fuel, either directly or indirectly, so as to propel the main fuel through the first-conduit means to the burner, and check valve means being provided in the second conduit means.

12. A method of supplying a liquid fuel to an oil burner substantially as hereinbefore described with reference to Figure 1, or to Figure 1 as modified by Figure 2, or by any of Figures 3 to 5 of the accompanying drawings.

13. A fuel supply system for an oil burner

used, for example ethyl-, propyl-, butyl-, and amyl-amines, butyl-di-amylamine, dibutylamine and dipropylamine. The specific gravity of the amine used should be lower than that of the main fuel. The amines are either immiscible or only very slightly miscible with petroleum products.

Synthetic plastic material with fine pores is preferably used for the plate 49 in Figure 4, but a natural or synthetic rubber with fine pores may be used instead. Similarly, the liner 53 in Figure 5 may be composed of a rubber.

It will be noted that the equipment required for the fuel supply system described above by way of example is of the simplest kind. Thus, except possibly in the arrangement of Figure 2, only very simple connections are provided for the source 3, and in all cases ordinary cylinders in the desired number may be used for the storage and supply of the main fuel. The same applies to the source 2. Similarly, the conduit system consisting of the lines 11, 17 and 22 is of a simple nature, and, apart from the pressure-regulating valves 12 and 23, the temperature control valves 18 and 25 and the check valve 55, only inexpensive shut-off valves are needed.

WHAT I CLAIM IS:—

1. A method of supplying a liquid fuel to an oil burner in which the fuel is propelled to the burner by exerting thereon the pressure developed by a liquefied fuel gas which is allowed to vaporise at the prevailing ambient temperature, and in which the pressure of the vapour resulting from this vaporisation is controlled to a value below its normal vapour pressure at the prevailing ambient temperature.

2. A method of operating an oil burner with a normally liquid, main fuel, in which method an auxiliary fuel consisting of a liquefied gaseous fuel is allowed to vaporise at the prevailing ambient temperature and to exert its vapour pressure at this temperature upon the main fuel so as to propel the main fuel to the burner, the auxiliary fuel being used to supply sufficient heat to the burner to allow vaporisation and ignition of the main fuel therein, and in which the pressure of the auxiliary fuel vapour is controlled to a value below its normal vapour pressure at the prevailing ambient temperature.

3. A method as claimed in Claim 2 in which the auxiliary fuel acts directly upon the main fuel.

4. A method as claimed in Claim 2 in which a solid body or a liquid layer is interposed between the main and auxiliary fuels so as to prevent direct contact therebetween whilst allowing the pressure of the auxiliary fuel to be exerted upon the main fuel.

5. A method as claimed in Claim 4 in which a layer of water, or of an aqueous solution which is substantially inert to the auxiliary and main fuels, is interposed between the auxiliary and main fuels.

6. A method as claimed in Claim 4 in which a layer of an amine with a specific gravity of 0.8 or below and a boiling point not lower than 14° C. is interposed between the auxiliary and main fuels.

7. A method as claimed in Claim 4 in which a plate with fine pores composed of a synthetic plastic material is interposed between the auxiliary and main fuels.

8. A method as claimed in Claim 4 in which a liner or diaphragm composed of a natural or synthetic rubber or other elastomer is interposed between the auxiliary and main fuels.

9. A method as claimed in any of Claims 2 to 8 in which the main fuel is vaporised within the burner and the auxiliary fuel heats the vaporised main fuel either from outside the burner or through combustion in heating means within the burner.

10. A method as claimed in any of Claims 2 to 8 in which the main fuel is atomised in the burner and the resulting atomised liquid is raised to a sufficiently high temperature for ignition by internal or external heating means which are fed by the auxiliary fuel.

11. A fuel supply system for an oil burner which system includes a source of a normally liquid fuel constituting the main fuel of the system, a source of a liquefied gaseous fuel constituting a costlier auxiliary fuel, first conduit means for supplying the main fuel to the burner, second conduit means for supplying the auxiliary fuel to internal auxiliary combustion means for vaporising the main fuel when this is supplied to the burner inlet and heating said main fuel to the ignition point thereof, and third conduit means connecting the auxiliary fuel source to the main fuel source, valve means being provided in the third conduit means for allowing the pressure of the vapour of the auxiliary fuel to be exerted upon the main fuel, either directly or indirectly, so as to propel the main fuel through the first conduit means to the burner, and check valve means being provided in the second conduit means.

12. A method of supplying a liquid fuel to an oil burner substantially as hereinbefore described with reference to Figure 1, or to Figure 1 as modified by Figure 2, or by any of Figures 3 to 5 of the accompanying drawings.

13. A fuel supply system for an oil burner

* C L M S *

substantially as hereinbefore described with reference to Figure 1, or to Figure 1 as modified by Figure 2, or by any of Figures 3 to 5 of the accompanying drawings.

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B.K.

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