

Aug. 14, 1956

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2,758,591

AIR HEATING FURNACE AND CONTROL SYSTEM THEREFOR

Filed March 14, 1952

3 Sheets-Sheet 1

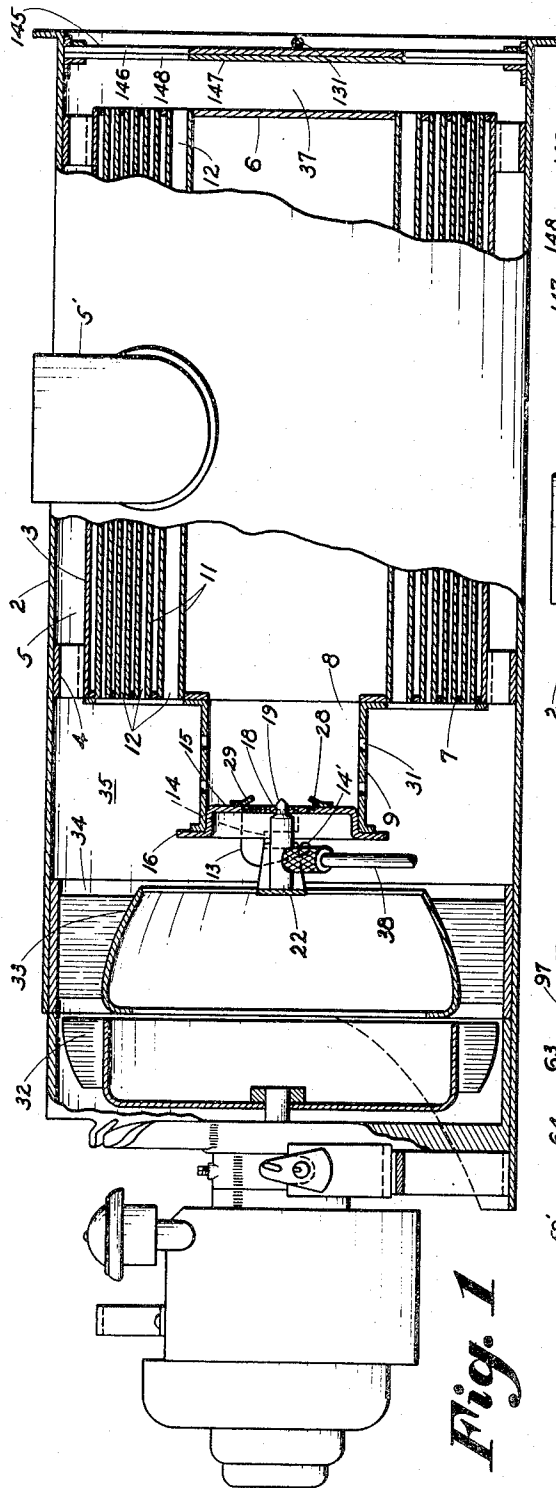


Fig. 1

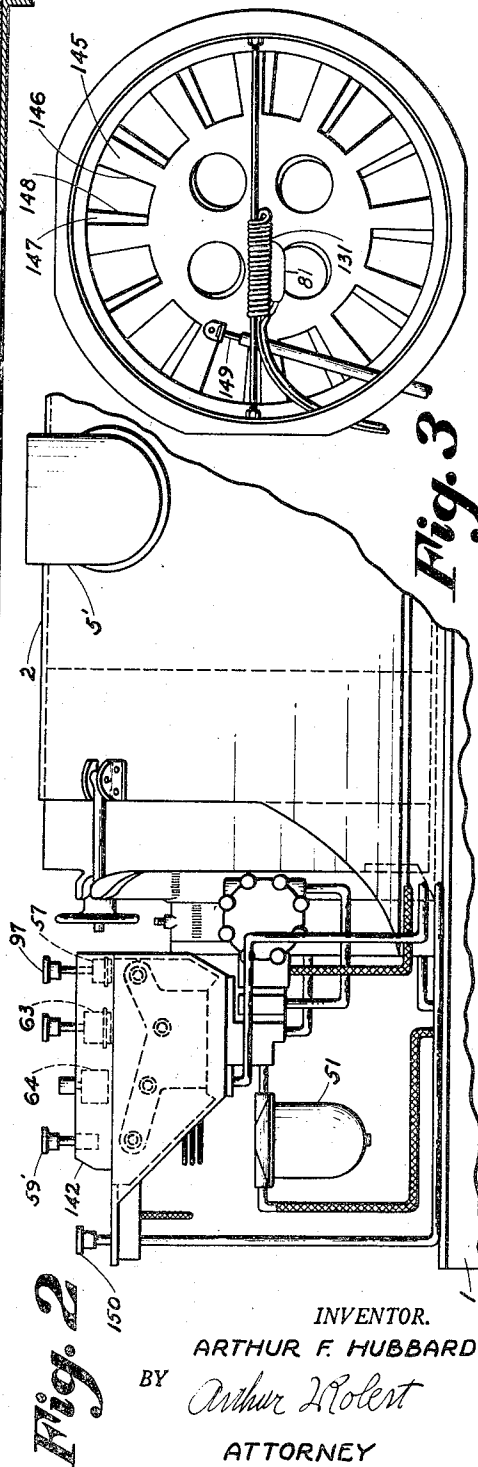


Fig. 2

Fig. 3

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3 Sheets-Sheet 2

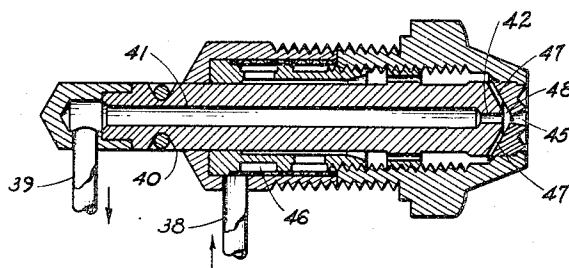


Fig. 4

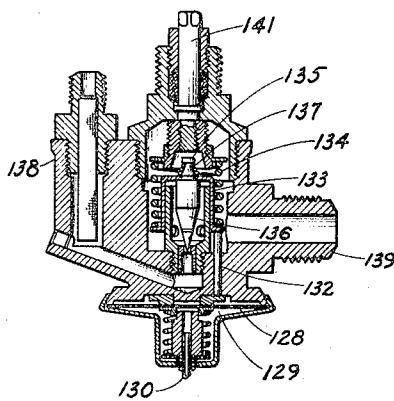


Fig. 5

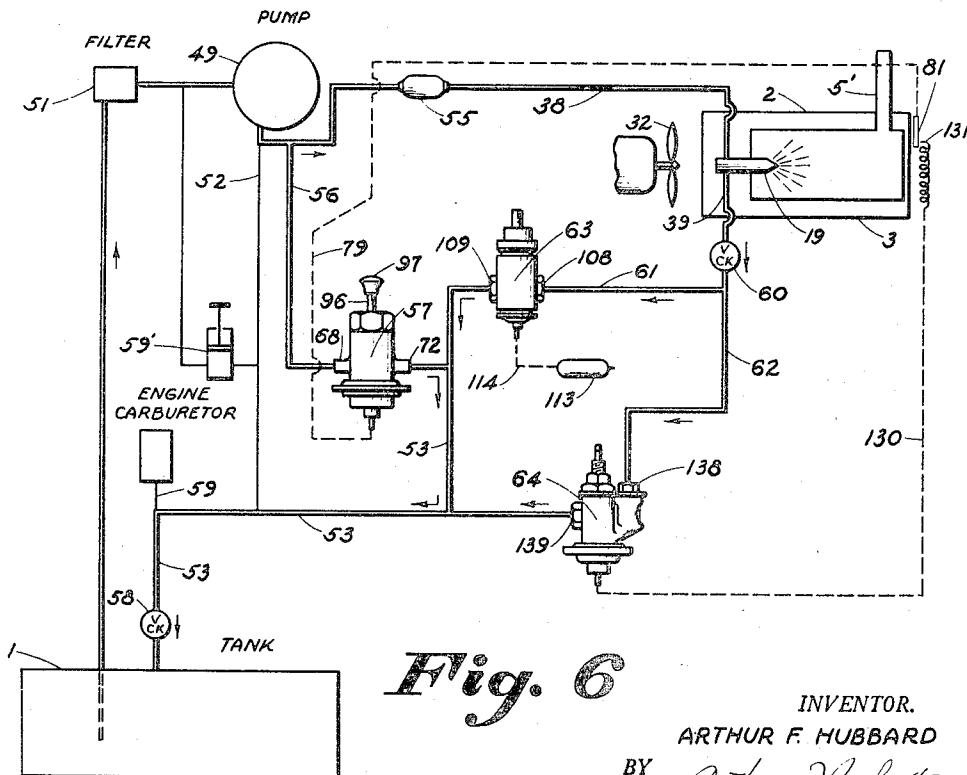


Fig. 6

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3 Sheets-Sheet 3

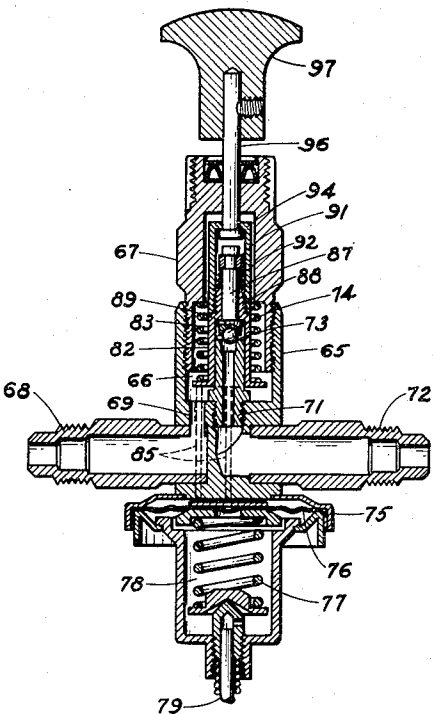


Fig. 7

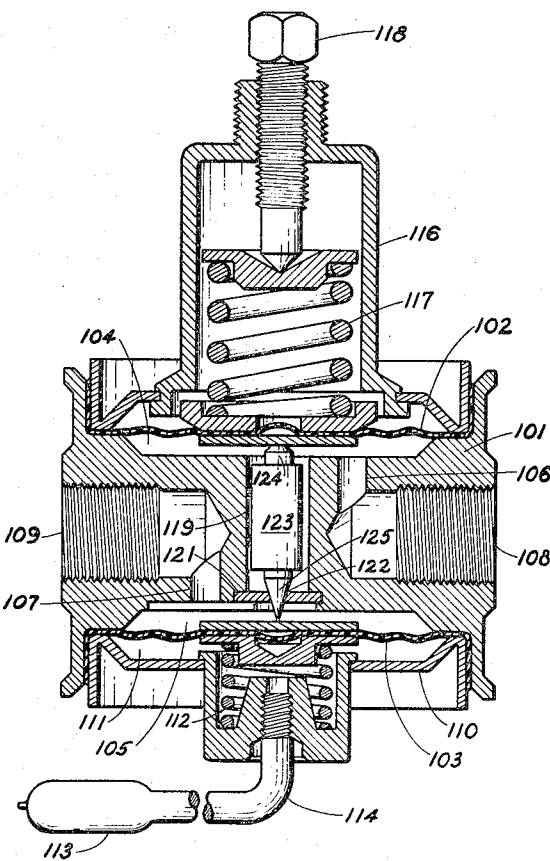


Fig. 8

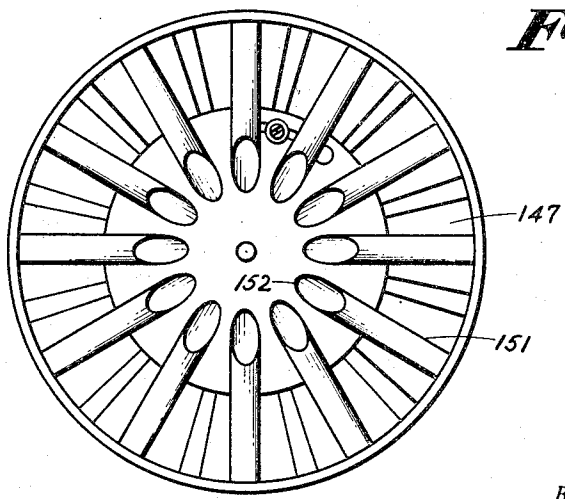


Fig. 9

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2,758,591

AIR HEATING FURNACE AND CONTROL SYSTEM THEREFOR

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Application March 14, 1952, Serial No. 276,664

12 Claims. (Cl. 126—110)

The present invention relates to portable space heaters employing gasoline or similar liquid fuel, and relates in particular to a control system for such a heater.

In one such type of heater, as for example, that illustrated in the Budlane Patent 2,421,370, a blower supplies air to fuel burner in a heat exchanger and to the heat exchanger, the air being heated by passing through the heat exchanger. The present invention relates to improvements in such heaters.

It is an object of the present invention to provide a safety control for a fuel burner to cut off the flow of fuel to the burner, should the temperature in the heat exchanger become excessively high, and which thereafter requires manual restoration of the fuel supply to the burner.

Another object is the provision, in a heater, of an automatic control to limit the fuel supply to the burner in accordance with the density of air supplied thereto, to obtain substantially the optimum proportion of air and fuel in starting the burner.

Another object is the provision in a heater of an automatic control variable in accordance with altitude and atmospheric temperature to limit the fuel supply to the burner to obtain substantially the optimum proportion of air to fuel in starting the burner.

Another object is the provision of a control means for the burner to maintain the burner in operation to produce a predetermined temperature range of heated air, in combination with means to cut off the fuel flow when excessive temperatures are reached, so that the fuel flow will not be restored when the temperature falls.

These and other objects attained by the present invention will be apparent upon consideration of the following description taken in connection with the accompanying drawing illustrating a preferred embodiment by way of example and wherein:

Figure 1 is a view, partly in section, of a type of heater to which the present invention is applied;

Figure 2 is a side elevation of a part of Figure 1 showing the arrangement of controls for the heater;

Figure 3 is an end view of Figure 1 as seen from the right;

Figure 4 is a sectional view of a bypass type of burner nozzle;

Figure 5 is a sectional view of a temperature responsive modulating valve;

Figure 6 is a schematic view to illustrate the operation of burner controls;

Figure 7 is a sectional view of a snap acting pressure seated valve;

Figure 8 is a sectional view of a flow controlling valve; and

Figure 9 illustrates a modification to equalize air temperatures at the discharge end of the heat exchanger.

Referring to the drawing, Figures 1 and 2, the heater is mounted on a fuel tank 1 which serves as a sledge or chassis, and comprises an outer cylindrical jacket 2 having a cylindrical heat exchanger 3 within the jacket held in spaced relation thereto by U-shaped pads or lugs 4 so as to provide an air passageway 5 between the outer jacket 2 and the outer wall of the heat exchanger. The heat exchanger has a cylindrical peripheral wall with an opening to which is secured a stack 5', an end wall 6 and an end wall 7, the latter having an opening 8 which receives

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a tubular extension 9 fastened thereto. Flattened lune or crescent shaped tubes 11 spirally arranged in walls 6 and 7 of the heat exchanger provide longitudinal passageways 12 for flow of air to be heated through the heat exchanger. One such type of heat exchanger is described and claimed in Patent No. 2,421,371 to Stanley J. Budlane, and need not be described here in greater detail.

At its open outer end extension 9 carries side fingers or hooks 13, each hook having a vertical slot 14, and the hooks each end in a knob or bill 14'. A cap or cover plate 15 has an offset flange 16 around a central depressed portion, the flange being notched or cut away at diametrically opposite sections to accommodate hooks 13. This cap is received on the end of extension 9 with the depressed portion received within the extension and the flange 16 resting on the edge of the extension so the notches accommodate the hooks 13. This cover plate has a central opening 18 to receive the burner nozzle 19, the burner nozzle being attached to a cross bar 22 in any suitable manner, and the cross bar preferably is offset to provide portions engaging the hooks 13 so that by rotating the cross bar the burner and cover can be removed.

A spark plug has its electrode extending through a hole in the cover in proximity to a grounded electrode on the cover and acts as an igniter. The cover plate has openings 28 for admission of air, and tabs 29 over the openings act to deflect air toward the burner nozzle. Suitable openings 31 in the extension 9 also provide for admission of air to the burner.

A fan 32 (Figure 1) at the end of the jacket 2 forces a stream of air past deflector 33 and radial vanes 34 into a plenum chamber 35, from which chamber some air flows to the burner through holes 28 and 31, and some air flows through passages 5 and 12. With the burner operating, the products of combustion pass spirally between the lune shaped tubes 11 and discharge to the stack 5' secured in an opening to the outer wall of the heat exchanger and passing through jacket 2, while the air that flows through passages 12 in tubes 11 is heated and is discharged at the opposite end chamber 37 of the heater, as will be explained later in greater detail.

The burner nozzle 19 preferably is of the bypass type, fuel being supplied thereto by a main supply conduit 38. One such type of burner nozzle is illustrated in Figure 4 by way of example. It comprises an internal sleeve 40 having a central bore 41 therein providing a reduced passage 42. The burner has a flared combustion jet orifice 45. Fuel is supplied by conduit 38 to the space 46, flows therefrom through radial bores 47 to the conical chamber 48, and some of the fuel escapes as a spray or jet through tip or jet outlet 45. Excess fuel flows from conical chamber 48 through jet bypass orifice 42 and central bore 41 to the jet bypass line 39, the bore 41 thus being part of the jet bypass conduit. It will be seen that with the fuel supplied at a constant pressure, the more the jet bypass line 39 is throttled, the more fuel issues through the combustion jet outlet 45; and conversely, the less the jet bypass line is throttled, the less fuel issues through the jet outlet.

Referring now to Figure 6, the pump 49 draws fuel through the filter 51 from tank 1. The supply line 38 from the pump has a spring loaded pressure relief valve 55 therein between the burner nozzle and the pump. Valve 55 is set to open at a predetermined pressure, and until the opening pressure of valve 55 is attained there can be no flow through line 38 to the burner. The fuel from the pump, under such condition, returns by line 52 to the tank, so valve 55 insures against flow of fuel to the burner nozzle when the pump pressure is too low, as when starting or stopping. Excess fuel from the burner returns by the jet bypass conduit 39, 61, normally open valve 63 and pipe 53 to the tank,

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so that the jet bypass conduit comprises bore 41, pipes 39, 61 and 53. A second or main bypass or relief line 56 is provided extending from the conduit 38 to the jet bypass conduit, the main bypass conduit having an open or shut control valve 57 therein. When valve 57 is open the fluid from the pump escapes therethrough to return line 53, thus preventing the pump outlet pressure from building up enough to open valve 55. A check valve 58 in the return line may be set to open at some low value, on the order of three pounds per square inch, thus providing a sufficient back pressure to insure a fuel supply through conduit 59 to the carburetor for the gasoline engine that drives the pump, and a hand pump 59' may be provided to prime the carburetor at the start. When the valve 57 is closed, the fuel flows by conduit 38 past check valve 55 to the burner nozzle 19 and the bypass flow in conduit 39 goes past check valve 60 and then flows by conduit 61 and valve 63 to return line 53 as above mentioned. The valve 63 is shunted by a control valve 64 in a shunt line or bypass 62 which extends from jet bypass conduit 39 to return conduit 53. As valve 64 is generally closed at the start of the burner, the entire bypass flow is through valve 63. Check valve 60 provides a minimum back pressure in the jet bypass conduit 39. The construction and purpose of the valves 57, 63 and 64 now will be described and explained.

The construction of the open or closed valve 57 is illustrated partly diagrammatically in Figure 7. The body 65 has a chamber 66 closed by a bonnet 67. The inlet 68 connects to chamber 66 by a duct 69, and an orifice bushing 71 connecting the chamber 66 with the outlet 72 has a seat 73 at its upper end to receive a ball valve 74. A diaphragm housing 75 contains a diaphragm 76 that is biased by a spring 77 in the chamber 78 under the diaphragm. The chamber 78 is connected by a suitable liquid filled capillary tube 79 to a temperature responsive bulb 81 (Figures 3 and 6) at the heated air outlet of the heater, so that as the heated air temperature rises, the pressure in chamber 78 increases, thus gradually moving the diaphragm 76 upwardly.

The orifice fitting 71 provides a guide for a flanged yoke or cage 82, and a spring 83 is interposed between the flanged sleeve of the yoke and an internal shoulder on bonnet 67. A plurality of pins 85 pass through the body 65 and abut the flanged sleeve 82 and diaphragm 76 so that spring 83 acts against and partly counterbalances spring 77. A stem 87 passing through the neck 88 of the yoke has a socket or cage 89 at its end to carry ball 74, and its other end has an abutment collar 91. When there is no substantial pressure at inlet 68, as for example, when the pump is not in operation, or when fuel is flowing through valve 57, spring 77, which is stronger than spring 83, holds flanged yoke 82 elevated, and a spring 92 between the sleeve neck 88 and collar 91 biases the valve stem 87, socket 89 and ball 74 away from the seat 73, the upward movement of the socket 89 being limited by engagement with the neck 88. A thimble 94 surrounds the spring 92, and a stem 96 with a knob 97 thereon extends through the thimble and bonnet, the stem being sealed against leakage by a suitable packing.

The ball 74 can be seated only when pins 85 have been retracted by bellows or diaphragm 76. In this condition, when stem or plunger 96 is depressed, it engages stem 87 and pushes ball 74 against its seat. With valve 74 closed the pump outlet pressure quickly builds up sufficiently to hold the ball seated against the unseating force of springs 77 and 92, and liquid fuel now is supplied to the burner through valve 55 in line 38. The valve 55 prevents flow of fuel to the burner until a predetermined minimum pressure is built up at the pump. At this time it may be pointed out that valve 57 is an overheat limit valve and should the air tem-

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perature delivered by the heater get too high, the thermo responsive element 81 will cause a pressure to build up in chamber 78 that augments the force of spring 77 and causes the diaphragm 76 to raise. This movement is transmitted through pins 85 to raise yoke 82, which in turn compresses spring 92 enough to raise the stem 87 against the fuel pressure, so as to lift valve ball 74 off its seat, and thus stop flow of fuel to the burner.

As the conduit 38 usually supplies an excess of fuel to the burner nozzle during operation (excepting when the burner nozzle is passing fuel at the maximum capacity) there is usually a bypass or return flow through conduit 39 to reduce the flow at the burner nozzle orifice. At the start valve 64 is closed, so this bypass flows through conduit 61 and valve 63 to return conduit 53.

Throttle valve 63 and its purpose now will be explained. Referring to Figure 8, the valve 63 has a body 101 with diaphragms 102, 103 secured at the top and bottom of the body to provide chambers 104, 105 connected by ducts 106, 107 to inlet 108 and outlet 109, respectively. A cover 110 for diaphragm 103 provides a chamber 111 and houses a spring 112 therein. A bulb 113 which is subject to atmospheric temperature is connected by a capillary tube 114 to chamber 111 so that atmospheric temperature changes cause changes in volume of the fluid in chamber 111 acting on diaphragm 103. A cover 116 for diaphragm 102 houses a spring 117 bearing on the diaphragm, the pressure of this spring being adjustable by a screw threaded stem 118, or the like.

A bore 119 in the body 101 extends between chambers 104, 105 and has an orifice fitting 121 in its lower end with an orifice 122 therein. A valve member 123 in this bore with a suitable clearance has at one end a rounded knob 124 to engage the lower face of diaphragm 102, and at the other end a tapered metering valve end 125 that passes through orifice 122 and engages diaphragm 103. Thus the position of metering valve end 125 in orifice 122 determines the rate of flow from conduit 61 and inlet 108 through duct 106, chamber 104, and bore 119 into chamber 105, duct 107, outlet 109, and conduit 53 to tank 1. That is, the free area of orifice 122 controls the flow in the burner nozzle bypass line 39, and thus determines the flow at the burner jet opening 45.

The position of metering valve 125, or the free area of orifice 122 is determined by the vertical position of valve member 123 which constantly engages diaphragms 102 and 103. The downward force on diaphragm 102 is regulated by the adjustment of spring 117, and the upward force on diaphragm 103 is determined mainly by the fluid pressure in chamber 111, which in turn, varies with atmospheric temperature. The spring 112 causes diaphragm 103 to maintain contact with the lower end of valve 123. These two opposing forces are also opposed or augmented by the fluid pressure in chambers 104 and 105. Assuming a fixed adjustment of spring 117, the position of valve 123 will be determined solely by atmospheric temperature, and it will be maintained by diaphragms 102, 103 so as to keep a constant pressure in chamber 104 and at orifice 42 at a constant atmospheric temperature. At low atmospheric temperature the contraction of fluid in chamber 111 allows spring 117 to position valve 123 downward and thus restrict orifice 122. The restriction of this orifice reduces the flow through bypass conduits 39, 61, thus causing an increased flow of fuel at burner tip outlet 45. Conversely, an increase in atmospheric temperature counteracts the loading of spring 117 on diaphragm 102 and opens metering orifice 122 and reduces the fuel flow at burner tip outlet 45. Now, assuming a constant atmospheric temperature, when screw 118 is turned to increase the compression of spring 117, a higher back pressure builds up in conduit 39 because metering valve

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123 moves to restrict orifice 122 to maintain a higher back pressure at jet orifice 42 and thus increase the full flow at burner tip outlet 45, and conversely a decrease in spring compression causes a decrease in fuel flow at the burner tip outlet. The screw 118 may be calibrated in units of altitude, and thus can be adjusted for any given altitude. Essentially, valve 63 is a back pressure regulating valve which is automatically adjusted by ambient temperature, and is manually adjusted for barometric pressure changes.

In the heated construction illustrated, the fan 32 supplies a substantially constant volume of air to the burner, regardless of the atmospheric temperature and pressure. Because cold air is denser than warm air, it is necessary at low atmospheric temperatures, to reduce the flow of fuel at the burner tip, while at high altitudes where the air is rarer, it is also necessary to reduce the flow of fuel at the burner tip, in order to provide the proper ratio of fuel and air for combustion. The throttling valve 63 performs this function at the start by controlling the amount of fuel which bypasses the burner back to the tank and thus determines the maximum flow at tip outlet 45 for the particular altitude setting of screw 118 and the prevailing atmospheric temperature.

If the burner is designed to operate through an atmospheric temperature range of -65° to $+60^{\circ}$ F., and at altitudes from sea level to 10,000 feet above sea level, the fan 18 will deliver the maximum gravimetric quantity of air at -65° at sea level. Assuming a constant atmospheric temperature, as the altitude increases the air becomes rarer and thus the fan delivers a smaller gravimetric quantity of air. The controller screw 118 can be adjusted for the particular altitude to increase the flow of fuel through orifice 122 and reduce the flow at burner tip 45 so as to maintain the desired constant proportion of fuel and air at the burner. Thus, by turning screw 118 to decrease the force exerted by spring 117 on diaphragm 102, the valve 123 will rise to allow a greater flow through orifice 122 and through the burner bypass, so less fuel will flow out of burner tip 45. Conversely, an increase in force exerted by spring 117 will decrease the burner bypass flow and thus increase the fuel flow through tip 45.

Now assuming a constant altitude and an atmospheric temperature of -65° F., as the atmospheric temperature increases, the expansion of liquid in bulb 113 exerts a greater force on diaphragm 103 thus raising valve 123 to allow a greater flow through orifice 122. Thus an increase in atmospheric temperature results in an increased burner bypass flow and a reduced flow through the burner tip 45. The temperature responsive element may be calibrated for the ambient temperature range to be encountered.

After the apparatus has become warmed the valve 64 regulates the fuel flow through the burner tip 45 in accordance with the temperature of the heated air issuing from the heater at end 37, as will now appear. Valve 64 is described and claimed in Patent No. 2,505,933 issued May 2, 1950, to Clarence L. Aughey et al., and need be described here only briefly. Referring to Figure 5, a diaphragm 128 provides a chamber 129 containing fluid subject by means of capillary tube 130, to the temperature responsive element 131 located at the heated air outlet. This diaphragm acts through pin 132 on a yoke 133, and a spring 134 acts contrariwise on the yoke. A stem 135 on valve 136 passes through the yoke and a spring 137 is interposed between the yoke and a cap on the stem. Lifting of diaphragm 128 opens the valve 136 to allow flow from inlet 138 to outlet 139. The stem 141 adjusts the pressure of spring 134 on the diaphragm. As the temperature of the heated air rises the diaphragm 128 raises in response to the action of thermo responsive element 131 until the valve 136 begins to open at a temperature which depends on the setting of stem 141. The opening of valve 136 allows flow

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through bypass line 62 to augment the flow through line 61, and thus reduces the flow at burner tip 45. If the temperature of the heated air continues to increase at element 131 the fuel flow to the burner is further decreased by further opening of valve 136, thus reducing the heating effect of the burner. When the temperature of element 131 begins to fall the fuel flow to the burner tip begins to increase, thus maintaining the heated air at a predetermined temperature range.

The primer pump 59', starting valve 57, limiting valve 63, and temperature control valve 64 are housed together in a casing 142 so they may be removed with the casing as a unit for repair.

The operation of the control system now will be described: To start the motor, hand pump 59' is operated to pump fuel to the carburetor. When the motor and pump 49 start, fuel flows through bypass line 56 and through open valve 57, and returns by line 53 to the tank 1. The spring loaded valve 58 insures a sufficient back pressure in line 53 to supply the carburetor through line 59. To start burner 19, the igniter is operated and rod 96 is pushed down manually to close ball valve 74, whereupon pressure builds up in chamber 66 to hold the valve 74 closed. The outlet pressure of the pump builds up enough to open valve 55 to supply fuel to the burner, and as valve 64 is closed and valve 63 is open, the bypass from the burner returns to the tank by line 61. Valve 63 is set for the particular altitude and atmospheric air temperature encountered so the fuel issuing from burner orifice 45 is in the correct proportion to the air supplied by fan 32. The air issuing at 37 thus becomes heated.

Valve 64 stays closed until the temperature of the air issuing at 37 has reached a predetermined value, which may be 120° F. by way of example, and then valve 136 therein starts to open. This allows an additional bypass flow through line 62 that reduces the flow at the burner opening 45 until the air temperature at 37 reaches a desired value, for example about 250° F., and the air temperature thus is kept within the desired range.

If for any reason, the air temperature continues to rise above about 250° to about 360° , the pressure developed in chamber 78 by thermostat 81 moves diaphragm 76 to raise yoke 82, thus increasing the compression of spring 92 on flange 91 until valve 74 lifts off its seat, thus cutting off flow of fuel to the burner. When this occurs, the fuel supply to the burner can only be restored by manually depressing rod 96 after the bulb has cooled.

Referring to Figures 1, 3 and 9 it will be seen that the front end of jacket 2 carries a plate 145 having openings 146 therein, and a second similar plate 147 has registering openings 148. By rotating plate 147 the openings 146 may be decreased in size to change the volume of heated air discharged from the heater. This register plate 147 may be rotated by means of a rod 149 operated by a knob 150 on a Bowden wire or other remote control arrangement. The heat exchanger is designed to allow a flow of air in the lunes 12 greater near the center than near the periphery in order to reduce the temperature spread of the heated air between the center and periphery. This temperature spread may be reduced further by the provision of radial tubes 151 on the plate 147, these tubes having skewed inner ends 152 and having open ends at the periphery. Thus, part of the cooler air near the periphery is scooped into the tubes and carried to the center where it mixes with the hotter air to provide a more equalized temperature in the air stream.

I claim as my invention:

1. An air heater comprising a heat exchanger having a combustion chamber and an air heating chamber; a burner nozzle in the combustion chamber; a supply conduit connected to the burner nozzle; a blower for supplying air to the combustion chamber and air heating chamber, said burner nozzle having a combustion jet orifice and a jet

bypass conduit; a pump connected to said supply conduit for supplying fuel to the burner nozzle at a substantially constant pressure; a main bypass conduit connected to the supply conduit; a normally closed valve in said main bypass conduit; means responsive to a predetermined rise in temperature of the heated air for unseating said valve to cut off the supply of fuel to the burner nozzle, said means preventing reseating of the valve as long as the temperature of said means is not below the predetermined unseating temperature; manually operated means for restoring the valve to its seat to restore fuel flow to the burner; a throttling valve in the jet bypass conduit; atmospheric temperature responsive means operating to open the throttling valve in response to increase in atmospheric temperature to reduce the flow of fuel from the jet orifice; a conduit for flow of fuel shunted around the throttling valve; a control valve in said latter conduit; and means controlled by the temperature of the heated air to open said control valve above a predetermined temperature to bypass flow around said throttling valve and reduce the flow of fuel from the jet orifice.

2. A fuel combustion system comprising: a burner; means including a main conduit for supplying fuel to said burner; a relief conduit connected to said main conduit and including a valve having a floating valve closure member adapted to be held in closed position on its seat by fuel pressure; means engageable with the valve closure member for unseating said valve closure member; temperature responsive means operative above a predetermined temperature produced by said burner to operate said second means to unseat said closure member and hold said closure member unseated at or above said predetermined temperature; and manually operated means engageable with said closure member through a lost motion connection for restoring said valve closure member to its seat.

3. A fuel combustion system comprising: a fluid fuel burner; means including a main conduit for supplying fluid fuel to said burner; a relief conduit connected to said main conduit and including a valve having a floating valve closure member adapted to be maintained on its seat by fluid pressure; retractible means to unseat said valve closure member; means operative upon unseating of said valve closure member to move said valve closure member away from its seat to hold said valve closure member open independently of the position of said retractible means; manually operative means acting oppositely to the retractible means for returning the valve closure member to its seat when the retractible means is retracted; and temperature responsive means subject to a temperature effect produced by said burner and operative at a predetermined maximum temperature to move said retractible means in a direction to move said closure member to open position.

4. A fuel combustion system comprising: a burner; a fuel supply conduit for supplying fuel to the burner; a relief conduit connected to said supply conduit including a valve maintained in closed position by fuel pressure; temperature responsive means effective at a predetermined maximum temperature produced by the burner to open said valve to cut off flow of fuel to said burner, said means preventing closing of said valve by fuel pressure as long as said temperature responsive means has not fallen below said predetermined maximum temperature; and manually operated means for moving said valve to closed position to restore flow of fuel to the burner when said temperature responsive means is below said predetermined maximum temperature.

5. A fuel system as specified in claim 4 wherein: the burner is of the jet bypass type and has a combustion jet orifice and a jet bypass orifice; there being a third conduit connected to the jet bypass orifice of said burner; a throttling valve in said third conduit; and means responsive to atmospheric temperature to open said throttling valve with increase in atmospheric temperature.

6. A fuel combustion system as specified in claim 4 having: a heat exchanger; means supplying a flow of air

to be heated along one side of the heat exchanger; and wherein said maximum temperature produced by said burner is the temperature of the air heated in the heat exchanger; and said burner is of the bypass type.

7. A fuel combustion system as specified in claim 6 wherein: said burner has a combustion jet orifice and a jet bypass orifice; there being a third conduit connected to the jet bypass orifice; a modulating valve in said third conduit; and means responsive to a temperature of the air heated in the heat exchanger above a minimum for opening said modulating valve to decrease escape of fuel from the jet orifice with increase in temperature of the heated air.

8. A fuel combustion system as specified in claim 7 having: a fourth conduit shunted around said modulating valve; and adjustable valve means in said fourth conduit to control the flow of fuel through said jet orifice.

9. A combustion system as specified in claim 4 having: means responsive to atmospheric temperature for opening said adjustable valve with increase in atmospheric temperature to decrease escape of fuel from the jet orifice.

10. An air heater as specified in claim 4 having: a spring resiliently biasing said valve to open position, the fluid pressure serving to hold the valve closed in opposition to said bias; and wherein said first means includes a member movable in one direction to compress said spring to move said valve to open position against the fluid pressure.

11. In a combustion system for a fluid fuel burner: a fluid fuel burner nozzle having a jet orifice; a fuel line for supplying fuel to the burner nozzle; a return line for fuel connected to said burner nozzle at one end and adapted to connect to a fuel tank at its other end; a throttling valve in said return line controlling the escape of fuel from said jet orifice, by controlling the flow of fuel in said return line; atmospheric temperature responsive means operative to open said valve in response to rise in atmospheric temperature to decrease the escape of fuel from the jet orifice; a conduit for flow of fuel shunted around said throttling valve; a modulating valve in said shunted conduit; and means responsive to a temperature above a minimum produced by said burner for opening said modulating valve to decrease escape of fuel from the jet orifice with increase in burner produced temperature.

12. A combustion heater comprising: a bypass type burner nozzle having a combustion jet orifice and a bypass orifice; a main fuel conduit connected to the nozzle for supplying fuel to said orifices; a second conduit connected to said bypass orifice; a valve resiliently biased to closed position in said second conduit for controlling the back pressure at the jet bypass orifice to thereby control flow through said combustion jet orifice; means responsive to ambient air temperature for opening said valve with increase in air temperature to correspondingly reduce the back pressure at the jet bypass orifice; means to manually adjust the resilient bias of said valve; a second third conduit for flow of fluid shunted around said valve; a control valve in said second third conduit; and means responsive to the temperature produced by the burner nozzle for opening said control valve with increase in temperature above a minimum.

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