

March 19, 1963

M. A. WEISS

3,081,948

OIL BURNER SYSTEM

Filed Dec. 1, 1960

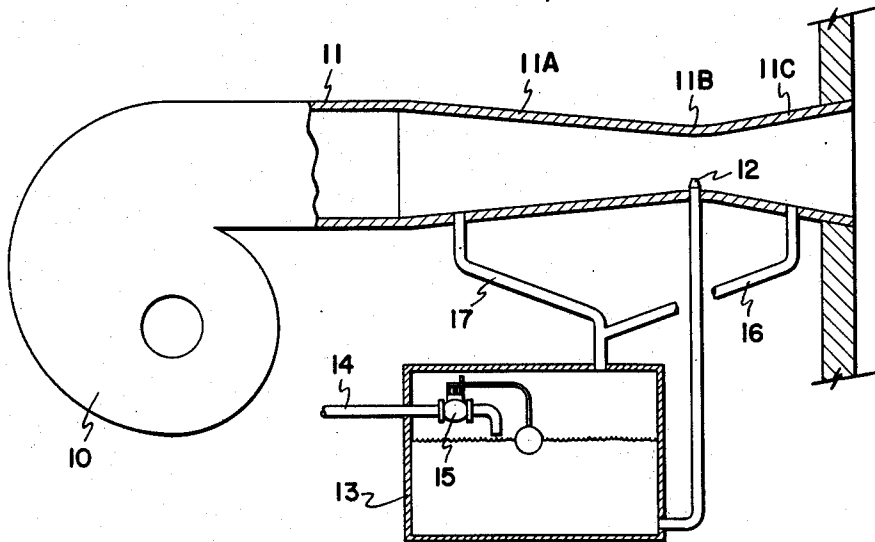


FIGURE 1

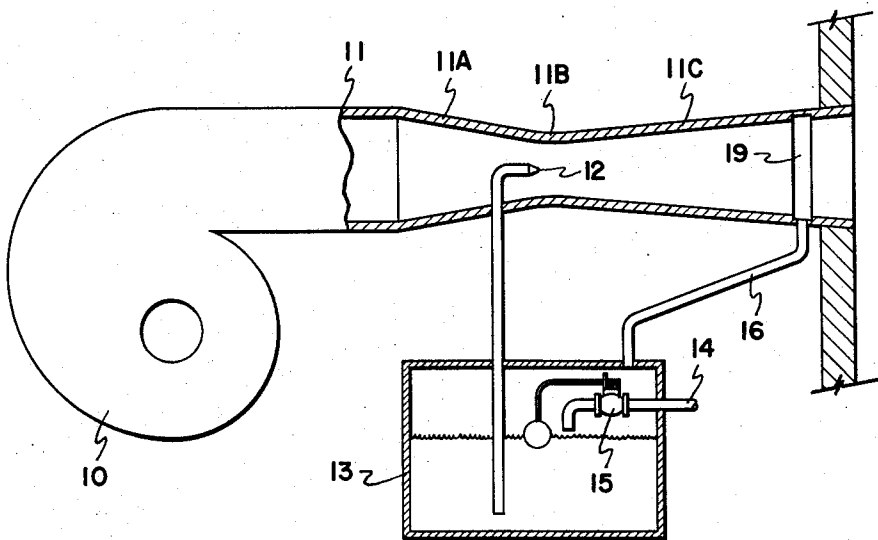


FIGURE 2

Malcolm A. Weiss INVENTOR

BY *Olin B. Johnson*

PATENT ATTORNEY

1

3,081,948

OIL BURNER SYSTEM

Malcolm A. Weiss, Union, N.J., assignor to Esso Research and Engineering Company, a corporation of Delaware

Filed Dec. 1, 1960, Ser. No. 73,031

5 Claims. (Cl. 239—369)

This invention relates to apparatus and methods employed in the burning of hydrocarbons, i.e. to a novel feed system for hydrocarbon burners and to an improved method for controlling the flow of hydrocarbons to a combustion device. This invention is particularly adapted to the burning of liquid hydrocarbons in connection with domestic heating plants.

More particularly, this invention is concerned with novel apparatus and methods for controlling the air-fuel ratio to a combustion chamber of an oil burner employing venturi atomization.

In conventional combustion devices, fuel and combustion air are customarily introduced separately and the resulting mixture subjected to burning in a combustion or flame chamber. In systems of this type the absence of a direct and continuous control of the fuel to air ratio fed to the combustion chamber often results in large local variations in such ratio in such chamber causing a needless waste of fuel due to improper mixing and incomplete combustion with an undesirable incidence of smoke and attendant hazards unless large amounts of excess air are used.

It is one object of this invention to provide a simplified oil feed system that will provide oil burners less sensitive to fuel quality than conventional gun burners, require a minimum of maintenance and afford a maximum of control of the air-fuel ratio throughout the combustion zone. It is another object to provide an oil burner system capable of effecting efficient smokeless combustion in a minimum of combustion chamber volume. It is another object of this invention to provide an oil burner system which does not require a high pressure fuel pump as is customarily needed, and to eliminate the customary nozzle with small passages which tend to clog and erode. It is another object of this invention to provide a controlled method of feeding oil and air to a combustion chamber which method allows complete modulation at an automatically controlled constant air-fuel ratio. It is a further object of this invention to provide a device for controlling oil feed to a combustion chamber at a rate dependent solely upon the air flow to such chamber.

In the instant invention the air to be used in the combustion chamber is blown through an area of converging diameter thereby increasing the velocity of flow and decreasing static pressure in proximity with a fuel inlet conduit from whence fuel is drawn into the air stream, atomized, and passed with the air through an area of divergence thereby increasing static pressure before passage into the combustion zone. Thus, the fuel which is introduced in the throat of the venturi is thoroughly atomized and intimately mixed with the air passing to the combustion zone assuring efficient combustion with a minimum excess of air. This in turn allows for a minimum chamber volume for combustion. Fuel is sucked into the venturi throat through a small feed line or inlet nozzle line from an auxiliary fuel container. The fuel inlet tube is preferably shaped so as to converge toward the mouth or end emptying into the venturi of the main feed pipe. The minimum area of this convergence, the diameter and length of the feed line, and the height of the end of this line above the liquid level in the auxiliary fuel container are all preferably chosen such that the pressure drop of the oil stream across the con-

2

vergence is large in comparison with the pressure loss in the feed line due to friction and in comparison with the pressure due to the liquid head corresponding to the difference in height between the end of the line and the level in the fuel container. The fuel container is back-
5 pressured by the air stream static pressure either upstream of the converging section or downstream of all or most of the diverging section so as to essentially equate the pressure drop across the end of the fuel inlet to the pressure drop across the venturi. Since air mass flow varies as the square root of the venturi pressure drop, and liquid mass flow varies as the square root of the pressure drop across the end of the fuel line, and these two pressure drops are equal, then the ratio of air mass flow to fuel mass flow must be constant for any reasonable air mass flow. Therefore, by varying the rate of air supply, for example by varying the air blower speed, modulation results with automatically constant air/fuel ratio.

Fuel may be supplied to the auxiliary fuel container
10 either by gravity feed or by a low-pressure fuel pump which may be clutch-coupled to the air blower shafts. It is only necessary to maintain a small head of liquid in the container.

At or near the end of the venturi, immediately before
15 entry of the air-fuel mixture into the combustion chamber, means are preferably provided for returning to the auxiliary fuel container liquid fuel that may be deposited on the walls of the venturi. This means may consist of a circular slot, rim, or porous or perforated section in the wall of the venturi whose bottom-most part is connected
20 by a return line to the fuel container. This line may also serve to back-pressure the fuel in the container.

The invention will be more easily understood by referring to the accompanying drawings.

FIGURE 1 represents a semi-diagrammatic illustration of one embodiment of the inventive feed system wherein the fuel inlet is directed perpendicular to principal direction of air flow and positioned nearer to the combustion
25 chamber than to the blower or other air pressuring device.

FIGURE 2 represents a modification of the feed system of FIGURE 1 wherein fuel inlet is directed parallel to the principal direction of air flow and positioned nearer to the blower than to the combustion chamber.

In FIGURE 1, an air driving means or blower 10, e.g.
30 a motor driven fan enclosed in a housing, communicates with a main feed tube so as to admit of a flow of air from blower 10 through the enclosure formed by tube 11. The tube 11 comprises a venturi tube, i.e. a tube converging through a first extension 11A toward a length or point of constriction, the throat of the venturi 11B, which in turn leads into a diverging extension 11C. At the end opposite blower 10 tube 11 empties into a combustion chamber, not shown. At the throat of the venturi is positioned fuel inlet tube 12 which communicates with
35 auxiliary fuel tank 13. Fuel is introduced into tank 13 via pipe 14. Gravity feed through pipe 14 is controlled by a float valve 15. Optionally a low pressure fuel pump may be employed, if desired. Air driven by blower 10 through tube 11 upon passing into venturi throat 11B is accelerated in velocity resulting in a decrease in static pressure causing fuel to be sucked from fuel inlet tube 12 into the air stream passing through throat 11B where such fuel is atomized, intimately mixed with such air stream and carried on into the combustion chamber. Any
40 excess fuel entering throat 11B which is not atomized and carried out by the air stream is returned by tubes 16 and 17 which in turn communicate with fuel tank 13 and may in addition serve as a pressure balance mechanism for the entire feed system.

FIGURE 2, which illustrates a preferred embodiment of the invention, is a modification of FIGURE 1 demonstrating the flexibility of design within the scope of this

invention. In FIGURE 2, a fuel collecting slot 19 about the interior wall of tube 11 is shown feeding into fuel return tube 16.

In operation, such a device may be designed to provide for oil feed rates in the range of about 0.1 to 2 gallons per hour. If the oil feed line converges at its exit, the minimum inside diameter of the convergence should be 1 to 15% of the diameter of the throat of the venturi, and preferably 3 to 7%. Additionally, this minimum diameter should be no larger than one-third of the inside diameter of the oil feed line, which is preferably in the range of $\frac{1}{16}$ " to $\frac{1}{4}$ ". The length of the oil feed line should be as short as practicable, preferably not exceeding 2 feet. The exit of this line should be at least one inch but preferably not more than 12 inches above the oil level in the auxiliary fuel container.

The air velocity in the throat of the venturi is preferably in the range of 150 to 500 feet/sec. but may extend outside of this range if higher degrees of modulation are necessary. The diameter of the throat is such that, at these velocities, at least enough mass of air will be passed to combine stoichiometrically with the oil fed but preferably not enough to exceed 150% of the stoichiometric requirement. In regard to rates and degrees of convergence and divergence, the venturi should be designed in accordance with the well-known standards of good practice. Introduction of the fuel line into the venturi should cause the minimum practicable obstruction and disturbance of the air flow.

The following example is offered for purposes of illustration and should not be considered as a limitation upon the true scope of the invention as set forth in the claims.

Example 1

A fuel feed system designed in accordance with FIGURE 2 is connected with a combustion chamber. The air driving means is powered to deliver about 1500 standard cubic feet of air per hour through a throat diameter of about 0.5 inch at a throat velocity of about 300 feet/sec. The total pressure requirement from the air driving means is equivalent to about 4 inches H_2O above atmospheric pressure and the theoretical power required for air compression is about 0.015 horsepower. The fuel oil, typically a No. 2 heating oil with a specific gravity of about 0.85, is drawn into the venturi throat from a fuel line with a minimum inner convergence diameter of about 0.025 inch under the above conditions at a firing rate of about 1 gallon per hour. The pressure differential between the surface of the fuel in the fuel container and the throat of the venturi is about 18 inches H_2O . Operating under the above described conditions, the fuel oil is delivered in a spray to the combustion chamber with a mass median drop size of about 20-40 microns.

This demonstrates advantages afforded by the feed system of this invention in the following particulars: First, the power requirements are such that the motor for driving the air fan could be smaller than those employed in conventional systems. Note there would be no motor load resulting from fuel pumping requirements at the usual high pressures. Second, the atomization effected, which is more than adequate for clean burning in view of the good air fuel mixture, could be improved to afford even smaller drop sizes by an increase in throat velocity. Third, the excellent control of fuel/air ratio and mixing allows use of a smaller combustion chamber than usual without loss of efficient smokeless burning. Third, the venturi would automatically reduce startup and shutdown smoke without employing a clutch on the motor since the oil is not delivered to the venturi throat unless the air velocity is brought near to the normal operating level. Fourth, there are no rotating parts other than the air blower and no small passages in the fuel line to clog or

erode so that maintenance and replacement of parts are minimized. Fifth, the air/fuel ratio can be held constant automatically at varying air rates. Thus, the burner output can be modulated by simply changing the air rate without disturbing this ratio. Finally, any problem of droplet deposition on the venturi walls is easily handled by a collecting slot and oil return line which can also be employed to effect pressure balance.

What is claimed is:

1. An apparatus for feeding an oil and air mixture to a combustion zone, said apparatus comprising (1) a feed tube of varying internal diameter having a first end, a second end of inside diameter approximately the same as that of said first end, and a constricted region intermediate its first and second ends of inside diameter appreciably smaller than that of either of its ends, the internal surface of said tube converging smoothly from its first end to its constricted region and diverging smoothly from its constricted region to its second end, and said tube being connected at its second end to a combustion zone, (2) a closed vessel for holding an oil supply, said vessel being not more than a small distance below the constricted region of said feed tube, (3) means communicating with said vessel for maintaining a supply of oil therein (4) an oil conduit having an inlet end communicating with said vessel near the bottom thereof and an outlet end communicating with said feed tube within the constricted region thereof, said conduit having a generally uniform inside diameter but converging locally internally toward its outlet end to an inside diameter thereat which is not less than 1% and not more than 15% of the inside diameter of the constricted region of said feed tube, and not more than one third of its own generally uniform inside diameter, (5) pressure balance conduit means having one end communicating with said vessel near the top thereof and at least one other end communicating with said feed tube at a point closely adjacent one of the ends of said tube, and (6) air blowing means connected to said feed tube at the first end thereof and adapted to discharge air into said tube at its first end.

2. An apparatus according to claim 1 in which the inside diameter of said oil conduit at its outlet end is not less than 3% and not more than 7% of the inside diameter of the constricted region of said feed tube.

3. An apparatus according to claim 1 in which the generally uniform inside diameter of said oil conduit is not less than $\frac{1}{16}$ inch and not more than $\frac{1}{4}$ inch.

4. An apparatus according to claim 1 in which the length of said oil conduit is not more than 2 feet.

5. An apparatus according to claim 1 in which said means communicating with said vessel for maintaining a supply of oil therein is adapted to maintain that supply at a controlled level, and the outlet end of said oil conduit is not less than 1 inch and not more than 12 inches above that level.

References Cited in the file of this patent

UNITED STATES PATENTS

980,801	Kraus	Jan. 3, 1911
1,208,341	Loftus	Dec. 12, 1916
1,267,760	Good	May 28, 1918
1,820,774	Boyce	Aug. 25, 1931
1,875,729	Hermann	Sept. 6, 1932
2,267,451	Eweryd et al.	Dec. 23, 1941
2,589,559	Lebeda	Mar. 18, 1952
2,861,838	Wyatt et al.	Nov. 25, 1958

FOREIGN PATENTS

12,808	Great Britain	1913
415,733	Great Britain	Aug. 27, 1934
957,200	France	Aug. 22, 1949