

Jan. 15, 1952

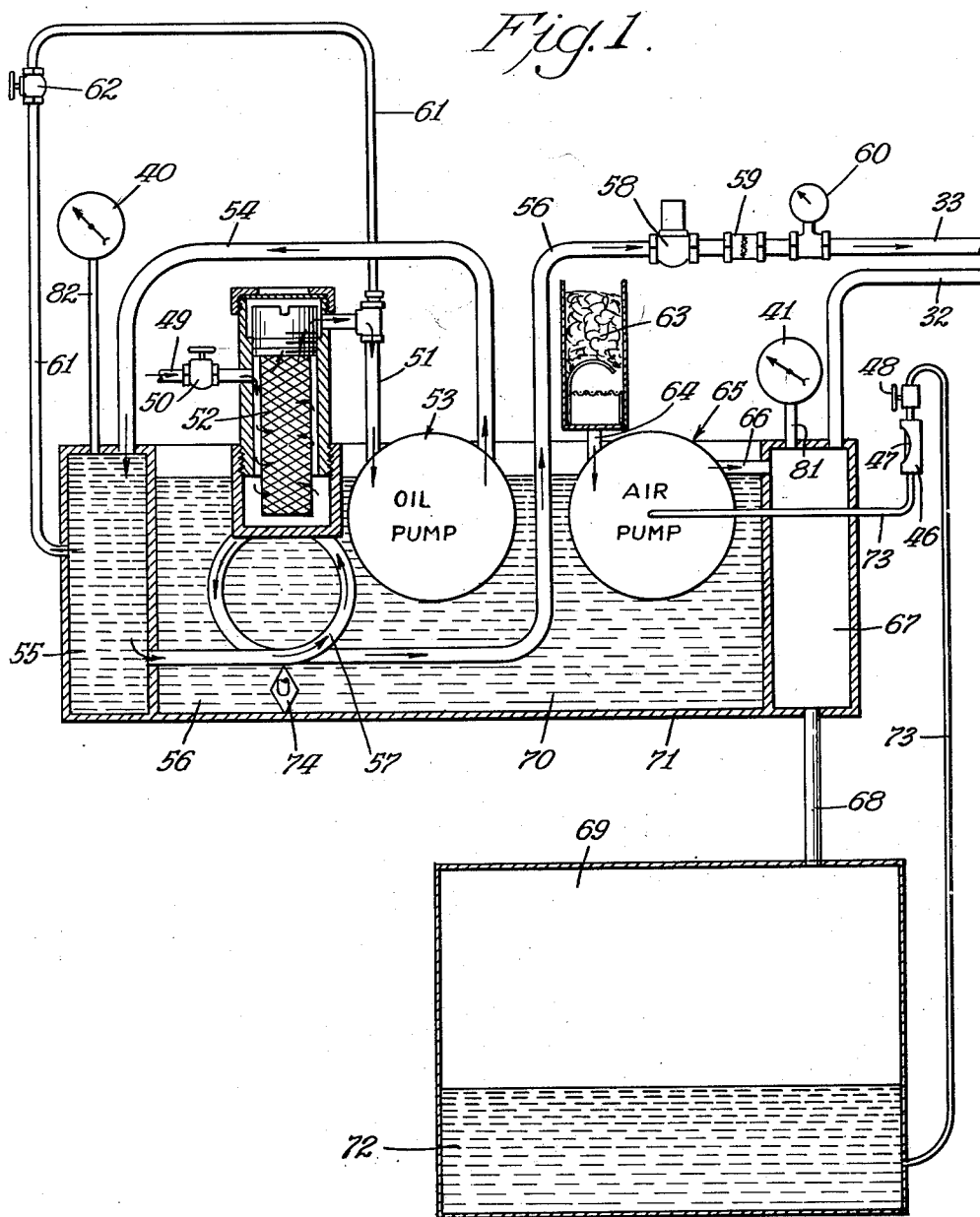
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2,582,827

SAFETY CONTROL SYSTEM FOR OIL BURNERS

Filed May 2, 1946

6 Sheets-Sheet 1



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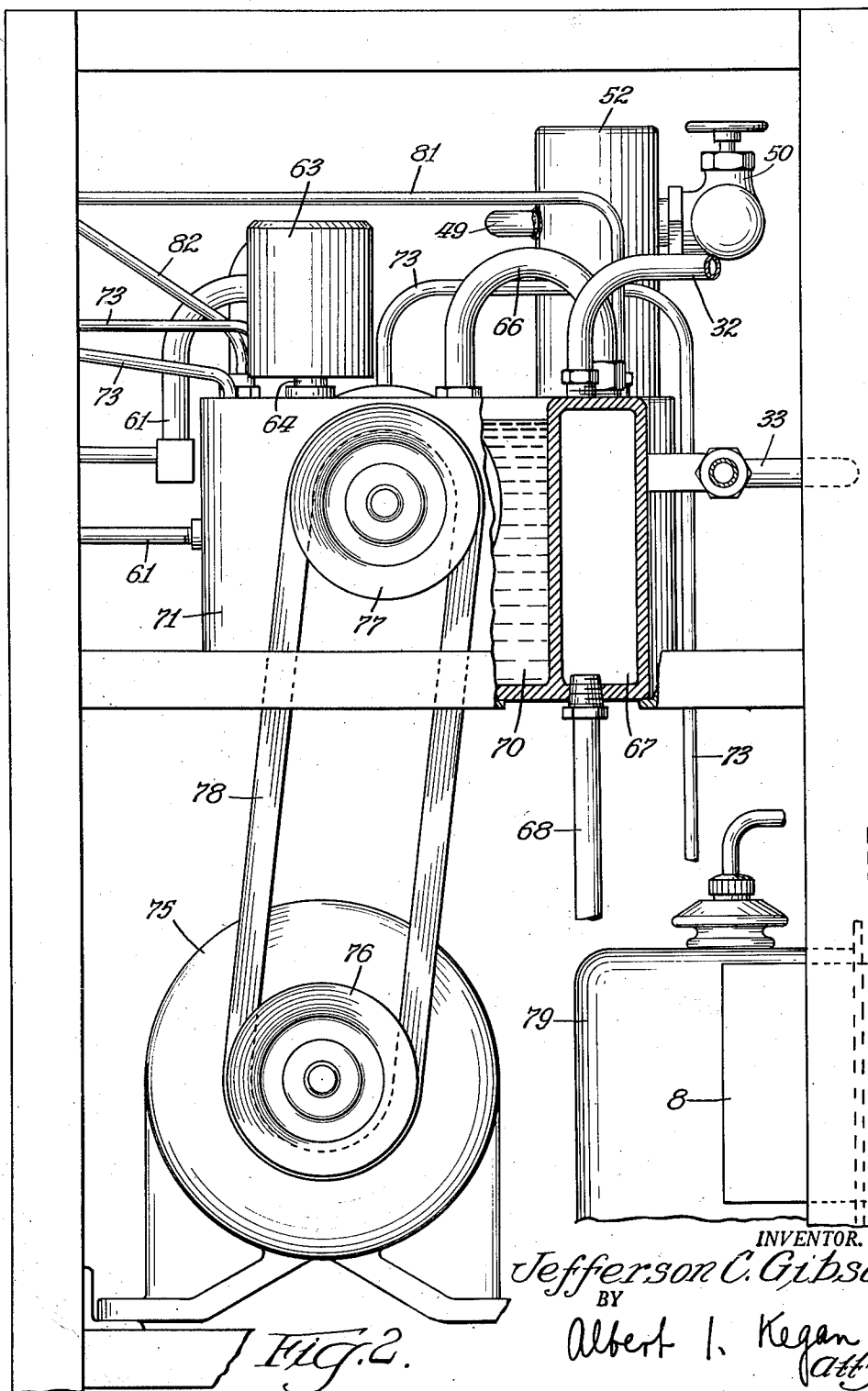
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SAFETY CONTROL SYSTEM FOR OIL BURNERS

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SAFETY CONTROL SYSTEM FOR OIL BURNERS

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6 Sheets-Sheet 3

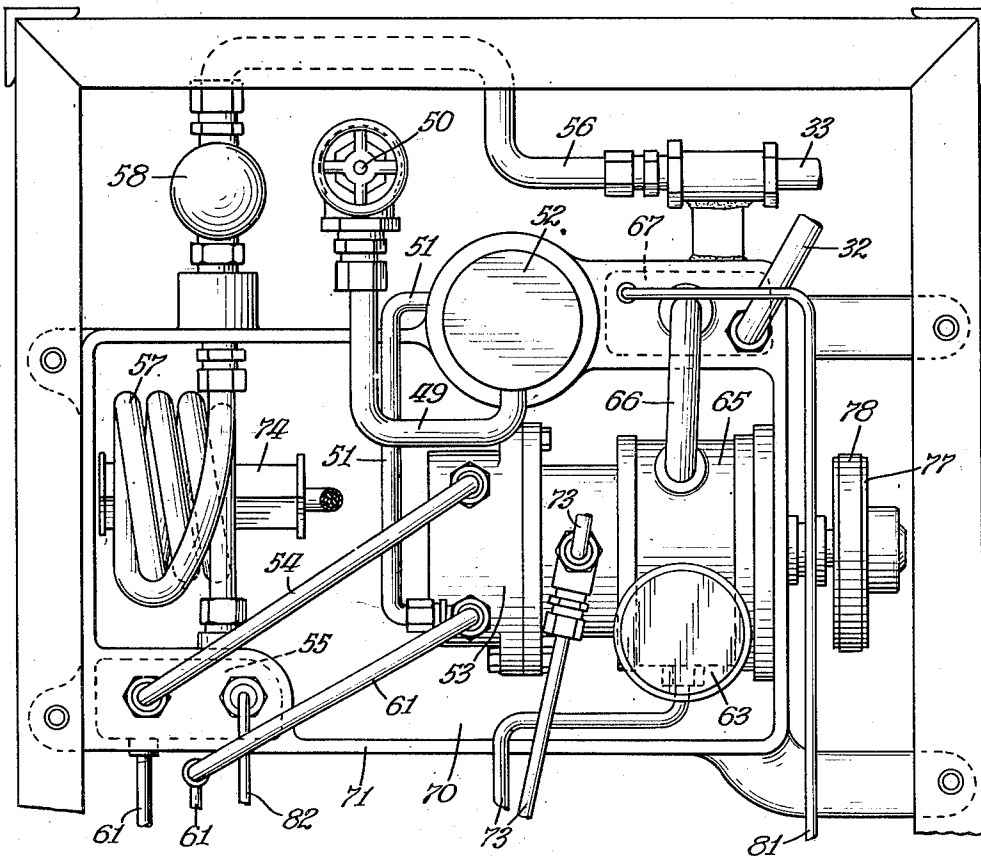


Fig. 3.

Fig. 4.

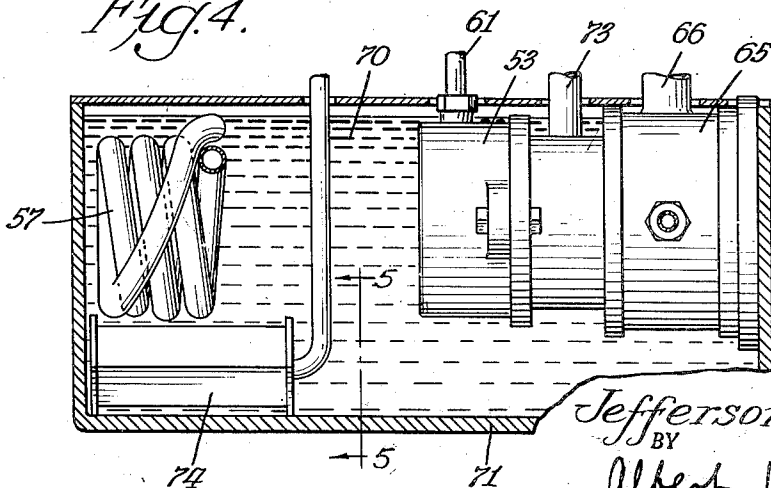
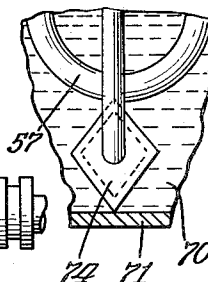


Fig. 5.



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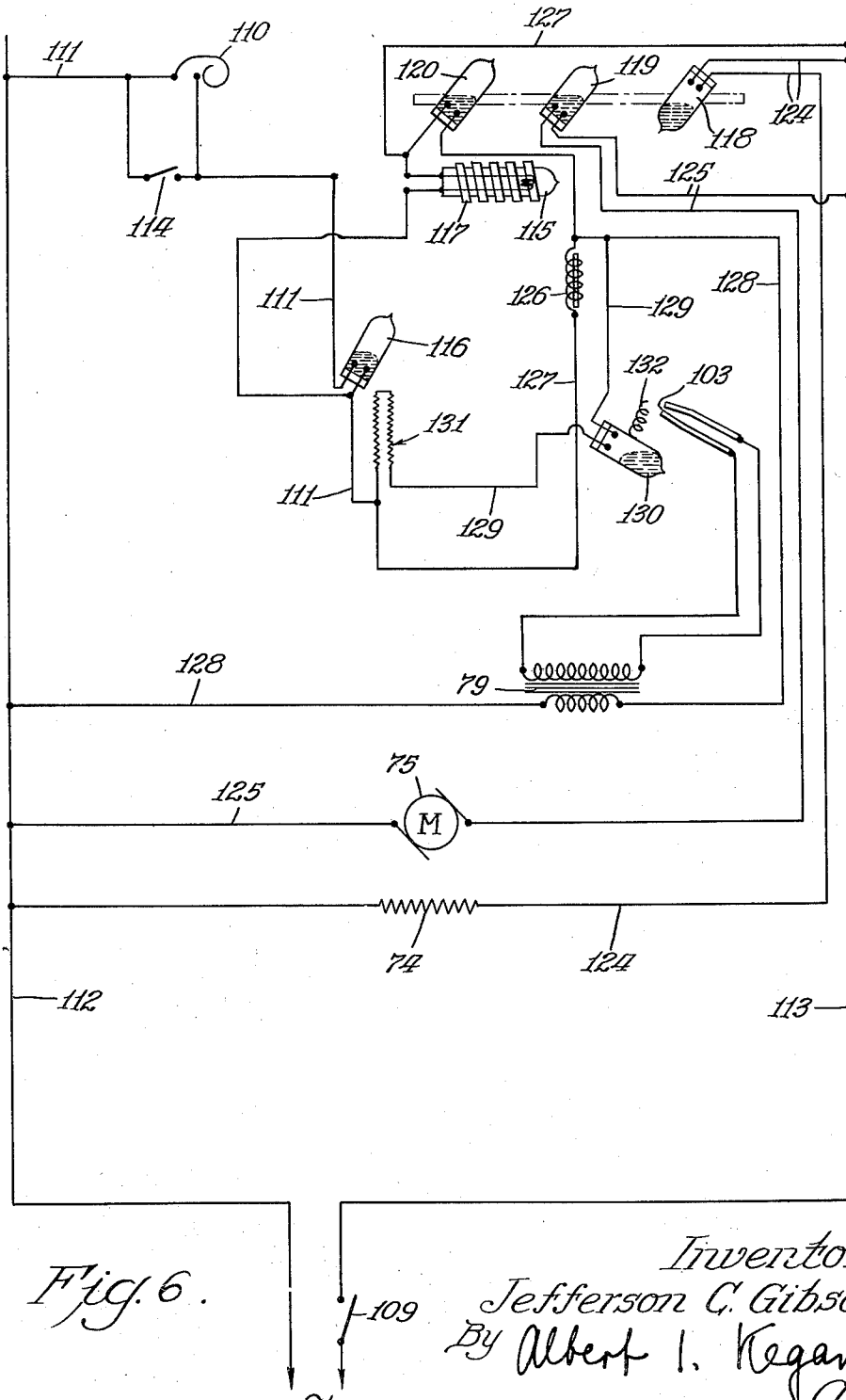
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SAFETY CONTROL SYSTEM FOR OIL BURNERS

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6 Sheets-Sheet 4



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6 Sheets-Sheet 5



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SAFETY CONTROL SYSTEM FOR OIL BURNERS

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Fig. 9.

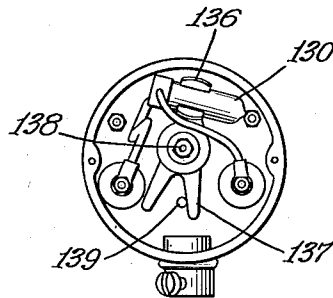
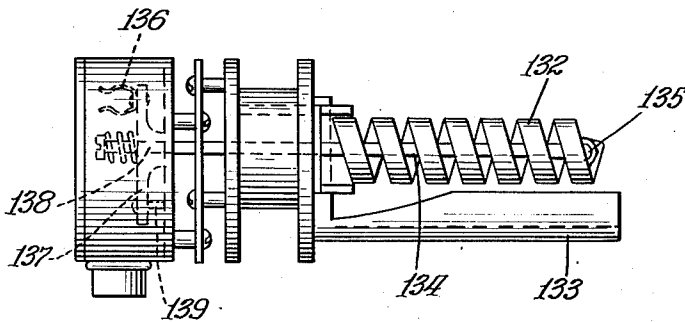


Fig. 10.

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UNITED STATES PATENT OFFICE

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SAFETY CONTROL SYSTEM FOR
OIL BURNERS

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Application May 2, 1946, Serial No. 666,693

3 Claims. (Cl. 158—28)

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The present invention relates to improvements in liquid fuel burners, and more particularly to improvements in an automatically operated fuel-oil burner adapted to burn low grade, viscous fuel oils and to heat economically industrial and domestic furnaces requiring a wide range of caloric input.

A principal object of my invention is to provide an improved, fully automatic fuel-oil burner which is relatively inexpensive to manufacture and to operate, yet which is efficient over a wide range of heating loads.

Another object of my invention is to provide inexpensive and efficient means for imposing a program of automatic operation upon the elements of a liquid fuel burner.

Still another object of my invention is to provide improved automatic safety controls in a liquid fuel burner.

Yet another object of my invention is to provide in a liquid fuel burner improved automatic means for pre-heating the liquid fuel prior to delivery at a combustion point.

A further object of my invention is to provide in a liquid fuel burner a control circuit which produces an automatic cleaning of the combustion points of excess fuel after each period of combustion in order to prevent carbonization and clogging at said points.

The foregoing and such other advantages, objects and capabilities as may appear herein or be pointed out as this description proceeds, or as are inherent in the present invention, are illustrated in the accompanying drawings, in which:

Figure 1 is a schematic representation of the parts in the fuel and air supply systems illustrating the flow of fuel and of air through my invention, and the relative position of the parts in said systems;

Figure 2 is a right side elevation of the control cabinet with the side panel removed to show the arrangement of parts inside said cabinet;

Figure 3 is a plan view of the control cabinet with the top panel removed and the front panel broken away;

Figure 4 is a view in vertical section through the pre-heating bath showing the oil and air pumps, the fuel carrying coil, and the electrical pre-heating unit immersed in said bath;

Figure 5 is a view in vertical, transverse section taken on line 5—5 of Figure 4;

Figure 6 is a diagram of a preferred arrangement of the electrical circuits in my invention, the mercury switch being shown in burner running position;

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Figure 7 is a partial rear elevation of the front panel of the control cabinet illustrating the trio of liquid contact switches which control the automatic program, and the safety control liquid contact switch;

Figure 8 is a side elevation of the safety control liquid contact switch, the electrically-heated bimetallic element cooperating therewith, and related parts;

Figure 9 is a side elevation of the bimetallic helix assembly which is positioned in the furnace with the combustion nozzle; and

Figure 10 is a front elevation of the bimetallic helix assembly of Figure 15 including the liquid contact switch made and broken by said helix.

Like reference characters are used to designate similar parts in the drawings and in the description of invention which follows.

The path taken by the fuel oil through the burner is best presented by the schematic flow diagram of Figure 1. The fuel oil enters the burner from a storage tank (not shown) in the line 49 through the valve 50. From the valve 50 the fuel oil is drawn in the line 51 through the strainer 52 into the fuel oil pump 53. On the pressure side of the pump 53 the fuel oil is propelled in the line 54 into the fuel oil chamber 55 which fulfills a heat exchange function hereinafter described. The flow of fuel oil divides upon leaving the chamber 55, one branch line 56 leading the fuel oil to the pre-heating coil 57, thence through the fuel supply solenoid valve 58, and preferably through an auxiliary strainer 59, and past a fuel meter 60 into the line 33 to the combustion nozzle 22 where said fuel oil is carburated with the primary air and ignited. The other fuel line branch 61 leaves the chamber 55 to lead through the fuel oil regulating valve 62 back again into the suction side of the oil pump 53. The pressure in the chamber 55 is regulated by adjustment of the valve 62 and it is this pressure which determines the amount of fuel oil which is propelled into the first branch line 56 to the combustion point. Thus the adjustment of the valve 62 by the handle 42 controls the amount of fuel oil delivered to the combustion point and regulates the caloric output of the burner. For example, if the burner is to be used to heat a small bungalow, the valve 62 is opened widely to lower the pressure in the chamber 55. Thus, most of the fuel oil is recirculated between the pump 53 and the chamber 55 and only a small proportion of the fuel oil is propelled into the combustion lines 56 and 33 and burned. If the burner is to be used to heat a fifty apartment

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building, however, the valve 62 is adjusted to raise the pressure in the chamber 55 thus forcing a far greater proportion of the oil flow to the combustion point and greatly increasing the caloric output of the burner.

The flow of primary air through my improved device is also best illustrated in Figure 1. By "primary air" is meant the air supplied to the combustion nozzle by the pumping system of the burner. The air is taken into the system through the air filter 63. From the filter 63 the air is sucked in the line 64 into the air pump 65 and propelled from said pump 65 in the line 66 into the air chamber 67 which damps the pulsations in the air lines produced by said pump. From the chamber 67 an air line 68 leads to a large accumulator tank 69. The chamber 67 is also tapped by the air line 32 leading to the combustion nozzle 22 where the air is mixed with the fuel oil and the mixture is ignited.

An important feature of my invention is the system for preheating both the fuel oil and the primary air prior to combustion. This preheating system is also best illustrated in Figure 1. I utilize the heat generated by the oil pump 53 and the air pump 65 to warm an oil bath 70. This bath 70 is contained in a tank 71 and most of the elements of the oil and air supply systems are arranged within said tank 71 to be immersed in said bath 70 so that the fuel oil and air en route to the combustion point have ample opportunity to absorb heat from said bath 70. Advantageously, oil may be supplied to the bath 70 from the reservoir 72 of lubricating oil in the air accumulator tank 69. The air pressure in said tank 69 forces the lubricating oil from the reservoir 72 up the line 73 through the drip valve 45 into the shaft bearings of the air pump 65 and thence into the bath 70. Overflow of lubricating oil from the bath 70 is carried by the primary air from the pump 65 into the chamber 67 from which said oil drips back down the line 68 into the reservoir 72.

It is apparent from Figure 1 that the fuel oil is first warmed in the strainer 52 which is immersed in the bath 70. The fuel oil is thus thinned immediately upon entering the burner system thereby settling out sediment, facilitating filtration, and requiring less vacuum from the oil pump 53 to draw said oil through the fuel lines 49, 51 and 61. The fuel oil is warmed again in the pump 53, in the heat-exchanging chamber 55, and in the preheating coil 57, all of which elements are immersed in the bath 70. While passing through the pre-heating coil 57, in addition to the heat of the bath 70, the fuel oil also absorbs heat from the electrical pre-heating unit 74 during the phases of the burner cycle wherein the pumps 53 and 65 are not operating and not generating heat. The electrical pre-heating unit 74 is automatically energized during the aforesaid phases of the burner cycle in a manner presently to be described. The result of the cumulative pre-heating of the fuel oil in my invention is a fuel oil temperature of 160° F. to 180° F. in the nozzle 22 at the start of the combustion period. These temperatures will drop no more than 20° to 30° F. during the combustion period when the electrical pre-heating unit 74 is de-energized and the fuel oil is pre-heated by the lubricating oil bath 70 alone. Since the primary air is also pre-heated in the said pump 65 and the chamber 67, the fuel oil is not cooled in carburation and I attain remarkably complete combustion and fuel economy in my burner.

The relative arrangement of parts within the

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cabinet 20 is best shown in Figures 2, 3, 4 and 5. Figure 2 illustrates the electric motor 75 which drives the pumps 53 and 65 through the sheaves 76 and 77 and the V-belt 78. The transformer 79 steps-up the voltage of a source of electrical power to bridge a spark gap in the ignition system presently to be described. A fuse block 8 is positioned beside the transformer 79. The air line 81 (also shown in Figure 1) leads from the chamber 67 to the air pressure gauge 41 on the instrument panel 39. The fuel oil line 82 (Figure 1 also) leads from the chamber 55 to the fuel oil pressure gauge 40 on the panel 39. Figures 3, 4 and 5 show the relative positions of parts described above within the lubricating oil bath 70.

The operation of my burner is fully automatic so that it requires no attention other than the closing of the main line switch 109 at the beginning and end of the heating season. The program of automatic and safety control is established in my burner by the combination in the electrical circuit of Figure 6 of the electrical, mechanical and thermal elements illustrated.

The rotation of the main line switch handle rotates the bell crank 107 which in turn flicks the switch button 108 (Figure 7). The switch button 108 makes and breaks the main line switch 109 (Figure 6). If my burner is to be used to heat a building, a house thermostat 110 is inserted in a circuit 111 between the main line leads 112 and 113. If my burner is to be used in an industrial furnace, an auxiliary switch 114, is inserted in the circuit 111. Both the thermostat 110 and the auxiliary switch 114 are shown in parallel in the circuit 111 in Figure 6. The circuit 111 also includes an incandescent bulb 115 and a liquid contact switch exemplified by the mercury-in-glass tiltable switch 116. The incandescent bulb 115 is embraced by a bimetallic helix 117 (Figure 7) which expands in response to the heat emitted by said bulb 115 when said bulb is electrically energized.

Still referring to Figure 7, three mercury bulb switches 118, 119 and 120 are mounted in spring clips 121, 122, and 123. Clips 121 and 123 are welded to clip 122 which in turn is fastened to the helix 117. The switch 118 is mounted to be made when said helix 117 is cool and broken when said helix 117 is heated. The switches 119 and 120 are mounted upon said helix 117 in opposite phase relationship from switch 118. In other words the switches 119 and 120 are broken when the switch 118 is made, and vice versa.

The mercury bulb switch 118 is connected in the circuit 124 in series with the electrical pre-heating element 74 between the main line leads 112 and 113 (Figure 6). The mercury bulb switch 119 is connected in the circuit 125 in series with the electric motor 75 between the main line leads 112 and 113. The mercury bulb switch 120 is connected in series with the solenoid 126 of the fuel supply valve 54 in a branch circuit 127 leading to the circuit 111 and then to the main line lead 112. The switch 120 is also in series with the primary coil of the step-up transformer 79 in a circuit 128 branching again from the branch circuit 127 to the main line lead 112. The secondary coil of the transformer 79 is connected across the fuel igniting spark gap 103. The circuit 128 does not include the solenoid 126.

In a circuit 129 between circuits 111 and 127 and shunted about the solenoid 126 is yet another mercury bulb switch 130 and a bimetallic resistance element 131 which moves in response to heat generated in itself when electrically energized. The switch 130 is mounted upon a second

bimetallic helix 132 illustrated in Figures 9 and 10. The bimetallic helix 132 projects into the firebox beside the nozzle 22 and moves in response to changes in the heat within said firebox. A shield 133 protects the helix 132 from direct contact with the combustion flame and tends to absorb the heat of combustion and reflect said heat evenly upon said helix 132. A rod 134 is fastened at one end 135 to the helix 132 and extends longitudinally through said helix. A spring clip 136 projects from a fork 137 journaled upon the other end 138 of the rod 134 and said clip 136 embraces the mercury bulb switch 130. Expansion and contraction of the helix 132 rotates the rod 134 in turn making and breaking the switch 130. When the helix 132 is heated, the switch 130 is broken; when said helix 132 is cooled, the switch 130 is made. Rotation of the clip 136 and switch 130 is limited by the stop pin 139 in the embrace of the fork 137.

Figure 8 discloses the cooperation of parts with the mercury bulb switch 116 in the circuit 111. The switch 116 is held in a spring clip 140 rotatably mounted upon a shaft 141 projecting from the rear face of the instrument panel 39. A weight 142 is fastened to the clip 140 remote from the switch 116. The clip 140 is held in a position with the weight 142 carried high and the switch 116 carried low by pointed pin 143 socketed in said clip at 144. Said pin 143 is fastened to the free end of a flexible arm 145 slidably journaled upon the shaft 141. The flexible arm 145 is fastened to the bimetallic resistance element 131 by the pin 146. When current is permitted to flow in said element 131, heat is generated therein and the element expands, flexing the arm 145 away from the clip 140. The pointed pin 143 is pulled from the socket 144 and the weight 142 rotates the clip 140 and breaks the switch 116 for a purpose hereinafter discussed.

A helical spring 147 on the shaft 141 is tensioned between the spring arm 145 and the nut 148. Tension in the helical spring 147 may be adjusted by rotation of the nut 148. The adjustment of the tension in said helical spring 147 fixes the period of time required for the bimetallic resistance element 131 to break said switch 116 after said element 131 is energized. Once broken, the switch 116 can be remade only by upward movement of the reset handle 45. Said upward movement of the reset handle 45 translates the vertical bar 149 to which said handle 45 is fastened. The reset pin 150 projecting from the bar 149 engages and lifts the weight 142 until the pointed pin 143 backed by the tension of the spring 147 against the arm 145 can re-engage the socket 144. The reset spring 151 returns the reset handle 45 to its original position.

Connector blocks 152 and 153 on the rear face of the panel 39 (Figure 7) furnish convenient means for connecting the above-described elements into the circuits of Figure 6 in which figure the mercury switches are shown in burner running position. When said circuits are established, the following program of automatic operation and safety control is imposed upon the burner. Assuming the burner is to be used in heating a dwelling place, the main line switch 109 is closed at the beginning of the heating season. A source of electrical power is thus brought across the lead lines 112 and 113 (Figure 6). The mercury bulb switch 118 is in the "made" position and current will flow in the circuit 124 through the electrical pre-heating ele-

ment 74 generating heat to warm the fuel oil in the fuel pre-heating coil 57. This phase of operation continues until the house thermostat 110 calls for heat by closing the circuit 111, whereupon the incandescent bulb 115 is energized and begins heating the bimetallic helix 117. Approximately one and one-half minutes later, the bimetallic helix 117 has responded sufficiently to the heat of the bulb 115 to break the mercury bulb switch 118 and to make the mercury bulb switches 119 and 120. This cuts off the current in circuit 124 and de-energizes the electrical pre-heating element 74. The making of switch 119 causes current to flow in circuit 125, thereby causing the electric motor 75 to drive the pumps 53 and 65. The pumps 53 and 65 generate heat in their operation and this heat is absorbed by the oil bath 70 and is thus utilized to warm the fuel oil supply elements immersed therein. The making of switch 120 causes current to flow in circuit 128, thus energizing the transformer 79 and creating a fuel ignition spark across the gap 103. The making of switch 120 also causes current to flow in circuit 127 actuating the solenoid 126 and opening the valve 58, thereby admitting fuel oil to the carburating chamber 90. In the meantime, the air pump 66 has been building up pressure in the chamber 67 and accumulator tank 69. The pressure in the tank 69 commences the circulation of the lubricating oil. Since it takes a short time to build up pressure in said tank 69, relatively little primary air is initially pumped to the carburating chamber 90 and the mixture reaching the ignition spark is rich in fuel oil at the start of the combustion period. The mixture is progressively cut by more primary air as air pressure builds up during the initial phase of the combustion period. Thus, I have established an automatic choke in my burner making for faster ignition by providing a relatively richer fuel mixture at the start of the combustion period.

I have noted previously that when there is no flame in the firebox and the bimetallic helix 132 is cool, the mercury bulb switch 130 is in the made position. Thus, when the mercury bulb switch 120 is also made at the start of the combustion period, current will flow in the shunt circuit 129 energizing the bimetallic resistance element 131. In a short period of time, depending upon the adjustment of the helical spring 147 (Figure 8), the heating of the bimetallic resistance element 131 will cause the same to move sufficiently to break the mercury bulb switch 116—unless the flame has caught in the firebox and heated the bimetallic helix 132, thereby breaking the switch 130 and de-energizing the bimetallic resistance element 131. The breaking of the switch 116 will cut the current in circuits 111 and 127, thus turning off the incandescent bulb 115 and actuating the solenoid 126 to close the fuel supply valve 58. Approximately one and one-half minutes later, as the bimetallic helix 117 cools, the switches 119 and 120 will break, de-energizing the electric motor 75 and spark gap 103. Thus, it is apparent that, if for any reason the ignition fails to catch a flame in the firebox, my burner will automatically turn itself off after a pre-determined brief period of time. The same sequence of operations will turn my burner off automatically if the flame in the firebox fails for any reason during the combustion period. I prefer to adjust the helical spring 147 in such tension whereby the switch 116 is broken approximately three and one-half minutes after

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the flame fails in the firebox, but it is understood that this period of time may be varied according to the safety requirements of the installation.

The program of automatic control of my burner includes an operational phase of cleaning the nozzle tip of excess fuel oil after each combustion period. When the house thermostat 110 cuts the circuits 111 and 127, the solenoid 126 is actuated immediately and the fuel oil supply is cut at the valve 58. However, the electric motor 75 continues to drive the pumps 53 and 65 for approximately one and one-half minutes while the bimetallic helix 117 cools enough to break the switches 119 and 120. Thus, for approximately one and one-half minutes immediately after the fuel supply is cut off each time, a blast of air cleans the nozzle tip of excess fuel oil. Carbonization and clogging at the nozzle tip is thus minimized, and the combustion nozzle thus requires practically no manual cleaning.

In the construction and operation of my invention above described, I achieve many objectives highly desirable in liquid fuel burners. It is apparent that my burner is adapted to a wide range of heating loads, since the regulation of the fuel supply valve 62 serves to deliver small or great quantities of fuel oil to the combustion nozzle or to a bank of such nozzles. In the use of relatively small volumes of primary air under considerable pressure, I attain complete combustion near the monoxide stage. All of the primary air is consumed in the combustion, none remaining to cool the flame or to push the heat through the firebox to be dissipated up the stack. Remarkably low stack temperatures are experienced with the use of my burner. The low velocity of air through the firebox produces a soft, clinging flame therein that economically distributes the heat evenly throughout the firebox.

The low stack temperatures characterizing the use of my burner obviates the concurrent use of a conventional stack switch as a safety control. However, I have found that the insertion of the bimetallic helix 132 directly into the firebox serves a distinct advantage. The high temperature of the firebox burns away carbon deposits tending to form on the helix, thereby eliminating the carbonization disadvantage of a stack switch. Furthermore, the burner is more compact, and the safety controls are easier to reach for inspection and repair in the furnace than an equivalent set of controls in the stack.

The pre-heating of both fuel oil and air is accomplished economically yet efficiently in my burner by utilizing the heat generated by the pumps 53 and 65. The preheated fuel oil which is not burned is re-circulated through the oil pump 53 and no heat is lost by return of preheated fuel to the storage tank. The high pre-heating temperature attained in the fuel oil permits the use of cheaper fuel oils of relatively high viscosity. The pre-heating of both fuel oil and air results in more complete combustion. Since the flame is not cooled by injection of cold primary air, greater economy of heat is attained in the furnace.

The automatic control system of my burner is comprised of relatively inexpensive and simple elements. However, these elements are not delicate or readily susceptible to wear and misadjustment. When worn or broken, they may be easily replaced—as, for example, the mercury bulb switches which may be readily replaced by

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disconnecting the leads and snapping the old switch from its supporting spring clip, inserting the new switch and connecting the leads.

The operation of my burner is fully automatic—to the extent of providing an automatic choke action for feeding a richer fuel mixture to the nozzle at the start of the combustion period, and to the extent of providing a blast of air at the end of each combustion period to dry the nozzle of excess fuel. Thus, my burner requires a minimum of attention from the householder or industrial user thereof for operation, cleaning or maintenance.

While I have described my invention as embodied in a specific form and operating in a specific manner for purposes of illustration, it should be understood that I do not limit my invention thereto, since various modifications will suggest themselves to those skilled in the art without departing from the spirit of my invention, the scope of which is set forth in the annexed claims.

I claim:

1. In a liquid fuel burner which includes a fuel supply system, an air supply system, and means for carburating fuel and air before ignition of a mixture thereof in a furnace; an electrothermal system for the automatic operation and safety control of said burner, comprising: an electrical power source; a main switch; a thermostatic switch; a safety switch; an electrical heating element connected in series with said main, thermostatic and safety switches across said source; a first thermostatic element disposed in association with and responsive to heat from said electrical heating element; a fourth switch made when said first thermostatic element is cold, and broken when said first thermostatic element is heated; fifth and sixth switches broken when said first thermostatic element is cold and made when said first thermostatic element is heated; a second electrical heating element for preheating said fuel connected in series with said fourth switch across said source; an electric motor for said fuel and air supply systems connected in series with said fifth switch across said source; a transformer having the primary winding thereof and said sixth switch connected in series across said source; a fuel igniting spark gap connected in series with the secondary winding of said transformer; a solenoid connected in series with said main switch; said sixth switch, said safety switch and said thermostatic switch across said source, a fuel supply valve, said solenoid controlling the actuation of said fuel supply valve; a second thermostatic element responsive to the heat of combustion in said furnace; a seventh switch made when said second thermostatic element is cold, and broken when said second thermostatic element is heated; a thermostatic actuator including a resistance element in series with said seventh switch, both forming a shunt circuit about said solenoid; and means for breaking said safety switch by the energization of said resistance element thereby shutting off the fuel supply, the ignition spark, and said electric motor when combustion fails in said furnace.

2. An electrical system for the automatic and safety control of a liquid fuel burner comprising: an electrical power source; a main switch; a thermostatic switch; a safety switch; an electrical heating element connected in series with said main, thermostatic and safety switches across said source; fourth, fifth and sixth switches

made and broken by thermostatic means responsive to heat from said electrical heating element, said fourth, fifth and sixth switches each being disposed as one element in each of three separate circuits across said power source, respectively, said fourth switch being in opposite phase from said fifth and sixth switches; a fuel preheating unit in series with said fourth switch; an electric motor for said burner in series with said fifth switch; a transformer having the primary winding thereof and said sixth switch connected in series across said source; a fuel igniting spark gap connected in series with the secondary winding of said transformer; a fuel supply valve; a solenoid controlling the actuation of said fuel supply valve connected in series with said sixth switch, said safety switch, said thermostatic switch, and said main switch; a seventh switch made and broken by thermostatic means responsive to the heat of fuel combustion; a thermostatic actuator including a resistance element connected in series with said seventh switch to form a shunt circuit about said solenoid; and means for breaking said safety switch activated by said resistance element adapted to shut off said burner when fuel combustion ceases.

3. A system for the automatic control of a liquid fuel burner comprising: an electrical power source; a thermostatic switch; an electrical heating element connected in series with said thermostatic switch in a circuit across said source; a heat activated control element adapted to be heated by said heating element, three switch members operatively connected to said control element, the first of said switch members being made when said control element is cold, and broken when said control element is heated, the second and third of said switch members being in opposite phase from said first switch; a sec-

ond electrical heating element for preheating fuel connected in series with said first switch in a second circuit across said source; an electric motor for said burner in series with said second switch in a third circuit across said source; a transformer having a primary and secondary winding; a fuel igniting spark gap formed by a pair of electrodes connected in series with the secondary winding of said transformer, said third switch and the primary winding of said transformer being connected in series in a fourth circuit across said source; a fuel supply valve; and a solenoid controlling the actuation of said fuel supply valve connected in series with said third switch and said thermostatic switch in a fifth circuit across said source.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,541,768	Diller et al. _____	June 9, 1925
1,594,020	Smith _____	July 27, 1926
1,594,022	Smith _____	July 27, 1926
1,608,271	Gibson _____	Nov. 23, 1926
1,610,957	Lawrence _____	Dec. 14, 1926
1,656,486	Huntington _____	Jan. 17, 1928
1,679,331	Williams _____	July 31, 1928
1,883,242	Bogle _____	Oct. 18, 1932
2,028,807	Reiboldt _____	Jan. 28, 1936
2,230,732	Tapp et al. _____	Feb. 4, 1941
2,347,843	Rayfield _____	May 2, 1944
2,369,530	Bulger _____	Feb. 13, 1945
2,370,205	Tate _____	Feb. 27, 1945
2,375,900	DeLancey _____	May 15, 1945
2,427,178	Aubert _____	Sept. 9, 1947