June 23, 1964 J. L. HAGERMAN 3,138,193

COMBUSTION OF LIQUID FUEL

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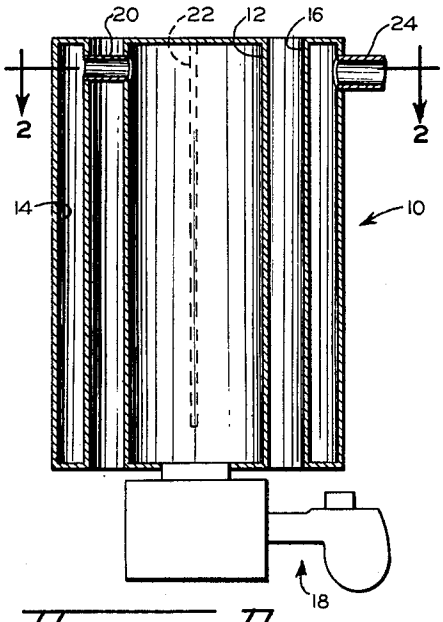


Fig. 1.

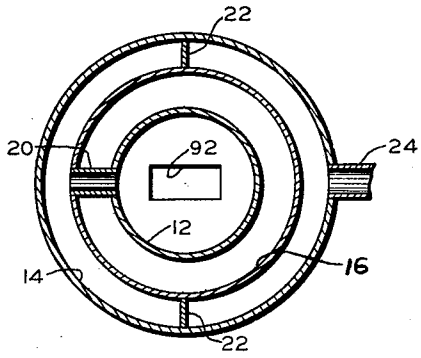


Fig. 2.

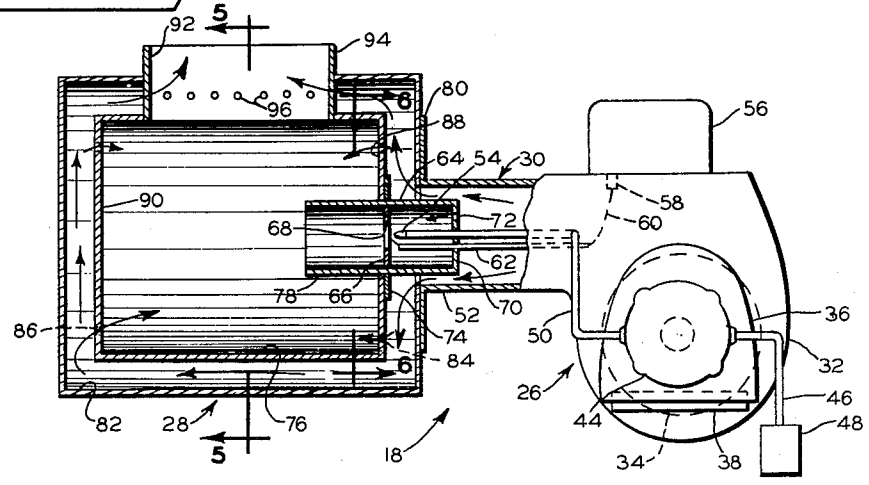


Fig. 3.

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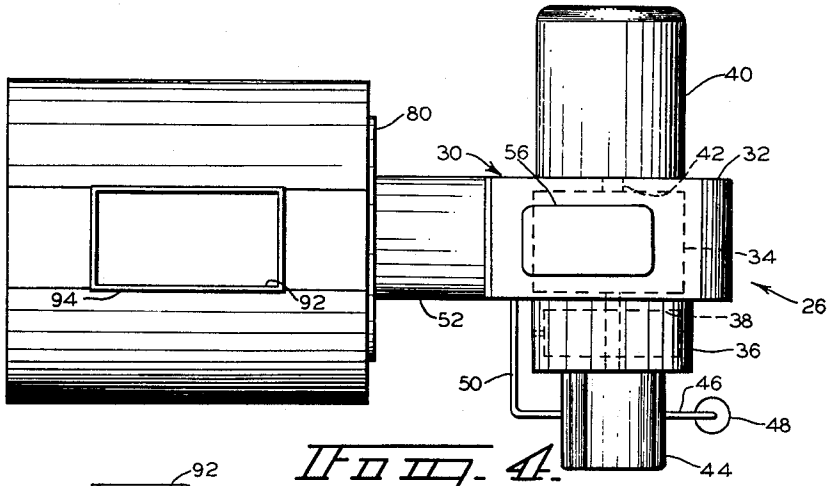


Fig. 4.

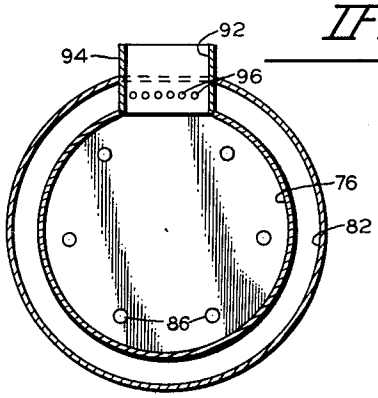


Fig. 5.

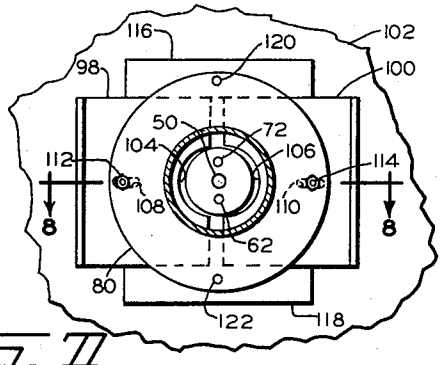


Fig. 7.

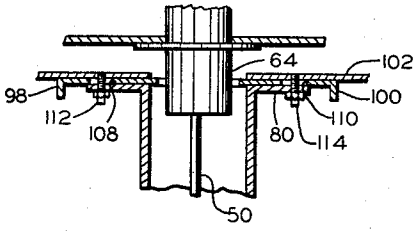


Fig. 8.

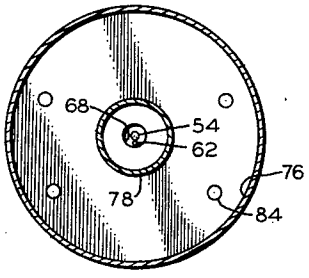


Fig. 6.

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COMBUSTION OF LIQUID FUEL

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5 Claims. (Cl. 158—4)

This invention relates to an improvement in the combustion of liquid fuel, particularly oil, and to an improved apparatus for burning liquid fuel.

Liquid fuel burners of an almost infinite number of types are known in the art. However, the use of liquid fuels has been decreasing over the years because of the lower cost of gaseous fuels and because the gaseous fuels tend to burn more cleanly.

The present invention provides an improvement in the combustion of liquid fuel by means of which improvement fuel is consumed more effectively and more completely, which renders combustion thereof cleaner and enables the utilization of more energy or heat therefrom.

It is, therefore, a principal object of the invention to provide an improved liquid fuel burner for burning liquid fuel by means of which the fuel is utilized more thoroughly and completely.

Another object of the invention is to provide an apparatus for burning liquid fuel which enables more usable heat to be obtained therefrom.

Additional objects of the invention will be discussed below, and other objects of the invention will be apparent from the following discusison of a preferred embodiment of the invention and a modification thereof, reference being made to the accompanying drawings, in which:

FIG. 1 is a somewhat schematic view, partly in cross section, of a domestic warm air furnace utilizing a burner embodying the principles of the invention;

FIG. 2 is a view in cross section taken along the line 2—2 of FIG. 1.

FIG. 3 is an enlarged side view, with parts broken away and with parts in vertical cross section, of the burner of FIG. 1;

FIG. 4 is a top plan view of the burner of FIGS. 1 and 3;

FIG. 5 is a view in cross section taken along the line 5—5 of FIG. 3;

FIG. 6 is a view in cross section taken along the line 6—6 of FIG. 3;

FIG. 7 is a view in elevation, with parts in cross section, of a portion of a modified burner embodying the principles of the invention; and

FIG. 8 is a view in horizontal cross section taken along the line 8—8 of FIG. 7.

A burner according to the invention is described in combination with a domestic warm air furnace, as shown in FIGS. 1 and 2. It is to be clearly understood, however, that the burner according to the invention can be used in an almost unlimited number of applications and is not to be limited at all to the furnace as shown. A warm air furnace 10 includes an inner heating chamber 12, and an outer, annular heating chamber 14, between which chambers is an annular warm air passage 16 through which air flows and which receives heat from the walls of both of the chambers 12 and 14. The resulting hot air is then transferred by suitable duct work to rooms in a building being heated by the furnace 10. Heat for the furnace 10 is supplied by a liquid fuel burner 18 embodying the principles of the invention, the products of combustion of which are ejected from the burner into the chamber 12 from which they flow though a connecting pipe 20 to the outer, annular chamber 14. After entering the chamber 14, the gases flow therearound and downwardly below baffles 22, and finally out a flue pipe 24.

Referring more particularly to FIGS. 3–6, the burner 18 is divided into two basic parts, a liquid fuel and air supply unit 26 and a combustion unit 28. The supply unit 26 has a casing 30 including a round portion 32 in which is rotatably mounted a centrifugal lower wheel 34 of any suitable, conventional design, and an inlet portion 36 having an open bottom with a damper-type valve 38 for regulating flow of intake air therethrough. The blower 34 is driven by a motor 40 mounted on one side of the casing 30, which motor is connected to a drive shaft 42 extending through the blower 34 and connected to a liquid pump 44 on the other side of the casing, so as to drive both the blower and the pump. An inlet pipe 46 for the pump 44 is connected to a liquid fuel supply 48 and an outlet pipe 50 extends into the casing 30 and centrally through a neck portion 52 thereof to a liquid fuel nozzle 54 (FIGS. 3 and 6) located beyond the end of the neck portion 52.

A transformer 56 (FIGS. 3 and 4), mounted on top of the casing 30, has a terminal 58 connected by a conductor 60 to a conventional ignition electrode 62. A spark is established between the tip of the electrode 62 and the nozzle 54 to ignite droplets of liquid fuel sprayed therefrom.

The nozzle 54 and the tip of the electrode 62 are located in a hollow member 64 behind a partition 66 therein having a central opening 68. The nozzle 54 and the electrode 62 extend through a rear wall 70 of the member 64 which has an orifice 72 therein to receive some of the air from the blower 34. The member 64 also has a flange 74 attached to a wall of an inner combustion chamber 76 of the combustion portion 28 and an extension 78 extending into the chamber 76.

The supply unit casing 30 also has a flange 80 which is attached to a wall of an outer chamber 82 supplying air or other combustion-supporting gas to the chamber 76. The inner chamber 76 is substantially symmetrically located in the outer chamber 82 and has a plurality of ports 84 and 86 in end walls 88 and 90 thereof to receive air from the outer chamber 82. The ports in each end wall are preferably staggered with respect to the ports in the other end wall so that air entering one set of ports will not be aligned with air entering the opposite set. An outlet or exhaust opening 92 is formed in the upper portion of the inner chamber 76 by a wall 94 extending above the outer chamber 82. The wall 94 has a plurality of holes 96 therethrough communicating with the outer chamber 82 to supply air to the opening 92.

In operation, the blower draws air through the lower opening of the inlet portion 36 of the casing 30 and expels it through the neck portion 52. A small portion of this air enters the member 64 through the orifice 72 and the remainder of its flows past the member 64 and through the outer chamber 82 from which it flows into the inner chamber 76 through the ports 84 and 86 and through the upper ports 96. Liquid fuel is pressurized by the pump 44 from the inlet pipe 46 and the supply 48 and is then fed through the outlet pipe 50 to the nozzle 54 from which it is sprayed through the extension 78 and into the inner, combustion chamber 76. The size of the droplets of the spray do not appear to be critical, although the smaller ones burn more rapidly. This liquid is sprayed preferably in a wide pattern having an included angle in the order of 80° so that part of the resulting liquid fuel droplets contact the inner surface of the extension 78. The fuel is ignited by the spark from the electrode 62 and burns with the aid of the air supplied through the orifice 72.

It has been found that the extension 78 is not needed after a relatively short warm-up period and that the burner 18 can be operated without the extension at all, the

only effect being that incomplete burning occurs during the short warm-up period, which may only last for approximately ten seconds.

Most of the liquid fuel droplets issuing from the nozzle **54** travel further into the chamber **76** where they mix with air issuing through the ports **86** and **88** and burn. The streams of air entering through the ports **86** and **88** cause considerable turbulence in the chamber **76** so that the air and fuel therein are thoroughly mixed and burned. An inspection of the chamber **76** indicates that combustion occurs in the extension **78** only during ignition and that otherwise substantially all combustion occurs within the chamber **76** with the flame being more apparent adjacent the air streams entering the ports **84** and **86**, but being spaced from these ports. Consequently, very little unburned fuel passes out the outlet opening **92**, and that which does mixes with additional air supplied through the ports **96** and completes burning before rising to any extent above the wall **94**. Only a whisp of flame is occasionally visible above the upper edge of the wall **94**.

The air flowing through the outer chamber **82** wipes heat from the inner chamber **76** to cause the air to be preheated and at the same time to cool the walls of the chamber **76**. The burning gases within the chamber **76** also tend to be maintained spaced from the walls thereof because of the location of the ports **84** and **86**. Hence, the walls of the chamber **76** remain relatively cool in spite of the high temperatures built up therein.

While the details of operation of the burner **18** are not fully understood, it has been found that a tremendous heat output is obtained from the liquid fuel, beyond that thought possible. Thus, by way of example, with a domestic forced warm air furnace, such as is shown in FIGS. 1 and 2, one quart of fuel oil burned in the new burner will produce a temperature rise of 100° F. in 288 cubic feed of air. In contrast, with an average burner used in the same warm air furnace, a quart of oil will produce a temperature rise of 100° F. for 258 cubic feet of air.

FIGS. 7 and 8 show a slightly modified form of a portion of the burner **18**. As shown, a pair of slidable shutters **98** and **100** are slidably mounted on an end wall **102** of the outer chamber **82**, between the end wall and the flange **80** of the burner casing **30**. The shutters **98** and **100** have inner, semi-circular edges **104** and **106** which are movable into adjustable surrounding relationship to the member **64** to restrict and to regulate flow of air through the annular passage formed between the member **64** and the neck portion **52** of the casing **30**. The shutters **98** and **100** have elongated slots **108** and **110** therein through which bolts **112** and **114** extend, these bolts serving to limit movement of the shutters **98** and **100** in cooperation with the slots **108** and **110**, as well as to maintain the adjusted position of the shutters with respect to the member **64**. At the upper and lower edges of the shutters **98** and **100** are guides **116** and **118** which direct movement of the shutters as well as prevent flow of air outwardly from the neck portion **52** of the casing **30** between the ends of the shutters **98** and **100** and between the end wall **102** and the flange **80**. The guides **116** and **118** are held in place by additional bolts **120** and **122** which also serve to connect the flange **80** to the end wall **102**. The amount of air supplied to the ports **86** and **88** thereby can be regulated by the shutters **98** and **100**, the position of which also affects the amount of air supplied to the orifice **72**.

By way of illustration, details of one specific burner having an output of one-half gallon per hour of No. 2 fuel oil will be set forth. The nozzle **54** of this burner is a Monarch oil nozzle with a capacity of one-half gallon per hour. The pump **44** supplies oil to the nozzle at a pressure of approximately 65 p.s.i. with the oil being emitted in a fine conical spray at an included spray angle of 80°. The blower **34** and the motor **40** supply air in a volume of 80 c.f.m. with a static pressure of approximately ⅛" w.c. in the neck portion **52** of the casing **30**. The orifice **72** has an area of 0.125 square inch and the opening **68** in the partition **66** has a diameter of ⅞". The inner diameter of the neck portion **52** is 3⅞" and the diameter of the member **64** is 3". The member **64** extends rearwardly 3" from the end wall **88** of the inner chamber **76** and the member extension **78** also extends 3" into the inner chamber **76**. The inner chamber **76** is 12" long with a diameter of 10" and has four of the ports **84** in the end wall **88**, each port measuring ¼" in diameter. Six of the ports **86** are provided in the end wall **90**, each port also being ¼" in diameter. All of the ports **84** and **86** are spaced 1" inwardly from the periphery of the end walls **88** and **90** with the closest of the ports being spaced 2" on either side of the lateral extent of the opening **92**. The inner chamber **76** is spaced 1½" from the outer chamber **82** on all sides, the outer chamber being approximately 15" long and 13" in diameter. The discharge opening **92** is rectangular being approximately 4" wide and 8" long, with the wall **94** extending 3" above the wall of the outer chamber **82**. Nine of the ports **96** measuring ⅛" in diameter are uniformly spaced along each of the longitudinal walls of the opening **92** and six of the ports **96** each measuring ⅛" in diameter are uniformly spaced along the lateral walls of the opening, making a total of thirty small air supply ports at this point.

A larger burner having an output of one gallon per hour is substantially similar to the above one but has certain larger dimensions. The oil nozzle **54** is also a Monarch nozzle and has an output rating of one gallon per hour while the pump **44** delivers the oil at a pressure of 100 p.s.i. The blower **34** supplies 9600 cubic feet per hour of air. The size of the neck portion **52** of the casing **30** and the dimensions of the member **64** and its components are the same as above. The inner chamber **76**, in this instance, has a length of 13" and a diameter of 15", with a volume about double that of the chamber used with a one-half gallon input, while the outer chamber **82** has a length of 16" and a diameter of 18". The ports **84** and **86** are arranged the same as above except that they have diameters of 5/16". A spacing of 1½" remains between the chambers, as above. The discharge opening **92** in this instance has a width of 5" and a length of 9" with the ports **96** being of substantially the same diameter and arrangement as above. In both of the above-described burners the walls of the inner chamber **76** and the member **64** are made of stainless steel.

Various modifications of the above described embodiments of the invention will be apparent to those skilled in the art and it is to be understood that such modifications can be made without departing from the scope of the invention, if such modifications are within the spirit and tenor of the accompanying claims.

I claim:

1. A liquid fuel burner comprising wall means forming a generally horizontally disposed, cylindrical combustion chamber having circular end walls with a plurality of spaced ports therein and having a substantially impervious cylindrical wall therebetween, wall means forming a combustion-supporting gas supply chamber spaced around said combustion chamber, a hollow member opening into said combustion chamber centrally through one of said end walls thereof, a liquid fuel nozzle positioned in said hollow member to supply fuel droplets centrally into said chamber, the cylindrical wall of said combustion chamber having a discharge opening spaced from said nozzle and from said end walls, means near said fuel nozzle for igniting fuel in said chamber emitted thereto from said fuel nozzle, means forming a combustion-supporting gas passage for supplying combustion-supporting gas to said hollow member and to said combustion-supporting gas supply chamber, and blower means for supplying combustion-supporting gas to said passage.

2. A burner according to claim 1 wherein said spaced ports in each of the end walls are staggered with respect to the ports in the opposite end wall.

3. A liquid fuel burner comprising wall means forming a generally horizontally disposed combustion chamber having end walls with a plurality of spaced ports therein and having a substantially impervious intermediate wall therebetween, wall means forming a combustion-supporting gas supply chamber spaced around said combustion chamber, a hollow member opening into said combustion chamber centrally through one of said end walls and having an extension extending into said combustion chamber beyond the associated end wall, a liquid fuel nozzle positioned in said hollow member to supply fuel droplets centrally into said chamber, the intermediate wall of said combustion chamber having a discharge opening spaced from said nozzle, means for igniting fuel in said chamber, means forming a combustion-supporting gas passage for supplying combustion-supporting gas to said hollow member to provide primary combustion-supporting gas for liquid fuel from said fuel nozzle, said gas passage means also adapted to supply combustion-supporting gas to said supply chamber, and blower means for supplying combustion-supporting gas to said passage.

4. A burner according to claim 3 characterized by said discharge opening being formed by a wall extending through said gas supply chamber, said discharge opening wall having a plurality of ports formed therein communicating with said gas supply chamber to supply additional combustion-supporting gas to combustion products passing through said discharge opening.

5. A liquid fuel burner comprising wall means forming a combustion chamber having a plurality of spaced ports therein, said combustion chamber having a restricted outlet opening, wall means forming a combustion-supporting gas supply chamber spaced around said combustion chamber, a hollow member having an end opening into said

combustion chamber through a wall thereof, said hollow member being otherwise closed except for an orifice therein located outside said combustion chamber, said hollow member having an annular partition at an intermediate point thereof, said partition having a central opening therein, a fuel nozzle in said hollow member on the side of said annular partition opposite the open end and terminating short of said annular partition and directed toward the open end through said partition opening, fuel supply means connected to said nozzle and extending through said hollow member, means forming a combustion-supporting gas passage encompassing at least a portion of said hollow member located outside said combustion chamber and communicating with said hollow member orifice, said gas passage also communicating with said gas supply chamber, blower means for supplying combustion-supporting gas to said combustion-supporting gas passage, and fuel supply means for supplying liquid fuel under pressure to said liquid nozzle.

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