July 14, 1953 H. B. HOLTHOUSE, SR., ET AL 2,645,278

IGNITION SYSTEM AND MEANS FOR INITIATING COMBUSTION OF FUEL IN A FUEL BURNER

Filed April 20, 1949 2 Sheets-Sheet 1

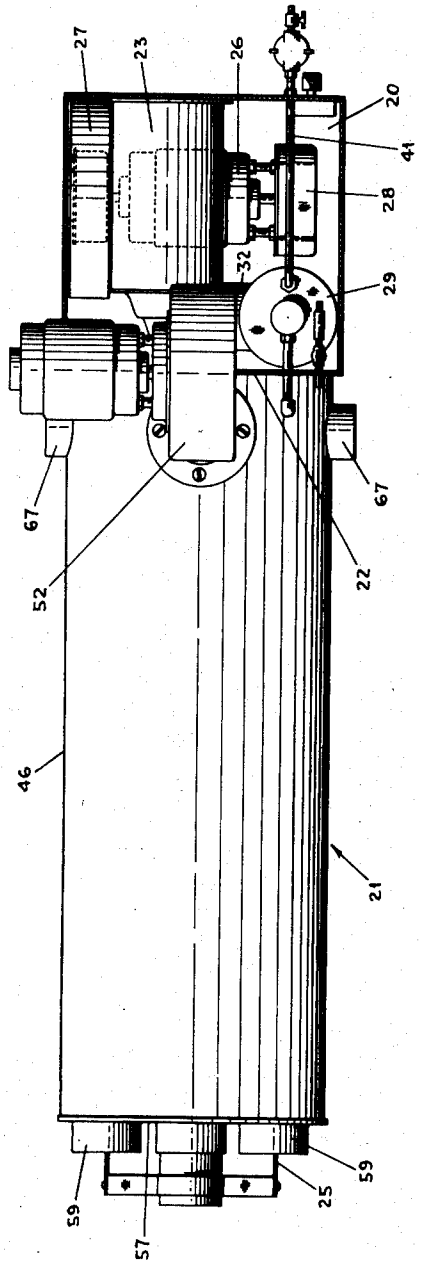


Fig. 2

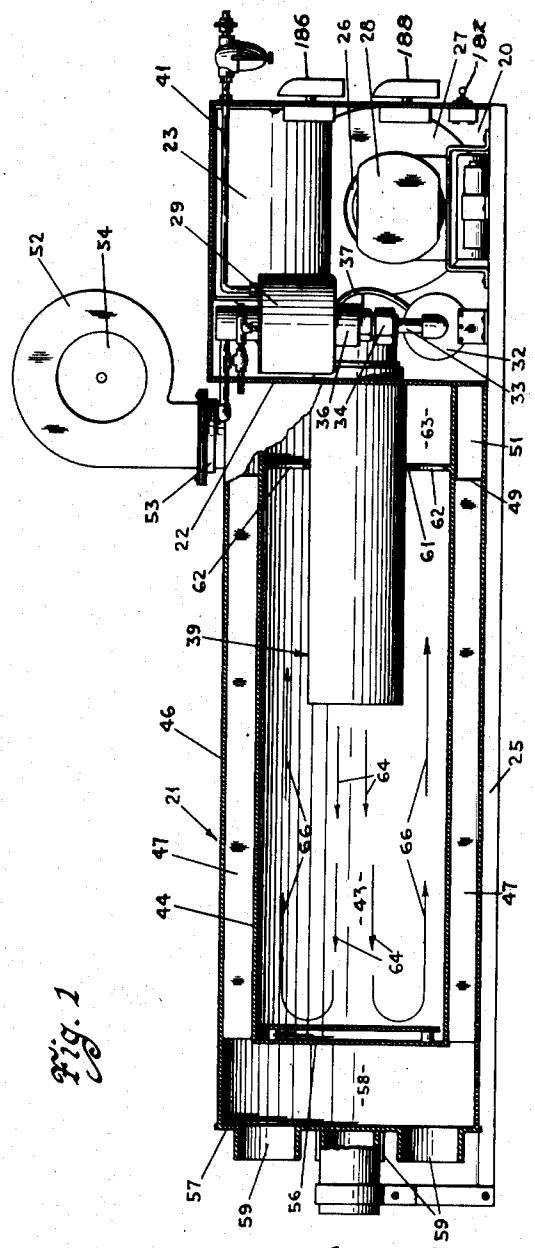


Fig. 1

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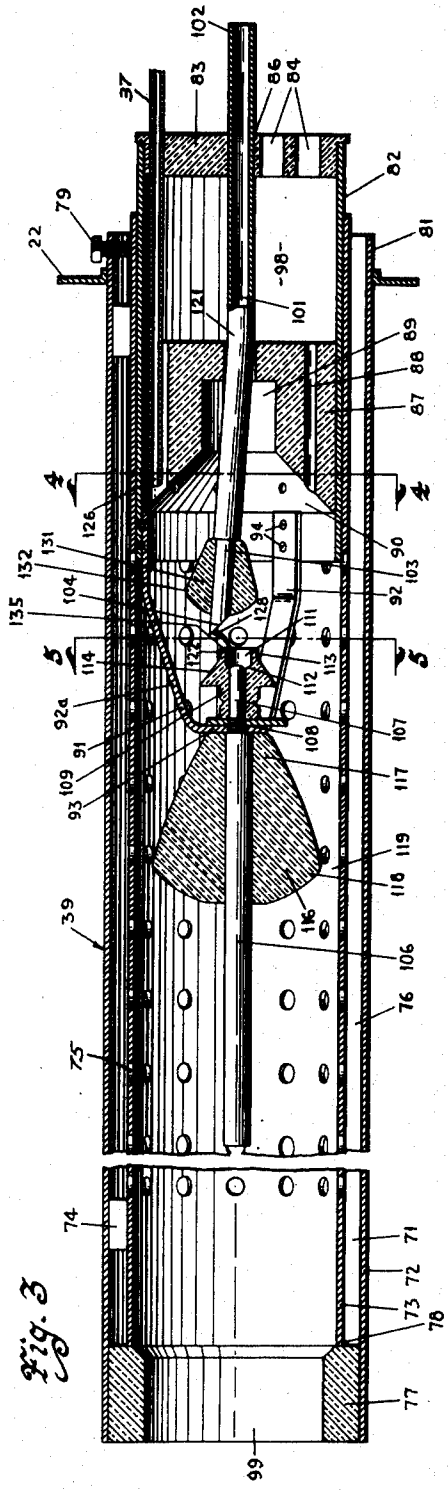


Fig. 3

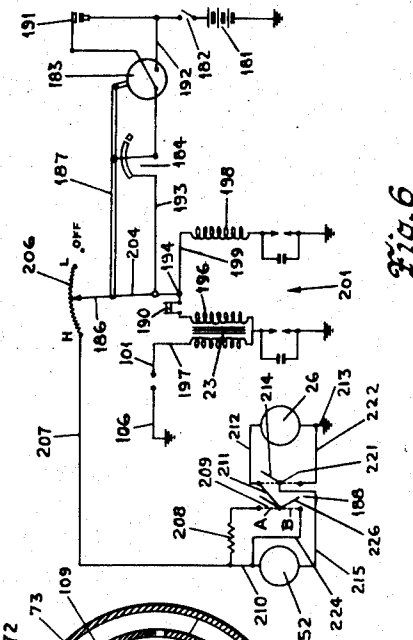


Fig. 6

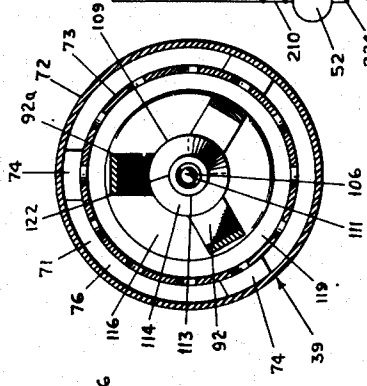


Fig. 5

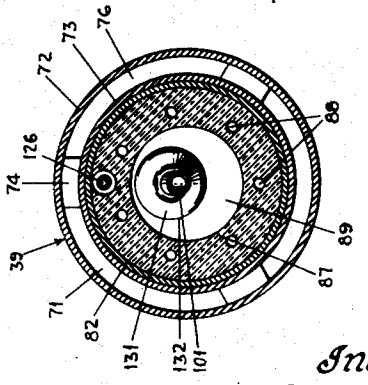


Fig. 4

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UNITED STATES PATENT OFFICE

2,645,278

IGNITION SYSTEM AND MEANS FOR INITIATING COMBUSTION OF FUEL IN A FUEL BURNER

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Application April 20, 1949, Serial No. 88,602

3 Claims. (Cl. 158—28)

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This invention relates generally to space heaters of internal combustion type and in particular to an ignition system and an improved means for initiating ignition or combustion of fuel in a fuel burner.

The ignition system of this invention is adapted to be used in any liquid fuel burner and is particularly applicable in initiating the combustion of fuel in a portable heater capable of operating efficiently under temperatures as low as minus sixty-five degrees Fahrenheit (—650° F.) with an available electrical supply limited to a storage battery having a rating of from twenty-four to twenty-eight volts. Under these operating conditions, and with the fuel as well as the combustion air chilled to minus sixty-five degrees Fahrenheit (—65° F.), considerable difficulties in initiating and then maintaining heater operation are encountered in that both the temperature of the air and the fuel counteract the effective heat developed by the ignition system for igniting purposes. Stated otherwise, with a given ignition heat derived from a source of low electrical output, it is necessary that the air and fuel as well as the heat of ignition, be relatively controlled to provide for the conservation of the ignition heat against dissipation by the cooling effects of the fuel and air, and for the available ignition heat being sufficiently great to initiate a rapid ignition of the fuel.

It is an object of this invention, therefore, to provide an improved system and means for initiating and maintaining combustion in a liquid fuel burner.

Another object of this invention is to provide an ignition system for a fuel burner capable of igniting fuel, such as aviation gasoline or jet oil, under temperature conditions in the neighborhood of minus sixty-five degrees Fahrenheit (—65° F.).

A further object of this invention is to provide an ignition system for a fuel burner which is adapted to initially ignite only a portion of the normal fuel supply to the burner, and then utilize such ignited portion as a pilot flame to ignite the remainder of the fuel supply.

Yet another object of this invention is to provide an ignition system for a fuel burner having an ignition heat of a predetermined value, in which that part of a normal fuel supply to the burner which can be heated and ignited by such ignition heat, is initially directed into the ignition zone of the burner.

A feature of this invention is found in the provision of an ignition system for a fuel burner

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having a fuel line and a source of combustion air, in which an arc discharge between a pair of electrodes is shielded from the cooling effects of the combustion air, and the heat developed by the arc is concentrated or localized in a zone between the electrodes. A part of the normal fuel supply to the burner is fed into the zone of localized heat and ignited, with this ignited fuel part then being directed into the remaining portions of the fuel supply to ignite the same, whereby to function as a pilot flame relative to such remaining fuel portions.

Further objects, features and advantages of this invention will become apparent from the following description when taken in connection with the accompanying drawings, in which:

Fig. 1 is a longitudinal sectional view of a space heater of internal combustion type embodying the ignition system of this invention, with parts of the heater being broken away and other parts being in elevation to more clearly show its construction;

Fig. 2 is a plan view of the heater shown in Fig. 1 with certain parts removed for the purpose of clarity;

Fig. 3 is an enlarged longitudinal sectional view of the burner unit, which is shown generally in Fig. 1;

Figs. 4 and 5 are sectional detail views of the burner unit of the heater as seen on the lines 4—4 and 5—5, respectively, in Fig. 3; and

Fig. 6 is a diagrammatic showing of an electrical circuit for the ignition system of this invention.

With reference to the drawings, the ignition or combustion system of this invention is illustrated in Figs. 1 and 2 in assembly relation with a space heater having a motor compartment **20** and a heat exchange unit **21** extended horizontally from one side **22** of the motor compartment. A base or stand for the heater is indicated at **25**.

Suitably arranged within the motor compartment is an ignition unit or coil **23**, a motor **26**, and a combustion air blower **27** which is operated from the motor **26**. The blower **27** has an inlet (not shown) open to the atmosphere, and an outlet (not shown) open to the motor compartment **20**. On operation of the blower **27**, therefore, air is supplied to the compartment **20** under pressure so that the motor compartment constitutes an air pressure chamber for a purpose to appear later. A cam and breaker assembly (not shown), which forms part of the heater ignition system, is carried within a housing **28** and is operated by the blower motor **26**.

The burner fuel system includes a fuel-metering unit 29, arranged near the top of the motor compartment 20, and a pump 32 positioned below the fuel-metering unit. The pump inlet 33 is arranged in an upright position within the compartment 20, and is connected by a suitable coupling 34 with the outlet 36 of the fuel-metering unit. The outlet of the pump 32 (not shown) is connected with a fuel line 37 which extends within the burner, designated generally at 39. Fuel from a suitable source, located outside of the compartment 20, is supplied to the fuel-metering unit 29 through a fuel supply line 41.

The burner 39 is carried in the side wall 22 of the motor compartment 20, and extends outwardly therefrom into a combustion chamber 43 formed within the heat-exchange unit 21. The heat-exchange unit 21 is of a generally cylindrical shape, and the burner 39 is arranged centrally thereof. Spaced about the peripheral wall or casing 44 of the combustion chamber 43, and between such wall and the outer shell 46 of the heat exchange unit, is a series of heat-radiating fins 47, the rearward ends 49 of which are spaced from the motor compartment side wall 22 so as to form an annular air manifold 51 between the rear end of the combustion chamber wall 44 and the shell 46. The air manifold 51 is common to all of the air passages formed between adjacent fins 47. A circulating air blower 52 is carried on the top side of the shell 46 at a position to provide for the blower outlet 53 being in open-fluid communication with the air manifold 51. The inlet 54 of the air circulating blower 52 is open to the atmosphere.

The fins 47 terminate at the forward end wall 56 of the combustion chamber 43 and the shell 46 extends beyond such forward end wall 56 to a forward end wall 57 of the heat-exchange unit 21. An air pressure equalizing chamber 58 is thus formed by the forward end walls 56 and 57 of the combustion chamber and the heat-exchange unit, respectively, and the shell 46. The equalizing chamber 58 has a plurality of outlets 59, open to the atmosphere, and provided in the end wall 57 of the heat-exchange unit.

Spaced outwardly from the side wall 22 of the motor compartment 20 and at a position between the combustion chamber wall 44 and the burner 39 is an upright annular flat ring 61 which is formed with a series of exhaust openings 62 so that an annular exhaust manifold 63, concentrically arranged relative to the air manifold 51, is defined by the ring 61, side wall 22 and the inner ends of the combustion chamber wall 44 and the burner 39. The exhaust gases from the burner 39 pass outwardly therefrom, as indicated by the arrows 64 in Fig. 1, centrally of the combustion chamber 43, and upon striking the combustion chamber end wall 56 are deflected and turned to flow in a reversed direction, as indicated by the arrows 66, for flow through the exhaust ports 62, into the exhaust manifold 63 and outwardly from the exhaust manifold through a pair of oppositely arranged exhaust outlets 67.

The burner 39 (Figs. 3, 4 and 5) is formed with a hollow tubular side wall 71 comprised of a pair of metal tubes 72 and 73 which are maintained in a spaced-concentric relation by spacer members 74 so as to form an air passage 76 therebetween. The forward end of the outer tube 72 carries an annular insert 77 composed of a ceramic material. This insert constitutes a stop adapted for abutting engagement with the forward end 78 of the inner tube 73, which is held in abutting engagement against the member 77 by a lock screw 79 threadably mounted at the rear end of the outer tube 72 for frictional engagement with the inner tube 73.

Mounted within the rear end 81 of the burner side wall 71 is a metal sleeve insert 82 which is provided at its rear end with an end wall 83 of a ceramic material formed with air openings 84 and an electrode opening 86. Arranged within the sleeve or insert 82, in an outwardly spaced relation with the end wall 83, is an end wall 87, also composed of a ceramic material, and formed with a circular row of air passages 88. The forward side of the end wall 87 is formed with a rearwardly extended tapered cavity 90 which terminates in an axial bore 89, with the air passages 88 being arranged about the bore 89 and terminating in the tapered surface or cavity 90. A spider or bracket 91 of an open construction is integrally constructed with three legs 92 having a common base or body member 93. The free ends of the legs 92 are secured as by screws 94 to the inside of the metal insert 82 at a position forwardly of the ceramic end wall 87 and constitute a stop for such end wall.

The rear end 81 of the burner 39 is positioned within an opening formed in the side wall 22 of the motor compartment 20 such that the rear end of the air passage 76 and the end wall 83 are located within the motor compartment or air pressure chamber 20. Air under pressure from the compartment 20 is thus permitted to flow through the openings 84 in the inner end wall 83, into an air equalizing chamber 98 formed within the metal sleeve 82 between the end walls 83 and 87, and from the equalizing chamber 98 through the air passages 88 in the end wall 87 for passage outwardly from the burner front end 99.

Extended through the electrode opening 86 and the bore 89, formed in the end walls 83 and 87, respectively, is an electrode 101, the rear end 102 of which projects within the motor compartment 20 for direct connection with the ignition coil 23. The front end 103 of the electrode 101 projects forwardly from the ceramic partition or end wall 87 and terminates in a tapered portion 104 which is located within the spider or bracket 91.

A ground electrode 106, extended axially of the burner 39, has its rear end 107 extended through the base 93 of the spider member 91 for threadable connection with the base member 93 at 108. Mounted on the projected rear end 107 of the ground electrode 106 is a ceramic member 109 of a generally cylindrical shape having a cavity 111 formed in its rear end, and arranged relative to the electrode 106, such that the rear end 107 of such electrode terminates within the bottom wall 112 of the cavity 111. The cavity side wall 113 is of a relatively narrow thickness, to reduce the mass thereof, and with this side wall terminating in a rearwardly and inwardly inclined or tapered surface 114. Mounted on the ground electrode 106 at a position forwardly of the spider base member 93 is a deflector member 116 of a generally pear shape having its small or rear end 117 adjacent to the base member 93 while its large or front end 118 terminates adjacent to the inner metal tube 73 of the burner side wall 71 so as to form with the tube 73 an annular passage 119. The electrode 106 is connected to ground through the spider 91, tube 73, sleeve 82, spacers 74, tube 72 and the compartment side wall 22.

As shown in Fig. 3, the adjacent ends 104 and

107 of the electrodes 101 and 106, respectively, are relatively spaced both axially and transversely of the burner 39, with the transverse spacing being accomplished by a bend in the electrode 101, as indicated at 121. It is thus seen that the apex of the tapered end portion 104 of the electrode 101 is positioned above the top portion 122 of the cavity side wall 113 and rearwardly of the ceramic 109. Further, it will be noted that the legs 92 of the spider 91 are inclined forwardly and inwardly from their ends secured at 94.

The electrodes 101 and 106 are in alignment longitudinally of the burner 39. Also, from a consideration of Fig. 5, it is seen that the spider leg, indicated as 92*a*, is vertically disposed above the adjacent ends of the electrodes 101 and 106, and in turn above the cavity side wall portion 122. The fuel line 37 for the burner 39 is extended through the ceramic end walls 83 and 87 at a position spaced vertically above the electrode 101 and has its discharge end 126 terminating in the tapered surface 90. The electrodes 101 and 106, the fuel line 37 and spider arm 92*a* are thus arranged in a substantially common vertical plane.

In the operation of the burner the electrode 101, which is the hot electrode, is supplied from the coil unit 23 with a high potential heavy current having a capacity in the neighborhood of from fifty to one hundred milliamps so as to effect a high heat arc discharge, indicated at 128 in Fig. 3, between the electrodes 101 and 106. By virtue of the arrangement of the ceramic member 109 relative to the adjacent ends of the electrodes 101 and 106, the arc 128 is directed to follow a path from the apex of the tapered portion 104 on the electrode 101, downwardly under and against the cavity side wall portion 122 to the electrode 106. As a result of this travel of the arc discharge 128 the heat developed thereby is localized or concentrated within the cavity 111 and in the cavity side wall portion 122, which, as was previously mentioned, is of a relatively low mass.

Air under pressure from the motor compartment 20 is admitted through the openings 84, in the end wall 83, into the equalizing chamber 98 and then through the air passages 88 in the end wall 87 for discharge about the electrode end 103. Mounted on the electrode end 103 is a ceramic member 131, of a pear shape similar to the deflector member 116, having the large end 132 thereof arranged adjacent to and rearwardly of the tapered portion 104 of the electrode 101. The air discharged from the passages 88 is deflected outwardly by the deflector member 131 and the tapered surface 114 on the ceramic member 109 so as to provide for a substantially non-turbulent air zone about the adjacent ends of the electrodes 101 and 106.

As a result of this introduction of air through the passages 88, and the cooperative action of the air deflectors or shields 131 and 114, the arc discharge 128 is shielded or protected against being cooled by the flow of the incoming combustion air. It is seen, therefore, that the heat developed by the arc 128 is both localized within the cavity 111 and conserved against being dissipated by the cooling effects of the combustion air, all for the purpose of obtaining and then utilizing the full effective heat developed by the arc for fuel igniting purposes.

The fuel entering the burner at 126 from the fuel line 37 impinges against the spider leg 92*a*

and a part thereof is deflected downwardly on to the cavity side wall portion 122. Due to the ceramic composition of the member 109 and the heating of the cavity side wall portion 122 by the arc discharge 128, some of the fuel falling on the cavity side wall portion 122 is heated and vaporized, while other parts thereof travel through the side wall portion 122 by capillary action, into the cavity 111. Still other parts of the fuel on the cavity side wall portion 122 may travel directly over the lip of such side wall portion, indicated at 135, for direct contact with the arc discharge 128 travelling about such lip.

It is contemplated that the fuel, deflected onto the member 109, have a mass, or be of an amount, such that it is readily capable of being heated and ignited by the available ignition heat of the arc discharge, for a temperature of the air and fuel in the neighborhood of minus sixty-five degrees Fahrenheit (−65° F.).

That part of the fuel ignited within the cavity 111 by the arc 128 is violently expelled from the cavity and projected against the large end 132 of the deflection member 131. This action is aided by the area of reduced air pressure created between the forward or large end 132 of the member 131 by the action of the incoming air from the passages 88 sweeping over the small end of the member 131. This ignited fuel or jet of flame from the cavity 111 ignites any fuel on the member 131 and is then swept or picked up by the air passing around the member 131 and carried into the remaining parts of the fuel discharged from the fuel line 37 to ignite such remaining parts. Stated otherwise, that part of the fuel initially ignited and projected against the deflector member 131 is reversed in direction and swept toward the deflector 116 so as to function as a pilot flame for the remaining parts of the fuel supplied from the fuel line 37. The resultant ignited air and fuel mixture then travels about the deflecting member 116 for passage outwardly from the burner through its end 99.

As this resultant air and fuel mixture travels through the burner supplementary or secondary air for combustion is progressively intermixed therewith by the provision of a series of openings 75 formed in the inner metal tube 73. Since the air from the passage 76 is under pressure, the air discharged through the openings 75 travels radially of the burner 39, and on mixing with the burning mixture forms radial jets of flame that project inwardly toward the axial center of the burner.

The electrical system for the burner, as shown in Fig. 6, includes a battery 181, a main line switch 182, a time-delay switch 183, a cut-off switch 184 and a temperature control or rheostat switch 186. The switches 183, 184 and 186 are mechanically connected for concurrent operation by a linkage system, indicated at 187, with the time-delay switch 183 being closed through a trip mechanism (not shown) actuated by the arm 204 of the switch 186. The electrical system also includes a switch 88 providing for either a "stand-by" or a "run" operation of the heater.

On starting of heater operation, the switch 188 is actuated to its stand-by position indicated in dotted lines at A, the arm 204 of the temperature control switch 186 is moved to a position on the rheostat resistance 206 and the main line switch 182 is then closed. A thermostatic switch 191, connected in parallel with the time-delay switch

183, is positioned so as to be responsive in operation to the heat radiated from the heat-exchange unit 21 and is normally open when cold. A second thermostatic switch 190 is connected in series with the ignition coil 23 at a position between the coil and a terminal 194 to be hereinafter explained. The switch 190 is responsive in operation to the heat of the exchange unit 21 and is normally closed when cold. Thus on starting, the circuit for the electrodes 104 and 106, from the battery 181, comprises the conductor 192, the time-delay switch 183, the cut-off switch 184, and the conductor 193 which is connected to the terminal 194 which in turn is connected with the winding 196 of the ignition coil 23 through the thermostatic switch 190. The coil winding 196 is connected through conductor 197 with the electrode 101; the electrode 106 being connected to the ground, in a manner previously explained, so as to complete the electrode circuit.

The pump 32 is of a solenoid-actuated type and has a winding 198 connected with the terminal 194 through conductor 199. A breaker assembly, indicated generally at 201, and carried within the housing 28, shown in Figs. 1 and 2, is interposed between the windings 196 and 198, and the ground. As hereinabove referred to, the breaker assembly 201 is operated by the motor 26 for the combustion air blower 27.

The circuit for the combustion air motor 26 is similar to that of the ignition coil 23 and pump 32 from the battery to the terminal 194. From the terminal 194 the combustion air motor circuit includes the switch arm 204 of the heat control switch 186, the rheostat resistance 206, conductor 207, a shunt resistance 208, arm 209 and conductor 211 of the switch 188, and conductor 212 which is connected to one side of the motor 26, with this circuit being completed through the motor ground 213.

The circuit for the circulating air motor 52 is similar to that of the combustion air motor 26 from the battery 181 through the conductor 207. The motor 52 has one side connected to the conductor 207, through conductor 210, while its other side is connected to ground through conductor 215, arm 214 of the switch 188, conductor 212, motor 26 and the ground 213. Thus for a stand-by position of the switch 188 the motors 26 and 52 are connected in series, and the shunt resistance 208 is connected in parallel with the motor 52.

As a result the combustion air motor 26 is operated at a nearly normal speed, as determined by the position of the rheostat arm 204, and the circulating air motor 52 operates at a greatly reduced speed, relative to a normal speed therefor, on less than a normal current input to the motor 26. This relative operation of the motor 52 at a reduced speed, and of the motor 26 at approximately a normal speed for a current input normally required for the motor 26 alone, is highly desirable for a stand-by operation of the heater in order to conserve the battery 181. After a normal operation of the heater has been attained, the circuits for the pump 32, air circulating motor 52, and combustion air motor 26 are closed by the thermostat switch 191 so that any later opening of the time-delay switch 183 is rendered ineffective in these circuits. With normal operation of the heater, or on the establishment of combustion, the circuit of the coil 23 is opened by the thermostatic switch 190. If, for any reason, heater operation fails to take place within the time limit predetermined by the time-delay switch 183, the complete circuit is opened by the time-delay switch whereby current is shut off to the coil 23, pump 32, and motors 26 and 52.

On a movement of the switch 188 to its run position, indicated in dotted lines at B in Fig. 6, the circuit of the circulating air motor 52 from the conductor 215 includes the arm 221, of the switch 188, and the conductor 222 which is connected to the ground 213. For this run position of switch 188, the shunt resistance 208 is cut out and the circuit of the combustion motor 26 from the conductor 207 includes the conductors 210 and 224, the arm 226 and conductor 211 of the switch 188, conductor 212 and the ground 213.

It is seen, therefore, that for a run operation of the heater, the motors 26 and 52 are connected in parallel and operate at normal speeds as determined by the position of the rheostat arm 204 relative to the resistance 206, and with this operation taking place with an increased current consumption for the motors 26 and 52, relative to the motor current required for stand-by operation.

By virtue of this system it will be noted that the supply of combustion air to the burner 39 is increased concurrently with a decrease in the resistance 206, as determined by the rheostat arm 24, to in turn provide for an increase in the heat output of the heater. This increased heat output is accomplished by virtue of the metering unit 29 being operable in response to the air pressure within the motor compartment 20 to vary the supply of fuel to the fuel line 37.

From a consideration of the above description, it is seen that the invention provides an improved system and method for igniting fuel in a burner, which is positive and efficient in operation to accomplish such ignition for varying types of fuel, and with such fuel, as well as the combustion air being supplied thereto, being capable of ignition at temperatures in the neighborhood of minus sixty-five degrees Fahrenheit (−65° F.). Although the invention has been described relative to operation from a battery, which can be of 6, 12, 24 or 32 volt capacity, it is to be understood that it can be used with either A. C. or D. C. at any voltage above 6 volts and including 120 volts. Also, where ample electrical energy is available the normal supply of fuel to the burner can be directed at one time into the burner ignition zone.

Although the invention has been described with respect to a preferred embodiment thereof, it is to be understood that it is not to be so limited since changes can be made therein which are within the full intended scope of this invention, as defined by the appended claims.

We claim:

1. In a liquid fuel burner the combination with means forming an elongated combustion chamber, means for supplying liquid fuel under pressure to said combustion chamber, and means for supplying combustion air under pressure to said combustion chamber, independently of said fuel supply, for forward flow longitudinally therethrough, of an ignition system including front and rear elongated electrodes arranged in adjacent end to end relation longitudinally within said combustion chamber, means providing for an arc discharge between the adjacent ends of said electrodes, said adjacent ends of the electrodes being longitudinally and laterally spaced from each other, a ceramic member surrounding the front one of said electrodes having a cavity therein, said front electrode having the arc end thereof terminating in the bottom wall

of said cavity so that the arc discharge is directed to travel within said cavity and along a portion of the cavity side wall prior to its passage to the arc end of the rear electrode, means for directing only a part of the liquid fuel from said fuel supply means to said ceramic member and the cavity therein for ignition by the arc discharge, and means on the arc end of said rear electrode for deflecting the flow of combustion air against direct entrance into said cavity so that the combustion air about said cavity is in a quiescent state, with said portion of the fuel, on ignition thereof, being dispersed away from said cavity into said flow of combustion air to initiate ignition of the other portions of fuel supplied to said combustion chamber.

2. In a liquid fuel burner the combination with means forming an elongated combustion chamber, means for supplying liquid fuel under pressure to said combustion chamber, and means for supplying combustion air under pressure, independently of said fuel supply, for flow longitudinally through said combustion chamber, of an ignition system comprising a pair of electrodes extended in adjacent end to end relation longitudinally within said combustion chamber, means providing for an arc discharge between the adjacent ends of said electrodes, deflectors, one mounted on the adjacent end of each of said electrodes for shielding said arc against the forward flow of combustion air so as to reduce any cooling effect on said arc by said combustion air, one of said deflectors having a cavity therein with the arc end of the carrying electrode terminating in the bottom wall of the said cavity so that the arc discharge is directed to travel within said cavity, means for directing a portion of the liquid fuel from said fuel supply means to said arc in an amount commensurate with the heating capacity of the arc such that said portion of the fuel is incapable of cooling the arc to a temperature which would be insufficient to ignite said portion of the liquid fuel directed thereto, with said portion of the fuel, on ignition thereof, being dispersed into the flow of combustion air about said shielding means to initiate ignition of remaining portions of the liquid fuel supplied to said combustion chamber.

3. In a liquid fuel burner the combination with means forming an elongated combustion chamber, means for supplying combustion air under pressure for flow through said combustion chamber from the rear end thereof, and means for supplying liquid fuel under pressure to said combustion chamber, independently of said air supply, of an ignition system comprising a front elongated electrode and a rear elongated electrode arranged in adjacent end to end relation longitudinally of said combustion chamber, means providing for an arc discharge between the adjacent ends of said electrodes, said adjacent ends of the electrodes being longitudinally and laterally spaced from each other, a ceramic member mounted on the rear end of the front electrode having a cavity in the rear face thereof, with the rear end of said front electrode terminating in the bottom wall of said cavity so that the arc discharge is directed to travel within said cavity and along a portion of the side wall thereof to the front end of said rear electrode, a second ceramic member mounted on the rear end of said front electrode at a position to shield said arc from the direct flow of combustion air thereon, and means for directing only a portion of the liquid fuel from said fuel supply means to said side wall portion of the cavity for ignition, with said portion of the fuel, on ignition thereof, being thrown rearwardly against said second ceramic member for dispersion into the forward flow of combustion air to initiate ignition of the remaining portions of fuel supplied to said combustion chamber.

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