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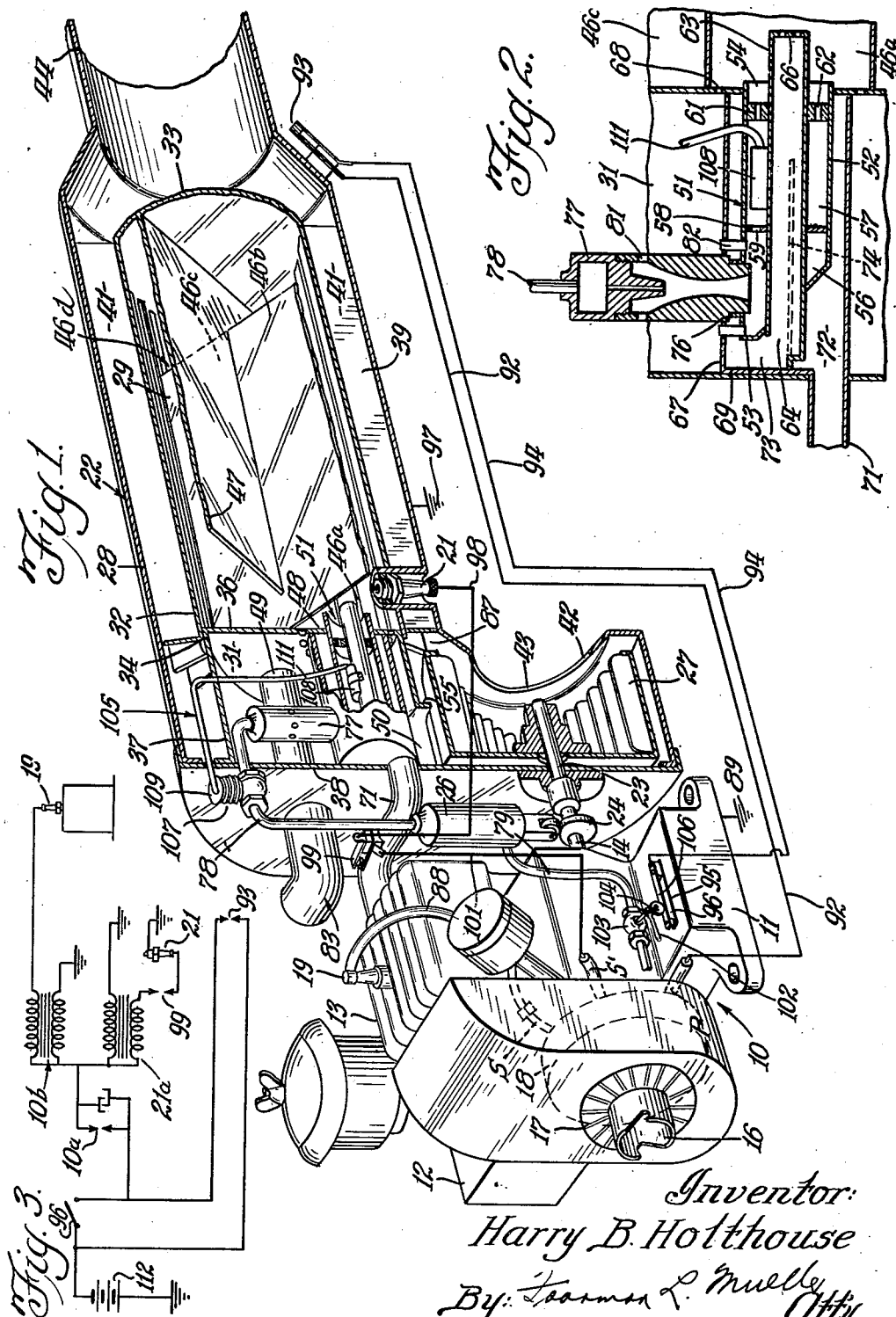
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2,384,468

CONTROL SYSTEM

Filed Jan. 19, 1942

2 Sheets-Sheet 1



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CONTROL SYSTEM

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2 Sheets-Sheet 2

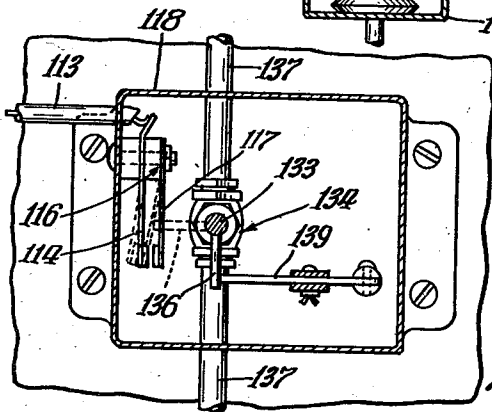
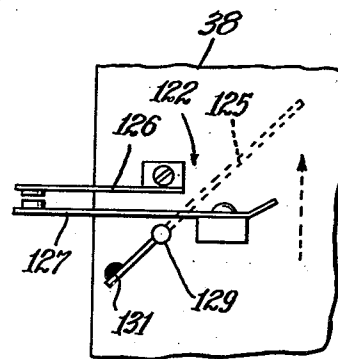
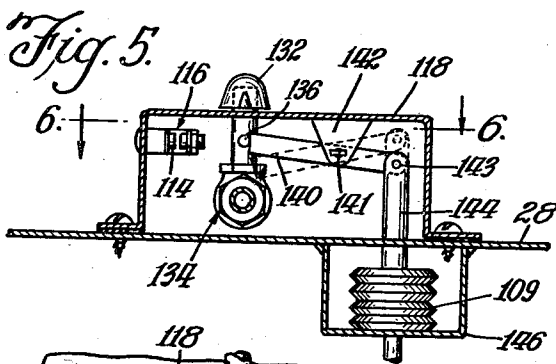
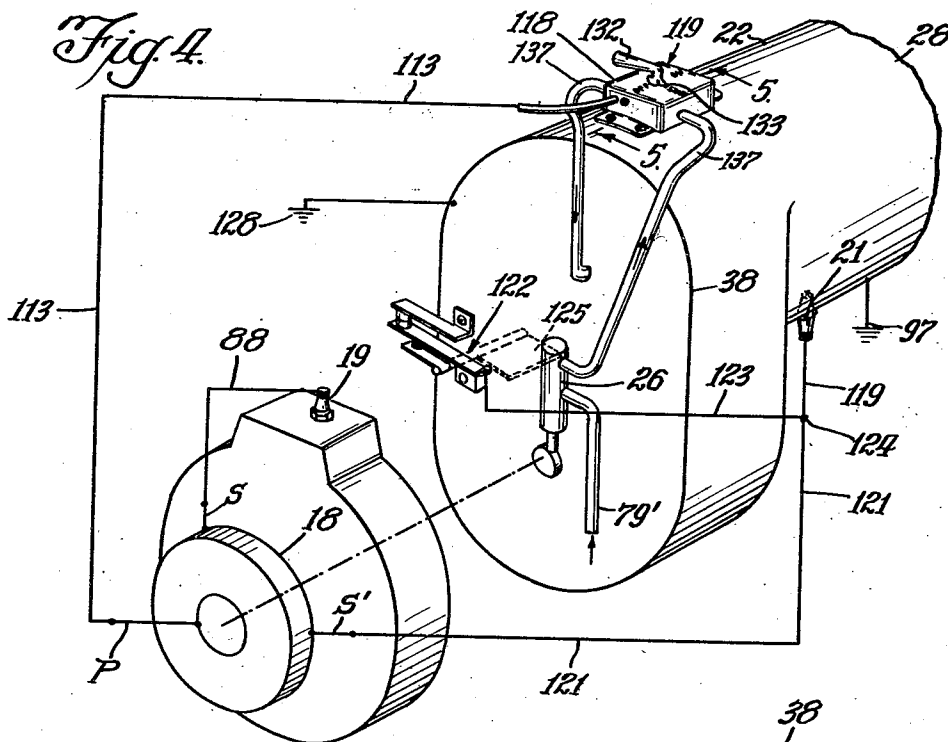


Fig. 6.

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UNITED STATES PATENT OFFICE

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CONTROL SYSTEM

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This invention relates generally to control systems for heating apparatus and particularly to a control system for heating apparatus including a heater of internal combustion type adapted to be operated entirely in conjunction with an internal combustion engine.

It is an object of this invention to provide an improved control system for heating apparatus.

Another object of this invention is to provide a control system for a heating unit of internal combustion type adapted on starting of said heating unit to have air supplied to the unit prior to the admission of any fuel thereto so as to prevent the occurrence of any explosions on initiation of ignition.

A further object of this invention is to provide a control system for a heater of internal combustion type having air and fuel supplied thereto for burning by means operated by a common motor, in which the motor operating circuit is made operative to start the motor prior to the energization of the circuit for the heater ignition means, and time delay means are operatively related with the fuel supply means for the heater so that fuel is admitted to the heater only after the heater air supply means and ignition circuit are in operation.

Another object of this invention is to provide a control system for a heating unit comprising a burner direct connected for operation with an internal combustion engine, which provides for a positive operation of the unit, is comprised of but a few parts requiring a minimum of adjustment and servicing attention, and which is adapted to always start the unit according to a predetermined pattern of operations to provide maximum operating safety and efficiency.

A particular feature of this invention is found in the provision of a control system for a heating unit including a burner having fuel vaporizing means heated by exhaust gases from an internal combustion engine operatively associated with the burner, which provides for the operation of the air supply means and the ignition circuit for the burner prior to the admission of fuel thereto, and includes means for delaying such admission of fuel until after the vaporizing means has been heated to at least a fuel vaporizing temperature by the engine exhaust gases.

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 front perspective view partly in section of a heating unit including an internal com-

bustion burner operatively connected with an internal combustion engine showing one form of the control system applied thereto;

Fig. 2 is a fragmentary sectional view as seen along the line 2—2 in Fig. 1 showing an air and fuel mixing device for the burner;

Fig. 3 illustrates diagrammatically a battery circuit for the engine and the burner in the heating unit of Fig. 1;

Fig. 4 is a diagrammatic perspective view of a heating unit similar in all respects to the heating unit of Fig. 1 but embodying a modified form of control system;

Fig. 5 is a transverse sectional view taken along the line 5—5 in Fig. 4 showing the construction of a control mechanism utilized in the control system of Fig. 4;

Fig. 6 is a plan sectional view as seen along the line 6—6 in Fig. 5; and

Fig. 7 is a detail view of a sail switch used in the control system illustrated in Fig. 4.

In practicing this invention there is provided a heating unit including a burner of internal combustion type having a combustion chamber operatively associated with an air and fuel mixing device. The burner is operated entirely in conjunction with an internal combustion engine adapted to operate a fuel pump and blower for supplying fuel and air, respectively, to the air and fuel mixing device and hence to the burner. In the operation of the heater, the mixing device is heated to at least a fuel vaporizing temperature by the exhaust gases from the engine, so that the fuel supplied to the mixing device is practically completely vaporized for mixing together with the air in the device prior to the passage of the mixture into the burner combustion chamber. The invention, contemplates the provision of a control system for the heating unit which operates in part to provide for the initial operation of the engine for a period of time sufficient to allow the exhaust gases therefrom to heat the mixing device to at least a fuel vaporizing temperature. By virtue of the air blower being in a driven connection with the engine, combustion air is supplied to the burner immediately on starting of the engine, with means being provided to set the burner ignition system in operation before the mixing device is heated to its fuel vaporizing temperature. A valve in the fuel line leading from the engine-operated fuel pump to the mixing device, is actuated by means responsive in operation to the temperature of the mixing device. When the mixing device reaches a substantially fuel vaporizing temperature the valve

actuating means operates the valve to admit fuel to the mixing device. Thus the control system functions to have the burner air supply and ignition means in operation prior to the supply of any fuel to the burner combustion chamber so as to completely eliminate any occurrence of explosions which might result from fuel accumulations in the combustion chamber. Since fuel is supplied to the burner only after the mixing device therefor is completely operative to vaporize the fuel for mixing with the air, combustion in the burner is complete and efficient immediately at the inception of burner operation.

Referring to the drawings there is shown in Fig. 1 an internal combustion engine 10 of air cooled type including a base 11, a fuel tank 12, and a cylinder 13. The engine crank shaft 14 extends outwardly from each side of the engine 10, with one end 16 thereof carrying a blower 17 for cooling the cylinder 13, and a magneto 18 operatively associated with a spark plug 19 in the engine cylinder 13, and a plug or igniter 21 provided in a heater or burner 22 of internal combustion type. The opposite end 23 of the engine crank shaft 14 has mounted thereon a cam 24 for operating a pump 26 adapted to supply fuel for burning to the heater 22. Also mounted at the shaft end 23 is a blower 27 for supplying air for combustion to the heater 22, and for circulating air to be heated through the heater 22 as will be later fully described.

The heater 22 is comprised of a substantially cylindrical housing member 28 having a combustion chamber 29 and an air chamber 31 therein. The combustion chamber 29 has a tubular outer wall 32 having one end closed by a cover plate 33 and an opposite end 34 by the base portion 36 of a substantially cup-shaped member 37 which defines the air chamber 31. The open end of the member 37 is closed by a cover or end plate 38 for the housing member 28. Thus as is evident from Fig. 1 the air chamber 31 and combustion chamber 29 are in alignment axially of the housing member 28 and separated from each other by the base portion 36 of the cup-shaped member 37. These two chambers are spaced from the heater housing 28 by fins 39 angularly spaced about the combustion chamber wall 32 and extending axially thereof to provide an annular passage 41 about the chambers 31 and 29. The air to be heated is circulated through the passage 41 by the fan or blower 27, the casing or scroll of which includes the cover plate 38 and a radially extending L-shaped portion 42 of the housing member 28. The portion 42 is formed with an air inlet 43, the air after being circulated about the combustion chamber 29 through the passage 41 being discharged from the heater 22 through the outlet 44 thereof.

The combustion chamber 29 is divided into four axially extending passages 46a-46d by a partition member 47 of substantially X-shape and of a construction providing for the connecting of such four passages to form a single continuous passage in the chamber 29. By virtue of this construction of the continuous passage the inlet 48 and outlet 49 of the passage and hence of the combustion chamber 29 are both located in the base portion 36 of the cup-shaped member 37.

Located within the air chamber 31 and at the inlet 49 to the combustion passages 46a-46d is a fuel conditioning unit (Fig. 2) designated generally as 51 and including a substantially tubular shaped housing 52 closed at one end 53 and having the opposite or outlet end 54 thereof in fluid

communication with the combustion chamber passage 46a. As is evident from Fig. 1 the greater part of the conditioning unit 51 extends within the air chamber 31. The housing member 52 is constructed of a high heat conducting material and includes an air and fuel mixing chamber 56 at the closed end 53 thereof and an equalizing chamber 57 adjacent thereto, the mixing chamber 56 and equalizing chamber 57 being separated by a heat conducting partition plate 58 having perforations 59 therein fluid connecting such two chambers (Fig. 2). The equalizing chamber 57 in turn is separated from the combustion passage 46a by a heat insulating plate 61 having perforations 62 arranged peripherally therein. Extending axially through the housing member 52 and supported in the housing end 53 and partition plates 59 and 62, is a heating element or conduit portion 63 having an inlet end 64 at the housing closed-end 53 and an outlet portion 66 extending with the combustion passage 46a.

Arranged in a spaced concentric relation about that portion of the housing member 52 which extends into the air chamber 31 is a conduit portion 67 in sealed engagement at one end 68 with the base portion 36 of the member 37 and connected at its opposite end 69 with an exhaust conduit 71 from the engine 10. The annular space formed within the conduit 67 and about the housing member 52 is divided into connected passages 72 and 73 by a partition or baffle plate 74 adapted to direct the exhaust gases entering the conduit 67 from the exhaust pipe 71 to travel in the passage 72 to the conduit end 68, and then in an opposite direction in the passage 73 into the inlet 64 of the heating element 63, from where it is discharged through the heating element outlet 66 into the combustion passage 46a. Since the housing member 52, partition plate 58 and heating element 63 are all constructed of high heat conducting material, the heat from the engine exhaust gases passing about the housing 52 and in the passages 72 and 73 is readily transferred to the heat conditioning unit 51 for a purpose now to be explained.

The fuel conditioning unit 51 has an inlet 76 at the closed end 53 thereof in which is positioned an air and fuel nozzle 77. As best shown in Fig. 2 the nozzle 77 has one end thereof extending through the conduit 67 into the air chamber 31. This extending end of the fuel nozzle 77 is connected through a pipe 78 with the fuel pump 26, which is in fluid connection with the fuel tank 12 through pipe 79. The fuel from the nozzle 77 is introduced into the mixing chamber 56 of the fuel conditioning unit together with combustion air from the air chamber 31, this combustion air being admitted into the fuel nozzle through ports 81 and through tubes 82 arranged about the inlet 76 and connecting the mixing chamber 56 with the air chamber 31. The fuel thus admitted into the mixing chamber 56 is heated and vaporized for mixing together with the air therein, the vaporous mixture passing through the apertures 59 in the partition plate 58 and into the equalizing chamber 57 from where it is discharged through the apertured insulating plate 61 into the combustion passage 46a. This vaporous mixture is mixed with the exhaust gases from the heating element outlet 66 for burning therewith in the combustion chamber 29. Combustion is initiated by the spark means 21 positioned in the combustion chamber passage 46a and operatively connected in a manner to be later fully explained

with the engine magneto 18. The gases from combustion are exhausted from the combustion passage outlet 49 into a tail piece assembly 83 for discharge from the heater.

As previously mentioned the air for combustion in the chamber 31 is supplied by the blower or fan 27. As shown in Fig. 1 a portion of the cup-shaped member 37 has an opening 50 formed therein with radially extending portions 55 of a contour corresponding to the fan 27. Thus a portion of the air delivered by the fan is diverted for passage into the chamber 31, the remaining portion going into the air circulating passage 41 of the heater.

From the above description it is seen that when the heater 22 is in operation the conditioning unit 51 is heated to a substantially fuel vaporizing temperature by the exhaust gases from the engine 10 to provide for a thorough mixing of the air and fuel in the unit and consequently for a complete and efficient burning of all of the fuel supplied to the burner. This manner of operating the heater 22 at all times of heater operation is accomplished in the present invention by the novel control system now to be described.

With reference to Fig. 1 the control system shown therein includes an ignition circuit for the engine 10 comprising the spark plug 19 connected to a secondary winding S of the magneto 18 by a conductor 88. The primary winding P of the magneto is selectively connected with an engine ground, indicated at 89, through conductor 92, normally closed thermostatic switch 93, conductor 94 and a normally closed manually operated control switch 96 having one contact 95 thereof grounded to the engine base 11. The spark means 21 for the heater 22 is grounded to the heater as indicated at 97 and is connected with the secondary S' of the magneto 18 through conductor 98 normally open thermostatic switch means 99, and conductor 101. The thermostatic switch means 93 in the engine ignition circuit is thermally connected with the combustion chamber 29 so as to be responsive to the temperature thereof, while the thermostatic switch means 99 in the heater ignition circuit is mounted on the engine exhaust conduit 71 so as to be actuated in response to the temperature thereof.

The manually operated control switch 96 includes an actuating arm 102 which is also common to a valve unit 103 connected in the fuel line 79. A cam 104 carried by the valve unit 103 is in a following operating relation with the contact 106 of switch 96 so that pivotal movement of the actuating arm 102 opens and closes the contacts 106 and 95 concurrently with an operation of the valve 103 to control the supply of fuel to the pump 26. When the heater 22 is not in operation the actuating arm 102 is in its position shown in Fig. 1 which corresponds to a closed position of the valve unit 103 and a closed position of the contacts 106 and 95 of the switch unit 96. In the operation of the control system to initiate operation of the heating apparatus the actuating arm 102 is moved in a clockwise direction as viewed in Fig. 1, to permit opening of the contacts 95 and 106 concurrently with an opening of the valve unit 103 to admit fuel from the tank 12 to the pump 26. The opening of the control switch 96 removes the ground 89 from the primary P of the magneto 18 to permit a spark being produced at the plug 19. It is to be understood of course that with the engine ignition circuit thus made operative that the closed thermostatic switch 93 is ineffective in grounding the

primary P by virtue of its series connection with the switch unit 96. With the engine ignition circuit thus made operative, the engine 10 may be started as by hand cranking or suitable self-starting means (not shown).

On starting of the engine, the pump 26 and blower 27 are set into operation immediately, the blower 27 supplying air to the chamber 31 for passage through the conditioning unit 51 into the combustion chamber 29 and also air for circulating through the heater passage 41. The pump 26, however, is ineffective to supply any fuel to the fuel conditioning unit 51 because of a normally closed valve unit 107 inserted in the fuel line 78 between the fuel injection nozzle 77 and the pump 26. It is seen, therefore, that only air is delivered to the burner when the engine 10 is first started.

It is apparent, of course, that with the engine 10 in operation the exhaust gases therefrom are discharged through the conduits 71 and 67 and through the heating element 63 into the combustion passage 46a. With a continued operation of the engine 10 the heat from these exhaust gases in the conduit 71 act on the normally open thermostatic switch means 99 to provide for a closing of the same, this closing of the thermostatic switch means 99 connecting the plug 21 with the secondary S' of the magneto 18. Thus on closing of the switch means 99 the burner ignition circuit is set into operation to fire any combustible mixture which might be present in the combustion chamber passage 46a. This sequential operation of the fan 27 and spark plug 21, serves to safely dispose of any fuel accumulations in the device 51 and combustion chamber 29 prior to the admission of any fuel to the fuel mixing device 51.

As the engine 10 continues in operation the temperature of the fuel conditioning unit 51 continues to increase. Located within the equalizing chamber 57 and secured to the heating element 63 of the conditioning unit 51 is a bulb 108, which is formed as a part of a Sylphon type unit designated generally as 105, for operating the valve unit 107. The bellows for the unit 105, indicated at 109, is in sealed connection with the bulb 108 through a tube 111. When the temperature of the conditioning unit 51 is increased to at least a fuel vaporizing temperature the bellows 109 is acted upon by the sealed fluid in the unit 105, in a well known manner, to open the valve 107, whereby fuel is admitted into the mixing chamber 56 of the conditioning or fuel vaporizing unit 51. This pre-heating of the conditioning unit 51 to at least a fuel vaporizing temperature, prior to the admission of any fuel thereto, provides for a substantially complete vaporizing of the fuel with the air, so that the fuel is prepared for efficient burning immediately at the inception of heater operation. It is seen, therefore, that in starting the heater the blower 27 is initially operated with the thermostatic means 99 being adjusted so as to next operate the burner ignition circuit at some predetermined time prior to the operation of the valve unit 107 by the heat responsive means or Sylphon unit 105.

In stopping operation of the heater the actuating arm 102 is returned to its starting position (shown in Fig. 1), the closing of the valve 103 cutting off any further supply of fuel to the pump 26 and the closing of the contacts 106 and 95 in the control switch 96 grounding the conductor 92 at 89. However, this grounding of the conductor 92 is ineffective to stop the operation of the engine 10 because of the thermostatic switch

93 having been opened by the heating of the combustion chamber 29 during the operation of the heater 22. The engine 10 and the heater 22 will thus both continue in operation after the closing of the switch 96 until the fuel remaining in the lines 78 and 79 between the nozzle 77 and valve unit 103 is pumped into the fuel conditioning unit 51. When this situation occurs the heater 22 will stop and the chamber 29 will start to cool, this cooling of the chamber 29 being accelerated by virtue of the blower 27 continuing in operation so that air continues to be circulated about the chamber 29 in the passage 41. It is understood of course that air also continues to be supplied to the conditioning unit 51 from the chamber 31. When the chamber 29 has cooled to a predetermined temperature value the thermostatic switch 93 closes and grounds the primary P of the magneto 18 thus rendering the engine ignition circuit inoperative and stopping the engine 10. On cooling of the exhaust conduit 71 and the conditioning unit 51 the thermostatic switch means 99 and the valve unit 107 corresponding, respectively, to these parts are permitted to return to their starting positions, namely, the thermostatic switch means 99 is opened and the valve unit 107 is closed.

It is seen, therefore, that the control system of Fig. 1 operates to provide for a complete scavenging of the combustion chamber 29 prior to the admission of any fuel thereto, with such fuel being admitted only when the conditioning unit 51 is capable of vaporizing it for mixing together with the air for combustion. On the stopping of heater operation a time delay is provided for the engine 10, by the thermostatic switch 93, so that the fan 27 continues in operation to substantially dissipate any and all fuel which might have accumulated in the combustion chamber 29 during the normal operation of the heater. Because of the sequential operation of the engine ignition circuit, the burner ignition circuit, and the burner air and fuel supply means both at the starting and stopping of heater operation the control system affords maximum safety of operation by completely eliminating any danger of explosions or back-firing in the heater 22.

It is apparent, of course, that the control system above described in connection with Fig. 1 is readily adaptable for operation with a battery operated engine, battery operated ignition circuits for the heater 22 and engine 10 being diagrammatically illustrated, by way of example, in Fig. 3. With reference to Fig. 3 the thermostatic switch 93 and control switch 96 in the engine ignition circuit are connected in parallel across the battery 112, with each switch connected in series with the spark plug 19. The distributor and coil for the engine ignition circuit are indicated at 10a and 10b, respectively. When the engine 10 is first started by closing the switch 96 the switch unit 93 is open, and remains open until closed by the heat acting thereon from the combustion chamber 29. During normal operation, therefore, both switches 93 and 96 are closed. On opening of the control switch 96 to shut the engine down, the engine continues to operate because of the switch 93 being closed. Switch 93 remains closed until the combustion chamber 29 has cooled down to a predetermined temperature. When both switches 93 and 96 are in an open position the engine ignition circuit is rendered inoperative and the engine is stopped, the delayed shutting off of the engine after the open-

ing of the switch 96 providing for a delayed operation of the fan 27.

The ignition circuit for the heater 22 includes the thermostatic switch unit 99 and the spark plug 21 which are connected in series across the battery 112, the coil for the circuit being shown at 21a. The thermostatic switch 99 in this battery circuit is normally open and is closed in response to the heat from the conduit 71 to complete the circuit for the plug 21. Since all of the other parts to be used with the battery ignition system in Fig. 3 are identical in all respects to the parts fully described above in connection with the magneto ignition system of Fig. 1, a further description of the battery operated circuit of Fig. 3 is believed to be unnecessary.

In Figs. 4-7, inclusive, there is shown a modified form of control system, with the heating unit including the engine and the heater or burner 22 being illustrated somewhat diagrammatically in Fig. 4. It is to be understood, however, that the heating unit operated by the control system of Figs. 4-7, is identical in all respects to the heating unit of Fig. 1. Similar numerals of reference shall be used, therefore, in Figs. 4-7, to designate heating unit parts therein similar to the corresponding parts in Fig. 1.

As shown in Fig. 4 the engine ignition circuit includes the plug 19 which is connected by conductor 88 to the secondary S of magneto 18, the primary P, when the circuit is inoperative, being grounded through conductor 113 and switch 116. The switch 116 (Figs. 4 and 6) is formed as a part of a manual control mechanism 118 having a casing 118 secured to the heater housing member 28. Switch 114 is positioned within the casing 118 and includes normally open contacts 114 and 117, contact 114 being connected with conductor 113 and the contact 117 being connected to the casing 118 for grounding as indicated at 128.

The ignition circuit for the burner (Fig. 4) comprises the plug 21 which is connected with the secondary S' of the magneto 18 through conductors 119 and 121 the plug ground being shown at 97. This circuit, when inoperative, is grounded through a sail switch unit 122 connected by conductor 123 to the junction 124 of the conductors 119 and 121. The sail switch unit 122 (Fig. 7) includes a pair of contacts 126 and 127, the contact 126 being connected to the heater cover plate 38 as a ground, indicated at 128, and the contact 127 being connected with the conductor 123. The switch unit 122 is secured by suitable means to the cover plate 38 of the heater housing member 28, with a sail 125 having an axis portion 129 pivotally supported in the plate 38 and arranged to permit a pivotal movement of the sail 125 in response to the airflow created by the fan 27. As clearly shown in Fig. 1 the plate 38 forms a part of the housing for the fan 27 so that the sail portion 125 is positioned adjacent the inner side of the plate 38 with the axis 129 at substantially right angles thereto to expose a maximum surface of the portion 125 to the action of the airflow from the fan 27. To the outside of the plate 38 and mounted on the axis 129 is an insulated contact arm 131. When there is no flow of air from the fan 27 the weight of the sail portion 125 pivots the insulated contact arm 131 upwardly, or in a clockwise direction as viewed in Fig. 7, into engagement with the contact 127, the weight of the sail portion 125 being sufficient to press the con-

tact 127 upwardly into a closed position with the contact 126. Because of this construction of the sail switch unit 122 the contacts 126 and 127 are in a normally closed position, with the direction of airflow, indicated by the arrow in Fig. 7, tending to pivot the sail portion 125 to the left, or in a counter-clockwise direction as also viewed in Fig. 7, which action moves the insulated arm 131 in an opposite direction to permit opening of the contacts 126 and 127 when the fan 27 is in operation. This open position is illustrated in Fig. 7.

The operation of the control system in Fig. 4 is controlled by manipulation of the actuating arm 132 in the control mechanism 119. The lever arm 132 (Figs. 4, 5 and 6) is mounted at the top of a valve stem 133 for a valve unit indicated generally as 134. The valve stem 133 has a radially extending projection or pin 136 therein for actuating the switch 116 in the engine ignition circuit. When the lever 132 is pointing to an "off" position, indicated in Fig. 4, the pin or projection 136 is in its dotted line position shown in Fig. 6, holding the contacts 114 and 117 in closed position, thus rendering the engine ignition circuit inoperative. This "off" position of the lever 132 corresponds also to a closed position of the valve unit 134 inserted in the fuel line 137 connecting the fuel pump 26 with the nozzle 77 in the fuel conditioning unit 51.

To initiate operation of the heater 22 the lever 132 is moved from its "off" to its "start" position, as shown in Fig. 4, the relative arrangement of the parts of the control mechanism 119 for a start position being indicated in full lines in Figs. 4, 5 and 6. This actuation of the lever 132 moves the pin 136 away from the switch 116 to permit the contacts 114 and 117 to open, thereby removing the ground from the engine ignition circuit and permitting operation of the engine. The valve unit 134 on movement of the actuating arm 132 from an "off" to a "start" position continues to close the fuel line 137 so that no fuel is admitted to the burner on the "start" position.

The "start" position of the lever 132 is defined by the engagement of the pin 136 with the end 140 of a lever arm 139 (Figs. 5 and 6) pivotally supported intermediate its ends on axis means 141 carried in a portion 142 of the housing 118 for the control mechanism 119. The opposite end of the lever 139 is pivotally connected as at 143 with a stem 144 carried on a bellows 109 supported in a casing 146 carried on the heater housing member 28. The bellows 109 forms a part of the Sylphon unit 105 which is connected, for operation with the conditioning unit 51 in all respects as was previously explained in connection with Fig. 1. A further description thereof is thus believed to be unnecessary. With the engine ignition circuit in operation, starting of the engine 10 provides for the operation of the fan 27, the airflow from which in turn operates the sail switch unit 122 to remove the ground from the heater ignition circuit. The heater ignition circuit is thus made operative substantially concurrently with the starting of the engine. As the engine continues to operate the temperatures of the exhaust conduit 71 and the fuel conditioning unit 51 are steadily increased. When the fuel conditioning unit 51 is heated to at least a fuel vaporizing temperature the bellows 109 of the Sylphon unit 105 expands whereby to move the stem 144 upwardly as viewed in Fig. 5. This direction of movement of the stem 144 in turn moves the end

140 of the lever 139 downwardly, as also viewed in Fig. 5, and out of an engaging position with the pin 136. The lever 132 is thus capable of being moved from the "start" to the "on" position indicated on the housing 118 for the control mechanism 119 in Fig. 4. This movement of the arm 132 from a "start" to an "on" position opens the valve unit 134 to permit fuel pumped by the pump 26 to be supplied to the fuel conditioning unit 51. The fuel is thus supplied to the fuel conditioning unit 51 only after it is able to be substantially completely vaporized therein, and only after a prior operation of the air fan 27 and igniter element 21.

When the heater 22 is to be stopped the lever 132, by virtue of the lever end 140 being in its downward position as indicated in dotted lines in Fig. 5, is moved directly from an "on" to an "off" position. With the lever 132 in an "off" position the supply of fuel is cut off to the fuel conditioning unit 51, and the engine ignition circuit is grounded because of the closed position of the contacts 114 and 117 of the switch 116. The heater 22 and engine 10 are thus shut off together, with the heater ignition circuit being rendered inoperative concurrently with the stopping of the fan 27.

From a consideration of the above description and drawings it is seen that the invention provides a system for controlling a heating unit comprising an internal combustion heater operated by an internal combustion engine, which functions to initiate operation of the heater according to a predetermined sequence of steps to assure a positive starting of the heater with a complete elimination of violent initial combustion or possible explosions. The control system is of a rugged construction and capable of operating efficiently and precisely over a long service life with a minimum of servicing. It is further readily adapted for operation when either a magneto or battery is utilized in the operation of the engine.

Although the invention has been described with specific reference to several preferred embodiments thereof it is to be understood that it is not to be so limited since changes in the parts and their relative arrangement can be made therein which are within the full intended scope of this invention as defined by the appended claims.

I claim:

1. In a control system for a heating unit including an internal combustion burner operatively connected with an internal combustion engine for concurrent operation therewith and wherein said engine is provided with an exhaust; a fuel vaporizing device including means defining a fuel and air mixing chamber from which a mixture of fuel and air may be transmitted to said burner, conduit means for conducting exhaust gases from said engine exhaust through said mixing chamber to provide for the heating of said chamber and said device by the exhaust gases from said engine, an ignition circuit for said burner including switch means for operating the same, a fuel system for said burner including valve means for controlling the admission of fuel to said vaporizing device, thermal responsive means responsive in operation substantially to the temperature condition of said vaporizing device, means interconnecting said thermal responsive means and said valve means to retain said valve means in a non-fuel feed position until said device is heated to a fuel vaporizing temperature by the engine exhaust

gases traversing said conduit means, and means responsive to the operation of said engine and acting on said switch means to provide for the operation of said ignition circuit after said engine is started, with said ignition circuit being in operation prior to the admission of any fuel to said vaporizing device through said valve means.

2. In a control system for a heating unit including an internal combustion engine operatively connected with an internal combustion burner, the combination of an ignition circuit for said burner including switch means adapted to retain said circuit operative only when said engine is in operation, an ignition circuit for said engine including manually operated control switch means, means supplying air for combustion to said burner operatively connected with said engine, a fuel supply system for said burner including valve means for controlling the admission of fuel to said burner, means for actuating said valve means only after said engine has been started so that said ignition circuit and air supply means are in operation prior to the admission of any fuel to said burner, and time delay means connected in said engine ignition circuit to retain the same operative after manual operation of said control switch means to a normal engine shut down position to provide for a delayed operation of said air supply means.

3. In a control system for heating apparatus including an internal combustion burner operated in conjunction with an internal combustion engine, with said burner having a fuel vaporizing device adapted to be heated by the exhaust gases from said engine, the combination of an ignition circuit for said burner including switch means adapted to permit operation of said circuit only when said engine is in operation, an ignition circuit for said engine including manually actuated switch means for controlling the operation of the same, a fuel system for said burner including valve means for controlling the supply of fuel to said vaporizing device, and means responsive substantially to the heat of said vaporizing device for maintaining said valve means in a closed position until said vaporizing device is at substantially a fuel vaporizing temperature and for preventing said valve means from being operated to an open position until after said burner ignition circuit is in operation.

4. In a control system for heating apparatus including an internal combustion burner operated in conjunction with an internal combustion engine, with said burner having a fuel vaporizing device adapted to be heated by the exhaust gases from said engine, the combination of an ignition circuit for said engine, an ignition circuit for said burner, a fuel system for said burner including a fuel line operatively associated with said fuel vaporizing device having normally closed valve means therein, thermal means responsive in operation to the heat of said vaporizing device for maintaining said valve means closed until said vaporizing device is at substantially a fuel vaporizing temperature, first switch means connected in said engine ignition circuit arranged to normally render said engine ignition circuit inoperative, and other switch means connected in said burner ignition switch circuit arranged to normally retain the same inoperative, said engine being capable of operation on actuation of said first switch means to a position permitting operation of said engine ignition circuit, with said other switch means being adapted on

operation of said engine to provide for the operation of said burner ignition circuit prior to the opening of said valve means to admit fuel to said vaporizing device.

5. In a control system for heating apparatus having an internal combustion burner with a fuel vaporizing device adapted to be heated by the exhaust gases from an internal combustion engine operatively connected with air and fuel supply means for said burner, the combination of an ignition circuit for said burner including switch means adapted to operate said burner ignition circuit concurrently with the operation of said engine and to render the circuit inoperative when said engine is inoperative, an ignition circuit for said engine including a manually actuated control switch, valve means operatively connected with said fuel supply means to control the admission of fuel to said vaporizing device, an actuating arm common to said control switch and valve means, with initial movement of said arm in one direction operating said control switch to permit operation of said engine ignition circuit, and means responsive in operation to the heat of said vaporizing device operatively connected with said actuating arm to lock the same against continued movement in said one direction until said vaporizing device is heated to substantially a fuel vaporizing temperature, with the continued movement of said arm in said one direction opening said valve means to admit fuel to said vaporizing device.

6. In a control system for heating apparatus including an internal combustion engine operatively associated with an internal combustion burner having fuel vaporizing means in thermal relation with the exhaust gases from said engine, the combination of an ignition circuit for said burner, an ignition circuit for said engine, a fuel system for said burner including thermally controlled valve means responsive to the temperature of said fuel vaporizing means to admit fuel thereto, a combination valve and switch unit for controlling the flow of fuel to said thermal valve means and for operating said engine ignition circuit, with the actuation of said combination unit to admit fuel to said thermal valve means operating said switch means to make said engine ignition circuit operative, with said thermal valve means being operated to admit fuel to said fuel vaporizing means when the fuel vaporizing means is heated to at least a fuel vaporizing temperature by said engine exhaust gases, and means in the ignition circuit for said burner adapted when said engine is inoperative to render the burner ignition circuit inoperative, and when said engine is in operation to provide for the operation of said burner ignition circuit.

7. In a control system for a heating unit including an internal combustion engine and an internal combustion burner, with said burner having a fuel vaporizing device adapted to be heated by the exhaust gases from said engine and receiving air for combustion from a blower driven by said engine, the combination of an ignition circuit for said burner, thermostatic switch means connected in said ignition circuit responsive in operation to the heat from said exhaust gases to control the operation of said circuit, a fuel system for supplying fuel to said vaporizing device including a supply line having normally closed valve means therein, and heat responsive means for opening said valve means when said vaporizing device is heated to at least a fuel vaporizing temperature, with said thermo-

static switch means being actuated prior to said heat responsive means so that said ignition circuit and blower are in operation before fuel is supplied to said burner through said valve means.

8. In a control system for a heating unit having a burner with a combustion chamber, with said burner being adapted for operation in conjunction with an internal combustion engine, the combination of an ignition circuit for said engine including thermostatic switch means thermally connected with said combustion chamber so as to be responsive in operation to the heat therefrom, said thermostatic switch means being normally arranged to be ineffective in controlling the operation of said ignition circuit, switch means in said engine ignition circuit including a manually operated actuating arm, a system for supplying fuel to said combustion chamber including a pump operated by said engine and normally closed valve means operatively connected with said actuating arm, and means for supplying air to said combustion chamber operatively connected with said engine, with movement of said actuating arm in one direction opening said valve means and operating said manual switch means to render the engine ignition circuit operative to start said engine, with the heat from said combustion chamber acting on said thermostatic switch means for render the same effective in controlling the operation of said ignition circuit, with manipulation of said actuating arm in a reversed direction closing said valve means and shutting off the fuel supply to said burner to stop the same, said engine continuing in operation until said thermostatic switch means is permitted to return to its normal position by the cooling of said combustion chamber.

9. In a control system for a heating unit having an internal combustion burner with means for supplying air and fuel thereto operated by a common motor means, the combination of an operating circuit for said motor means including manually operated switch means, valve means operatively associated with said fuel supply means to control the admission of fuel to said burner, an ignition circuit for said burner including said switch means arranged to normally retain said burner ignition circuit inoperative, an actuating lever common to said manual switch means and valve means movable to one operating position for actuating said switch means to operate said motor circuit, said valve means remaining closed at said one lever operating position, with the air flow from said air supply means on operation of said motor means acting on said sail switch means to make said burner ignition circuit operative, said lever being movable to a second operating position to open said valve means while maintaining said switch means in a motor operating position, and means for preventing said lever from being operated to said second operating position until after said burner ignition circuit is in operation.

10. In a control system for a heating unit having an internal combustion burner with a fuel vaporizing device adapted to be heated by the exhaust gases from an internal combustion engine operatively connected with the air and fuel supply means for said burner, the combination of an ignition circuit for said burner including sail switch means normally arranged to retain said burner ignition circuit inoperative, an ignition circuit for said engine including manually actuated switch means, valve means operatively con-

nected with said fuel supply means to control the admission of fuel to said vaporizing device, an actuating arm common to said manual switch means and valve means, with initial movement of said arm in one direction operating said manual switch means to provide for the operation of said engine ignition circuit, said engine on being started operating said air supply means, with the air from said air supply means acting on said sail switch means to render said burner ignition circuit operative, and means responsive in operation to the heat of said vaporizing device operatively connected with said actuating arm to lock it against continued movement in said one direction until said vaporizing device is heated to at least a fuel vaporizing temperature, with the continued movement of said arm in said one direction opening said valve means to admit fuel to said vaporizing device.

11. In a control system for a heating unit having an internal combustion burner with means for supplying air and fuel thereto operated by an internal combustion engine having a source of waste heat, the combination of an operating circuit for said engine including manually operated switch means, valve means operatively associated with said fuel supply means to control the admission of fuel to said burner, an ignition circuit for said burner including sail switch means responsive to the flow of air from said air supply means and arranged to normally retain said burner circuit inoperative, an actuating lever common to said manual switch means and valve means, said lever on movement to said one operating position actuating said manual switch means to render said engine circuit operative, said valve means remaining closed at said one lever operating position and being opened in response to movement of said lever from said one operating position to a second operating position, means normally locking said lever against movement from said one operating position to said second operating position, with the air flow from said air supply means, an operation of said engine, acting on said sail switch means to make said burner ignition circuit operative, and means responsive in operation to the heat from said waste heat source operatively connected with said locking means to release said lever for opening said valve means after said burner ignition and engine circuits are in operation.

12. In a control system for a heating unit which includes a heater provided with a combustion chamber, a fuel vaporizing unit for delivering fuel to said chamber, an internal combustion engine and means for utilizing the exhaust gases from said engine to heat parts of said unit to a fuel vaporizing temperature; the combination which includes an ignition circuit for said heater, means for supplying fuel to said unit, means for preventing fuel from being delivered to said unit before said parts of said heater are heated to a fuel vaporizing temperature by the exhaust gases from said engine, and means controlled by the heated exhaust gases from said engine for controlling the energization of said ignition circuit.

13. In a control system for heating apparatus including an internal combustion heater operated in conjunction with an internal combustion engine; air moving means driven by said engine and operative to deliver combustion air to said heater, fuel supply and fuel ignition systems for said heater, means controlled in accordance with the operation of said engine for controlling at least one of said systems to prevent the operation of

said heater from being initiated until said engine has been in operation for a period of time, means for controlling said fuel supply system to arrest the operation of said heater, and means for continuing the operation of said engine for an interval following the operation of said last-named means.

14. In a control system for heating apparatus including an internal combustion engine operated in conjunction with an internal combustion heater; air moving means driven by said engine and operative to supply combustion air to said heater, a fuel supply system for said heater, means for controlling said fuel supply system to arrest the operation of said heater, and means controlled in accordance with the heat generated by said heater for arresting the operation of said engine a short time interval following the operation of said last-named means.

15. In a control system for heating apparatus which includes a heater provided with a combustion chamber, a fuel vaporizing unit for delivering a mixture of fuel and air to said combustion chamber, an internal combustion engine and means for utilizing waste heat from said engine to heat the parts of said unit to a fuel vaporizing temperature; the combination which includes a fuel ignition circuit for said heater, and thermal responsive means controlled by the heat generated by said engine for selectively closing said circuit.

16. In a control system for heating apparatus which includes a heater provided with a combustion chamber, a fuel vaporizing unit for delivering a mixture of fuel and air to said combustion chamber, an internal combustion engine and means for utilizing waste heat from said engine to heat the parts of said unit to a fuel vaporizing temperature; the combination which includes normally inactive means for supplying fuel to said unit, and means responsive to the heating of said parts of said unit to a fuel vaporizing temperature by the waste heat from said engine for conditioning said fuel supply means to supply fuel to said unit.

17. In a control system for heating apparatus which includes an internal combustion engine capable of producing waste heat, a heating unit including means defining a combustion chamber, a normally inoperative ignition circuit including means for igniting fuel within said chamber, switching means operative to render said circuit operative in response to operation of said engine, means driven by said engine for supplying combustion air to said chamber, a fuel supply system for said chamber including valve means for controlling the admission of fuel to said chamber, thermal responsive means operative in response to the waste heat developed by said engine during its operation, and means connecting said thermal responsive means and said valve means to retain said valve means closed until after said engine is in operation, thereby to insure operation of said air supply means and energization of said igni-

tion circuit prior to the admission of fuel to said chamber through said valve means.

18. In heating apparatus which includes an internal combustion engine provided with an exhaust, a heating unit including means defining a combustion chamber having an inlet, a fuel and air mixing and vaporizing device provided at said inlet and including means defining a mixing chamber communicating with said combustion chamber, means driven by said engine for supplying air to said mixing chamber, a fuel supply system including means driven by said engine for supplying fuel to said mixing chamber, valve means included in said fuel supply system for controlling the admission of fuel to said mixing chamber, conduit means for conducting exhaust gases from said engine exhaust through said mixing chamber and for discharging the gases into said combustion chamber, an ignition circuit including means for igniting fuel within said combustion chamber, switching means operative to render said circuit operative in response to operation of said engine, thermal responsive means operative in response to the heat of said exhaust gases and including heat absorbing means arranged in heat exchange relationship with said conduit means within said mixing chamber, and means connecting said thermal responsive means and said valve means to retain said valve means closed until after said engine is in operation, thereby to insure operation of said air supply means and energization of said circuit prior to the admission of fuel to said mixing chamber through said valve means.

19. In heating apparatus which includes an internal combustion engine provided with an exhaust, a heating unit including means defining a combustion chamber having an inlet, a fuel and air mixing and vaporizing device provided at said inlet and including means defining a mixing chamber communicating with said combustion chamber, a fuel supply system including valve means for controlling the admission of fuel to said mixing chamber, conduit means for conducting exhaust gases from said engine exhaust through said mixing chamber and for discharging the gases into said combustion chamber, an ignition circuit including means for igniting fuel within said combustion chamber, switching means operative to render said circuit operative in response to operation of said engine, thermal responsive means operative in response to the heat of said exhaust gases and including heat absorbing means arranged in heat exchange relationship with said conduit means within said mixing chamber, and means connecting said thermal responsive means and said valve means to retain said valve means closed until after said engine is in operation, thereby to insure operation of said air supply means and energization of said circuit prior to the admission of fuel to said mixing chamber through said valve means.

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