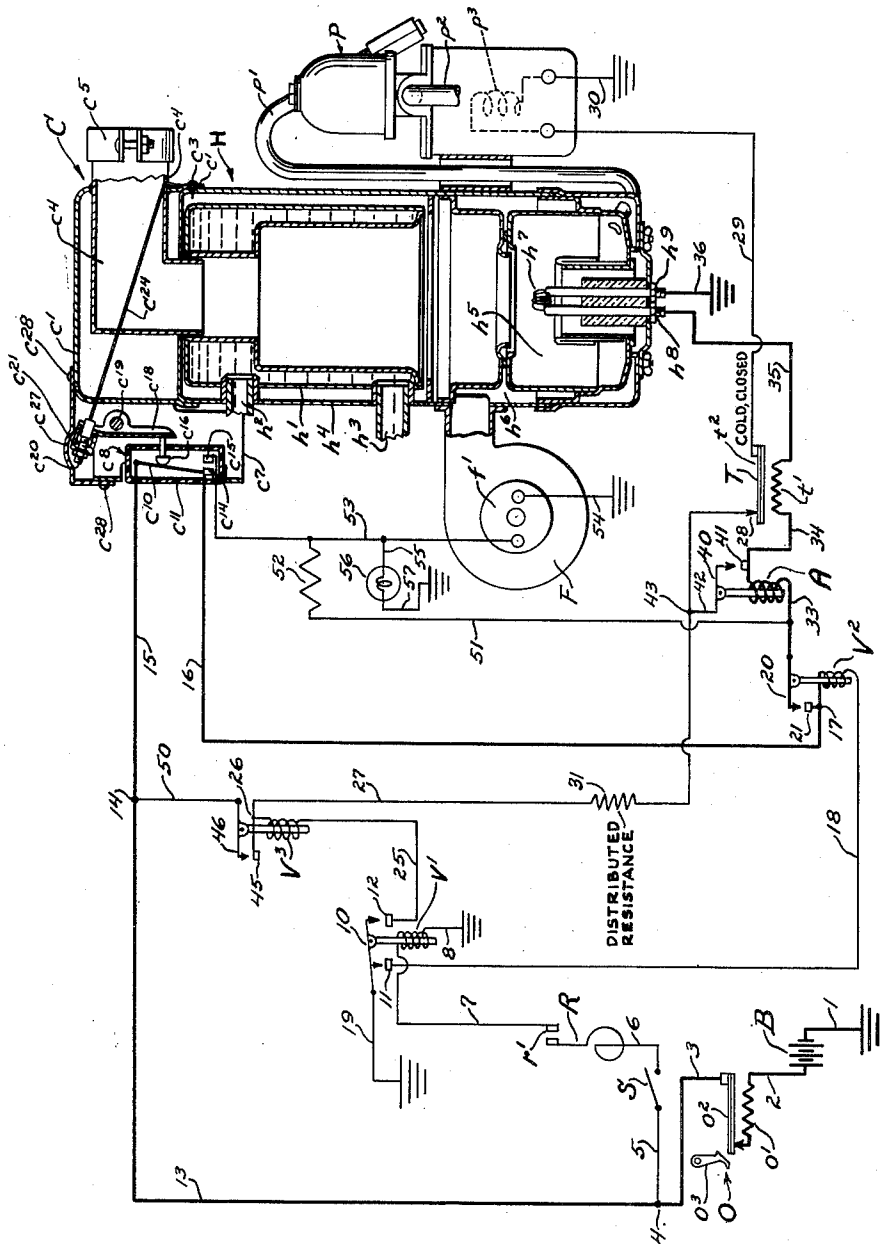


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ELECTRICAL CONTROL MEANS FOR LIQUID
FUEL BURNING APPARATUS
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ELECTRICAL CONTROL MEANS FOR LIQUID
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This invention relates to the class of electrical control systems for combustion devices and has particular, though not exclusive, utility as a means for automatically effecting a series of operations in response to certain conditions occurring in the functioning of a combustion device.

For the purpose of the present disclosure and explanation, the invention is shown and described herein in connection with an engine heating apparatus incorporating a liquid fuel combustion device that forms the subject matter of the copending application of Marc Resek, Serial No. 674,012, filed June 3, 1946, now Patent No. 2,509,399, dated May 30, 1950, the present invention embracing improvements in the circuits of an electrical control system for such a heating apparatus—a somewhat similar control system constituting the subject matter of my copending application Serial No. 719,374, filed December 31, 1946, now Patent No. 2,500,663, dated March 14, 1950. The present, as well as my earlier invention just referred to, has special application to combustion devices wherein an electrical igniting element is employed to initiate combustion, and some means is desirably included or required to deenergize said igniting element upon the attainment of proper combustion within the device.

The primary object of my invention is the provision of an electrical control system for heating apparatus incorporating a liquid fuel combustion device, and by means of which system a complete cycle of operation is automatically accomplished which includes a starting or igniting phase, a so-called "operating" phase, and a shut-down phase, and wherein there is a safety feature that effectively protects the heating apparatus and the various parts of the system from damage in case of failure of combustion during said operating phase, as well as during starting phase.

Other objects and advantages will appear as this description proceeds, in the course of which reference is made to the accompanying drawing wherein the figure is a diagrammatic representation of my improved electrical control system in operative association with a heating apparatus of the liquid fuel combustion type equipped with a fuel pump and a combustion air fan, said apparatus being shown in central vertical section.

The heating apparatus is designated, generally, by the reference letter H. It includes a heat exchanger h' in the form of an annular

liquid circulating element having a central flue and the usual inlet and outlet connections h^2 and h^3 , respectively. Said exchanger occupies a combustion chamber provided by the upper portion of a casing h^4 . Situated in the lower portion of said casing is a combustion device h^5 , shown as a burner bowl that is arranged to discharge its products upwardly into the combustion chamber and through the heat exchanger h' . Interior parts of the apparatus are so shaped and related and so joined to the casing as to set off within the latter a combustion air space h^6 to which air is supplied by an air impeller or blower F, hereinafter called the combustion fan, and which is driven by an electric motor f' . The combustion device is equipped with an electrical igniter h^7 , the terminals of which are designated h^8 and h^9 .

Liquid fuel is supplied to the combustion device by a pump P, desirably of the kind known to the trade as an autopulse pump and which is actuated by electromagnetic means, such as a solenoid, the winding of which is indicated diagrammatically in dotted lines at p^3 . The outlet of the pump has communication with the combustion device through a pipe p' , and receives fuel from a suitable source (not shown) through a pipe p^2 that has connection with the inlet of the pump.

A so-called control head or unit C surmounts the heater casing h^4 and it is shown as comprising an inverted cup-like shell c' , having substantially the same cross sectional size and shape, or diameter, as the casing h^4 and it is slightly enlarged at its open end and is telescoped over the top of the casing to which it is secured by a suitable number of screws c^3 . An outlet for the products of combustion is provided by an elbow c^4 which has the end of its vertical branch extended into the flue of the heat exchanger h' , while its horizontal branch is projected through an opening in the peripheral wall of the shell c' , the elbow and shell being welded together about said opening so as to make a rigid structure of two parts. The outer end of the horizontal branch of the elbow is equipped with a clamp c^5 by which a flexible conduit or other type of flue may be fastened to the element for carrying off the products.

Fastened to the side of the shell c' opposite that through which the horizontal branch of the elbow c^4 projects, is a bracket c^7 that supports a switch c^8 of a type known as a Micro switch, although switches of other suitable types may be substituted. The Micro switch includes a leaf

spring conducting element c^{10} that is suitably fastened at its upper end to a part of the switch casing c^{11} , and its opposite end swings between and alternately engages contacts c^{14} and c^{15} . The conducting element c^{10} , by reason of its normal shape and inherent resiliency is biased toward and (if not otherwise influenced) held in engagement with the contact c^{15} ; and it is adapted to be swung into engagement with the contact c^{14} by movement of a plunger c^{16} that is guided within a bore of the casing c^{11} and has a head that engages the conducting element near the fixed end of the latter, wherefore a very slight movement of the plunger is required for swinging the conducting element from the contact c^{15} to the contact c^{14} .

The outer end of the plunger c^{16} is engaged by a lever c^{18} that is pivoted on a pin c^{19} , supported by and between the sides of the bracket c^7 . A relatively short distance above the pivotal axis of the lever c^{18} , compared to the distance between said axis and the point of contact between the lever and the thrust pin c^{16} , said lever is provided with an opening within which is guided the head of an adjusting screw c^{20} , said head and opening being shaped to prevent turning of the former within the latter. A nut c^{21} is threaded on the screw c^{20} and bears against the lever c^{18} . Fastened to the head of the adjusting screw c^{20} , as by having its end brazed within an axial bore of the head, is one end of a thermostatic tension element c^{24} . This element, in the present embodiment, consists of a wire of heat resistant thermosensitive metal, and its end opposite the screw c^{20} is projected through a hole in the bottom of the horizontal branch of the elbow c^4 a short distance outwardly beyond the plane of the wall through which said elbow projects and is turned back and welded to said wall immediately below said branch. The member c' and elbow c^4 have apertures that are in alignment with the hole in the bottom of the branch c^4 through which the fixed end of the element c^{24} passes and the connection between the opposite end of said element and the screw c^{20} for the accommodation of said element. When relatively cool, as when subjected to atmospheric or ambient temperature, the thermostatic tension element is sufficiently taut to hold the lever c^{18} in a position which, through the intervention of the plunger c^{16} , will maintain the conducting element c^{10} of the Micro switch c^8 in engagement with the contact c^{14} , as illustrated in the drawing. When subjected to the temperature of the hot products of combustion that rise from the combustion device h^5 through the heat exchanger h' and escape through the elbow c^4 , said element will expand and relax its tension, allowing the conducting element c^{10} of the Micro switch to swing into engagement with the contact c^{15} . Obviously (all other factors being constant), the time element involved in this operation may be varied by changing the tension of the element c^{24} , and this is accomplished by adjusting the nut c^{21} along the screw c^{20} . To protect these parts, a cap c^{27} is applied to the upper end of the bracket c^7 and is held thereto, and to the member c' , by screws c^{28} .

By reason of the fact that the functioning of the control head is dependent entirely upon the linear expansion and contraction of the thermostatic tension element, and in view of the relatively small cross sectional area of said element, which causes it to absorb and give up heat at a very rapid rate, the control head is quick and

accurate in operation. In other words, it responds quickly when subjected to the exact temperature value at which it is set to shift the conducting element of the switch c^8 from one contact to the other.

I shall now proceed to describe the other electrical devices and circuits represented diagrammatically in the drawing, and which, with the beforementioned parts incorporated in the control head, constitute the electrical control system of my invention by which is automatically accomplished a series of operations in orderly sequence, inaugurated by the lighting of the combustion device.

Briefly, the control system embraces a comparatively low resistance main circuit, shown in the drawing in relatively heavy lines. This main circuit includes a source B of electric current, represented as a battery; an overload cutout thermo-switch O (which may be any of the well known varieties); the conducting element c^{10} of the switch c^8 that is incorporated in the control head C, and the contact c^{14} thereof; contacts 21 and 20 of a voltage relay V^2 ; a high current relay A, illustrated diagrammatically as a solenoid; the resistance heating coil t' of a time-temperature cutout switch T (which involves, also, a thermosensitive element t^2 , shown as a bimetal strip, and which is in circuit closing position when cold, as indicated in the drawing), and the electrical igniter h^7 of the combustion device h^5 . The conductors which, with the foregoing electrical devices, make up the main circuit, will be presently introduced by reference characters.

Branching from said main circuit is an auxiliary one including a switch S that is in series with a thermostat R, as will hereinafter more fully appear. The thermostat R is subjected to the temperature that is to be controlled. Said auxiliary circuit also includes a voltage relay V' . This voltage relay acts, when energized, to close two circuits. The first of said circuits includes the previously mentioned voltage relay V^2 (which, as will presently appear, controls the main circuit), and the second of said circuits includes a voltage relay V^3 , the latter, upon being energized, closing a circuit through the thermosensitive element t^2 of the beforementioned time-temperature cutout switch T, as well as through the winding p^3 of the pump actuating electromagnetic means previously referred to.

The two circuits last referred to effect a cycle of operation of the combustion device which includes a starting phase and a so-called "normal operating" phase. I shall first describe the circuit responsible for the starting phase, and therefore termed the "starting circuit." Preliminary to this, however, I shall complete the main and auxiliary circuits by introducing the conductors thereof.

One terminal of the battery B is grounded through a conductor 1, while the other terminal thereof is connected, through a conductor 2, to a resistance heater o' that forms a part of the overload cutout switch O and is in a position to heat the thermosensitive element o^2 (shown as a bimetal strip) thereof. Said element o^2 is normally in circuit closing position, as when cold; as indicated in the drawing. When said element o^2 is heated and warps to circuit opening position, it is held in such position, as by a latch o^3 , until manually released. A conductor 3 leads from the other side of the said overload cutout switch to a junction represented at 4. From this junction

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tion a conductor 5 leads to one side of the switch S, while the other side of said switch is connected, through a conductor 6, to the thermosensitive element of the thermostatic switch R. A contact r' , into engagement with which the thermosensitive element of the switch swings when subjected to a sufficiently low temperature, has connection, through a conductor 7, with the coil of the relay V' which is grounded through a conductor 8.

It is evident from what has so far been said that when the switch S is closed, and it is assumed that the overload switch O and the thermostatic switch R are closed, that current will flow from the battery through the switch O, conductors 3 and 5, switch S, conductor 6, thermostatic switch R, conductor 7, the coil of the relay V' and conductor 8 to the ground. Upon energization of the relay V', a switch element 10, that is swung from normal to circuit closing position by the armature of the relay, bridges contacts 11 and 12, resulting in the closing of the two circuits previously referred to, one as the "starting circuit," and which will presently be described. A part of the current supplied by the battery passes the junction 4 and continues through a conductor 13, past a junction 14, and via a conductor 15 to the conducting element c^{10} of the switch c^8 that is incorporated in the control head C.

During the starting phase of the operation, which is at present under consideration, the thermostatic tension element c^{24} of the control head is cold, so to speak, and, therefore sufficiently taut to act, through the lever c^{18} and plunger c^{16} , to hold the conducting element c^{10} of the switch c^8 against the contact c^{14} . Consequently current will continue on through a conductor 16, past a junction 17, to the coil of the relay V², and thence through a conductor 18 to the previously mentioned contact 11 of the relay V'. As will be remembered, this relay V' has previously been energized to swing the switch element 10 into engagement with the contacts 11 and 12, wherefore the current flowing through the circuit last described, involving the conductor 18 and the contact 11, taking the course of least resistance will be grounded through a conductor 19. Energization of the relay V² causes the switch element 20 thereof to engage a contact 21 that is included in the circuit that branches off from the junction 17 of the previously described circuit involving the conductor 16. The greater part of the current reaching junction 17 continues through the contact 21, switch element 20, and conductor 33 through the coil of the first described relay A, the current continuing on through conductor 34, the resistance heater t' and conductor 35 to the terminal h^8 of the igniter h^7 , the other terminal h^9 of the igniter being grounded through a conductor 36. It may be explained that a relatively heavy current is required to operate the relay A and cause it to move a switch element 40 into engagement with a contact 41 that joins the previously mentioned conductor 34. When the relay A is energized it closes a circuit including the contact 41, whereupon current will flow through a conductor 42 to its junction 43 with a conductor 27. This conductor is represented as including a resistance 31, which as designated on the drawing, is symbolic of a distributed resistance in the circuit whereof said conductor is a part. Accordingly, a relatively small amount of the current passing relay A will reach the conductor

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27 through the path just described—that is to say, by way of the contact 41, element 40 and conductor 42 to junction 43. From junction 43 a part of the current will go in one direction through the conductor 27 to a contact 28, and thence through the thermosensitive element t^2 and a conductor 29 to the coil p^3 of the electromagnetic operating means of the pump P and thence to the ground through a conductor 30. The remainder of the current reaching junction 43, will momentarily pass in the other direction through the conductor 27, past junction 26, through the coil of the relay V³, conductor 25, contact 12, circuit closing element 10 and conductor 19 to the ground. This will result in the relay V³ operating to close the circuit between the contact 45 and element 46, thereby to effect a flow of the current supplied to the pump operating means through a path described as follows: from junction 14, through a conductor 50, to element 46 and thence through contact 45, conductor 27, thermostatic element t^2 and conductor 29 to the coil p^3 of the pump and on to the ground through the conductor 30. A part of the current flowing from junction 14 will flow past junction 26 through the coil of the relay V³ and, through a path already described, to the ground, thereby to maintain the relay V³ energized and, as a consequence, the circuit closing element 46, in engagement with the contact 45. Thus, it will be seen that, when this point in the operation of the system is reached the relay V³ will serve to lock in the pump circuit, and this condition will continue so long as the system is in operation. It will be understood that the impedance, as symbolized by the resistance 31, of the circuit represented by conductor 50, the conducting element 46 and contact 45 of relay V³, conductors 27 and 42, and the conducting element 40 and contact 41 of relay A (which circuit is closed when the relay A is energized), is of sufficient magnitude as compared to the impedance of relay coil A to prevent that current necessary for the continued energization of relay A from being diverted through said circuit and short circuiting said coil.

Remembering that we are still concerned with the starting phase of the operation, with the conducting element c^{10} of the control head switch c^8 in engagement with the contact c^{14} , due to the fact that the thermostatic tension element c^{24} is cold, so to speak, the igniter h^7 is supplied with current through the ignition circuit already described. Now, with the pump operating to supply fuel to the combustion device h^5 , and with the igniter h^7 energized, the latter will vaporize and ignite the fuel and start the combustion device in operation, provided that conditions are normal.

At this point it may be explained that there is an advantage in supplying a limited amount of air to the combustion device h^5 during the starting phase. Such amount, however, should be much less than that required during the normal operating phase. Consequently, I desire to provide a circuit for supplying a limited amount of current to the combustion fan motor f' at the time the igniter h^7 is energized. Therefore, I include a circuit represented in part by a conductor 51 that leads from conductor 33 to one terminal of a resistance element 52, the other terminal of which is connected, through a conductor 53, to one of the binding posts of the combustion fan motor f' , the other binding post of which is grounded through a conductor 54. The conduc-

tor 53 also electrically connects the combustion fan motor f' with the contact c^{15} of the control head switch c^8 . Intermediate the point at which the resistance element 52 has connection with the conductor 53 and the combustion fan motor, a signal circuit branches from the conductor 53 which is represented by a conductor 55, an incandescent lamp 56, and a conductor 57 that leads to the ground.

Accordingly, during the starting phase, a limited amount of current flows through the conductor 51, past the resistance element 52, and by way of conductor 53, through the combustion fan motor, and on to the ground, causing the fan motor to turn relatively slowly and supply a draft of air to the combustion device which will aid in initiating combustion. At the same time, this condition will be indicated by a weak glow of the lamp 56.

With combustion under way, the products will rise into the combustion chamber and pass out through the flue of the heat exchanger h' and on through the passage provided by the elbow c^4 . The heat imparted under these conditions to the thermostatic tension element c^{24} will cause said element to expand and lengthen sufficiently to relax the pressure of the lever c^{18} on the plunger c^{16} , thereby to permit the conducting element c^{10} of the switch c^8 to shift from contact c^{14} to contact c^{15} , thus interrupting the flow of current through the circuit represented in part by the conductor 18 and including the coil of the relay A. Deenergization of this relay causes withdrawal of the circuit closing element 40 from the contact 41 which opens the ignition circuit. Opening of the aforesaid circuit also deprives voltage relay V^2 of current, resulting in the withdrawal of element 20 from contact 21 of said voltage relay. Although deenergization of the relay A causes withdrawal of the circuit closing element 40 from the contact 41, this has no effect upon the supply of current to the pump, due to the fact that the pump circuit is locked in by the relay V^3 , as previously described.

Therefore, the pump will continue to supply fuel to the combustion device, and to meet the demands of normal operation, the motor of the combustion air fan F will be operated at full speed by current now supplied from conductor 15, through conducting element c^{10} of the switch c^8 , contact c^{15} and conductor 53. The fact that the fan is now operating at full speed will be indicated by a brilliant glow of the lamp 56, to which a greater amount of current is now supplied from the fan circuit.

The final or "shut-down" phase of operation of the control system may be effected manually by opening the switch S, or it may result from the opening of the thermostatic switch R caused by a rise, to a given value, of the temperature to which said thermostatic switch is subjected. Upon the opening of the auxiliary circuit at either of these points, the relay V' is deenergized. This results in the circuit closing element 18 withdrawing from the contacts 11 and 12. The breaking of the circuit including the last mentioned contact causes deenergization of the relay V^3 . This results in the opening of the pump circuit by the withdrawal of the switch element 46 from the contact 45. Consequently, the combustion device h^5 will be deprived of fuel, excepting for that which remains in the device at the time the pump circuit is interrupted. In order that this remaining fuel may be consumed without creating a smoky condition and the formation of an undue

amount of carbon, it is necessary to keep the combustion fan running until said fuel is consumed. This is automatically brought about by the fact that the thermostatic tension element c^{24} remains heated so long as combustion prevails, and, therefore, in sufficiently relaxed condition to leave the conducting element c^{10} of the switch c^8 in engagement with the contact c^{15} . It is through this contact that current is supplied to the motor f' of the fan for normal operation of the latter. When the fire dies out and the heat subsides and the thermostatic tension element c^{24} cools and contracts and thus recovers its former tension, it will function, through the intervention of the lever c^{18} and plunger c^{16} , to shift the conducting element c^{10} from contact c^{15} to contact c^{14} , thus conditioning the system for a subsequent operation.

During the foregoing description of the cycle of operation of the heating apparatus and its control system, it has been assumed that all conditions are normal. There are times, however, when abnormal conditions occur, as will hereinafter be explained, when the system functions to safeguard the apparatus and associated parts from injury under these abnormal conditions. Such abnormal conditions may consist of failure of the fuel to ignite; the lack of fuel, or a short circuit anywhere in the system.

In the event the fuel in the combustion device fails to ignite, prolonged flow of current through the ignition circuit will build up sufficient temperature in the resistance element t' of the time-temperature cutout switch T to cause the thermosensitive element t^2 thereof to withdraw from the contact 20, thus interrupting the pump circuit at this point and preventing flooding of the combustion device with fuel. If this condition prevails for any appreciable length of time, as for example, four or five minutes, sufficient heat will build up in the resistance element o' of the cutout O to cause the thermosensitive element o^2 thereof to withdraw from the contact wherewith it normally engages. The element o^2 will be held out of engagement with said contact by the latch o^3 , even after said element cools and until an opportunity is afforded to correct the conditions responsible for the present failure. After correction of such conditions the latch o^3 may be released to allow the circuit to close at the cutout O, thereby to place the system in condition for a repetition of the starting phase, it being understood that, upon cooling due to deenergization of the resistance element t' , the thermosensitive element t^2 resumed normal condition and closed the pump circuit at the contact 20.

In case the supply of fuel to the combustion device stops from any cause during a normal operating phase, the fire will go out and the thermostatic tension element c^{24} will cool and contract and, through its operative connections with the control switch c^8 , shift the conducting element c^{10} of the latter out of engagement with the contact c^{15} and into engagement with the contact c^{14} , thus conditioning the system for a starting phase of operation. Naturally, if the cause of the trouble is not removed, the heating apparatus will fail to function and conditions of the system will remain unchanged until sufficient heat builds up in the resistance element o' to cause the cutout to open the circuit in the manner already described. Likewise, if a short circuit occurs in the system, the cutout O will function in the manner stated to shut down the system. In case the thermostatic tension element c^{24}

breaks during a normal operating phase, the heating apparatus and system will continue to operate in a normal way until the auxiliary circuit is opened, either at switch S, or at the thermostat R; but, under these conditions, while the blower will continue to run with the advantageous effect of thoroughly purging the combustion apparatus of gases before it can be reignited, the system will not operate automatically to reestablish the ignition and pump circuits until the broken thermostatic tension element is replaced.

Having thus described my invention, what I claim is:

1. In an electric control system for a liquid fuel combustion device, means governing the supply of fuel to said device, an electric actuator for said means, an electrical igniter for the combustion device, an air impeller for supplying combustion air to the device, an electric motor for driving said impeller, a source of direct electric current, a circuit closing instrument, an electric control-unit switch having two circuit closing positions represented, respectively, by a first contact member and a second contact member and characterized by a conducting element movable alternately into engagement with one and the other of said members, a first circuit closing relay involving two circuit closers, a second circuit closing relay, a third circuit closing relay, and a fourth circuit closing relay, each relay comprising an energizing coil and a circuit closer; a main circuit including said source, said conducting element of the control unit switch and the first contact member thereof, the circuit closer of the second relay, the coil of the third relay, and the igniter; an auxiliary circuit, branching from the main circuit between said source and the control-unit switch and including said circuit closing instrument and the coil of the first relay, and energizable by said source of current; a branch circuit also energizable by said source of current and leading from the main circuit between the first contact of control-unit switch and the circuit closer of the second relay and including the coil of the second relay and one circuit closer of the first relay; a second branch circuit energizable by said source of current and including the second circuit closer of the first relay, the coil of the fourth relay, and the actuator of the fuel supply means; a shunt between the main circuit, at a point intermediate the coil of the third relay and the igniter, and the second branch circuit, at a point intermediate the coil of the fourth relay and the fuel supply means, and including the circuit closer of the third relay, and through which shunt said second branch circuit is first energized; a second shunt between the second branch circuit, at a point intermediate the coil of the fourth relay and the last named point, and the main circuit at a point in the latter between its junction with the auxiliary circuit and the control-unit switch and including the circuit closer of the fourth relay, and through which second shunt the second branch circuit is supplied with current after the first mentioned shunt is opened; a circuit leading from the second contact member of the control-unit switch and including the electric motor of the air impeller, and a thermostat subjected to the heat of the combustion device and having operative connection with the conducting element of the control-unit switch for causing said element to move out of engagement with the first contact member of said switch and into engagement with the second

contact member thereof when said thermostat is heated.

2. An electric control system comprising the combination and arrangement of parts defined by claim 1, and, in addition thereto, a circuit leading from the last mentioned circuit at a point between the second contact member of the control-unit switch and said motor to a point in the main circuit intermediate the circuit closer of the second relay and the coil of the third relay, and a resistance element included in the last mentioned circuit whereby the motor is caused to operate at relatively low speed while the igniter is energized.

3. An electric control system comprising the combination and arrangement of parts defined by claim 1, and, in addition thereto, a thermostatic switch in the second branch circuit serving, when cold, to maintain said circuit closed, and an electrical resistance heater in the main circuit in heating relation to said thermostatic switch to actuate said thermostatic switch after the igniter has been energized for a given period of time.

4. In an electric control system for a liquid fuel combustion device, means governing the supply of fuel to said device, an electric actuator for said means, an electrical igniter for the combustion device, a source of direct electric current, a circuit closing instrument, an electric control-unit switch including a contact member and a conducting element movable into and out of engagement with said member, a first circuit closing relay involving two circuit closers, a second circuit closing relay, a third circuit closing relay, and a fourth circuit closing relay, each relay comprising an energizing coil and a circuit closer; a main circuit including said source, said conducting element of the control-unit switch and the contact member thereof, the circuit closer of the second relay, the coil of the third relay, and the igniter; an auxiliary circuit, branching from the main circuit between the source and the control-unit switch and including said circuit closing instrument and the coil of the first relay, and energizable by said source of current; a branch circuit also energizable by said source of current and leading from the main circuit between the control-unit switch and the circuit closer of the second relay and including the coil of the second relay and one circuit closer of the first relay, a second branch circuit energizable by said source of current and including the second circuit closer of the first relay, the coil of the fourth relay, and the actuator of the fuel supply means; a shunt between the main circuit, at a point intermediate the coil of the third relay and the igniter, and the second branch circuit, at a point intermediate the coil of the fourth relay and the fuel supply means, and including the circuit closer of the third relay, and through which shunt said second branch circuit is first energized; a second shunt between the second branch circuit, at a point intermediate the coil of the fourth relay and the last mentioned point, and the main circuit at a point in the latter between its junction with the auxiliary circuit and the control-unit switch and including the circuit closer of the fourth relay, and through which second shunt the second branch circuit derives current after the first mentioned shunt is opened; and a thermostat subjected to the heat of the combustion device and having operative connection with the conducting element of the control-unit switch for causing said element to withdraw from the contact member of said switch when said thermostat is heated.

5. In an electric control system for a liquid fuel combustion device, means governing the supply of fuel to said device, an electric actuator for said means, an electrical igniter for the combustion device, a source of direct electrical energy, a control-unit switch, a thermostat subjected to the heat of the combustion device and having operative connection with said switch, three relays, each comprising an energizing coil and a circuit closer, a main circuit including said source, said switch, the circuit closer of the first relay, the coil of the second relay, and said igniter; a branch circuit energizable by said source of energy and leading from the main circuit in advance of the circuit closer of the first relay and including the coil of said first relay; a second branch circuit energizable by said source of energy and leading from the main circuit intermediate said source and the control-unit switch and including the circuit closer of the third relay and the aforesaid actuator, a further circuit energizable by said source of energy and leading from the second branch circuit between the circuit closer of the third relay and said actuator and including the coil of said third relay, and a shunt between the main circuit, at a point intermediate the coil of the second relay and the igniter, and the second branch circuit at a point intermediate the circuit closer of the third relay and said actuator, said shunt including the circuit closer of said second relay, the thermostat, when heated, causing the control-unit switch to open.

6. In an electric control system for use with a liquid fuel combustion device, electrical means for supplying fuel to said device, an electrical igniter for the device, a control-unit switch, a thermostat subjected to the heat of the combustion device, operative connections between said thermostat and said switch, the switch being closed when the thermostat is cool and open when the thermostat is heated, a source of direct electrical energy, a main circuit including said source and separating into a first branch and a second branch, a relay comprising a coil and a circuit closer, the first branch including said switch, the coil of said relay, and the igniter, the second branch including the fuel supply means, a shunt between the first and second branches from a point in the first branch intermediate the igniter and the coil of said relay to a point in the second branch on the source side of the fuel supply means, and including the circuit closer of said relay, the relay coil in the first branch serving, when energized, to hold said circuit closer of the relay in circuit closing position, a second circuit closer in the second branch between the shunt and the main circuit and having an associated electrical means for actuating it, said latter electrical means being in a leg from the second branch that is in parallel circuit relation with said fuel supply means and that leads from a point in said second branch between the second circuit closer and the shunt and serving to maintain the second branch closed after the aforesaid switch is opened by the thermostat in response to heat generated by the combustion device.

7. In a direct current electric control system for use with a liquid fuel combustion device, a source of direct electric current, an electrical actuator for effecting the delivery of fuel to said device, an electrical igniter for the combustion device, an air impeller for supplying combustion air to said device, an electric motor for operating said impeller, an electric control-unit switch having two circuit closing positions represented, respec-

tively, by a first contact member and a second contact member and characterized by a conducting element movable alternately into engagement with one and the other of said members, a thermostat subjected to the heat of the combustion device, operative connections between said thermostat and said conducting element, the latter being in engagement with the first contact member when the thermostat is cold and in engagement with the second contact member when the thermostat is heated, an electric circuit energizable by said source of current and including the first contact member of said switch and the igniter, a second electric circuit energizable by said source of current and including the other contact member of said switch and said electric motor, a relatively high resistance circuit leading from a junction with the first mentioned circuit intermediate said first contact member and the igniter to a junction with the second circuit intermediate said other contact member and the electric motor, said high resistance circuit being energizable by said source of current, and another electric circuit in parallel circuit relation with said control-unit switch and energizable by said source and including the aforesaid electrical actuator.

8. An electrical control system comprising the combination and arrangement of parts defined by claim 7, and, in addition thereto, a further electric circuit energizable by said source of current and branching from the second circuit intermediate said junction and the motor, and an electrical indicator in said further circuit for indicating the strength of the current flowing there-through.

9. In an electric control system for use with a liquid fuel combustion device, electrical means for supplying fuel to said device, an electrical igniter for the device, an air impeller for supplying combustion air to the device, an electric motor for driving said impeller, a control-unit switch having two circuit closing positions represented, respectively, by a first contact member and a second contact member and characterized by a conducting element movable alternately into engagement with one and the other of said contact members, a thermostat subjected to the heat of the combustion device, operative connections between said thermostat and the conducting element of said control-unit switch, said conducting element engaging the first contact member when the thermostat is cool and the second contact member when the thermostat is heated, a source of electrical energy, a first circuit closer, a second circuit closer, a first electrical means and a second electrical means which serve, when individually energized, to hold the respective circuit closers in circuit closing position, a main circuit including said source and separating into a first branch and a second branch, the first branch including said conducting element, the first contact member of said control-unit switch, the first electrical means and the igniter, the second branch leading from the main circuit in advance of the control-unit switch and including the second circuit closer and the fuel supply means, a shunt including said first circuit closer and extending from the first branch at a point intermediate the first electrical means and the igniter to the second branch intermediate the second circuit closer and the fuel supply means, said second electrical means having electrical connection with the second branch at a point in the latter intermediate the second circuit closer and the junction of said

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shunt with the second branch, whereby said second electrical means is first energized by current supplied thereto through said shunt and through the intervening part of the second branch, and, upon the shifting of the conducting element of the control-unit switch from the first contact member to the second contact member in response to the action of the thermostat when heated, is thereafter maintained energized by current supplied from the main circuit through the second circuit closer, and a further circuit energizable by current from said source and including the second contact member of the control-unit switch and the electric motor of the impeller.

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