Sept. 9, 1941. W. C. MASON 2,255,672

ELECTRICAL CONTROL DEVICE

Filed July 1, 1938 2 Sheets-Sheet 1

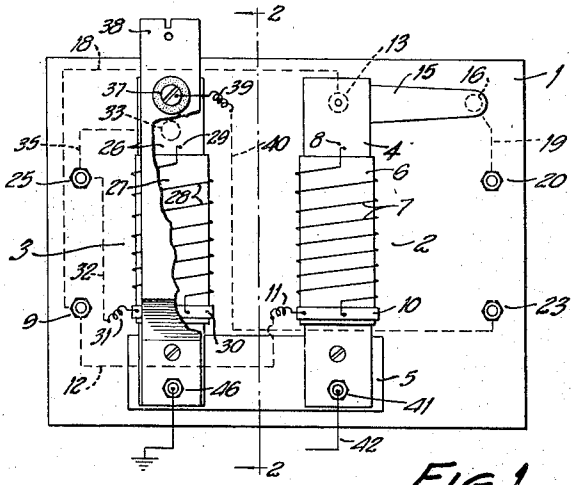

FIG. 1

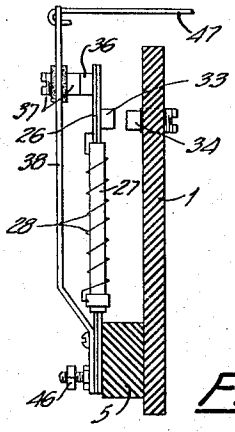

FIG. 2

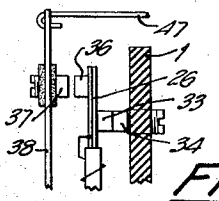

FIG. 4

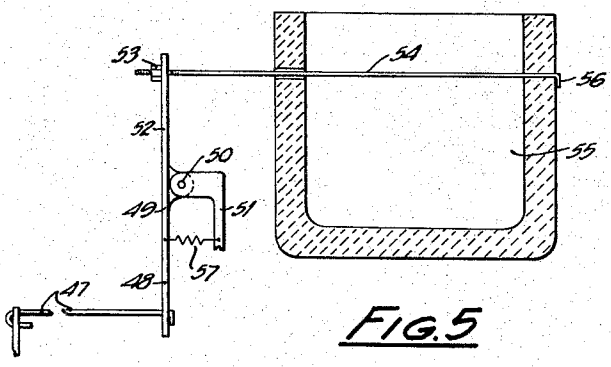

FIG. 5

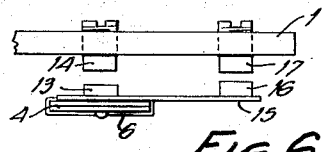

FIG. 6

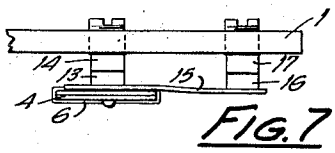

FIG. 7

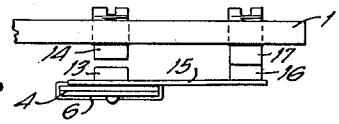

FIG. 8

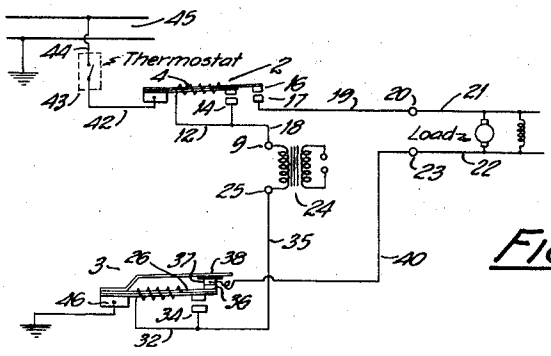

FIG. 3

INVENTOR
William C. Mason
by R. V. Craddock,
ATTORNEY

Sept. 9, 1941. W. C. MASON 2,255,672

ELECTRICAL CONTROL DEVICE

Filed July 1, 1938 2 Sheets-Sheet 2

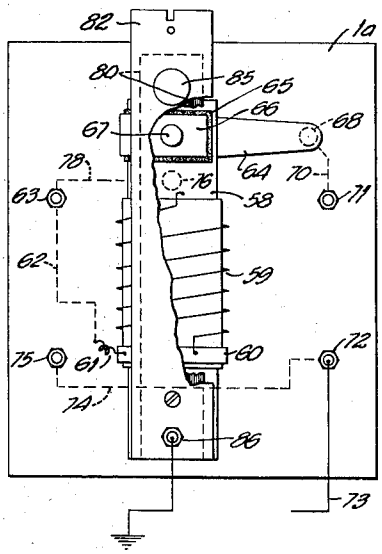

FIG. 9

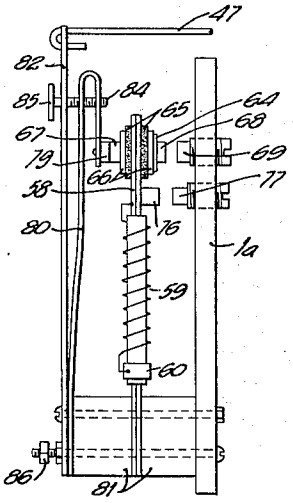

FIG. 10

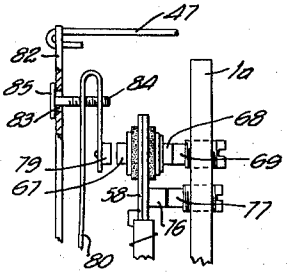

FIG. 11

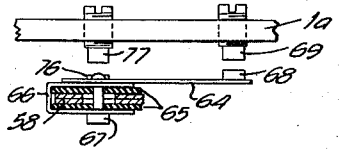

FIG. 12

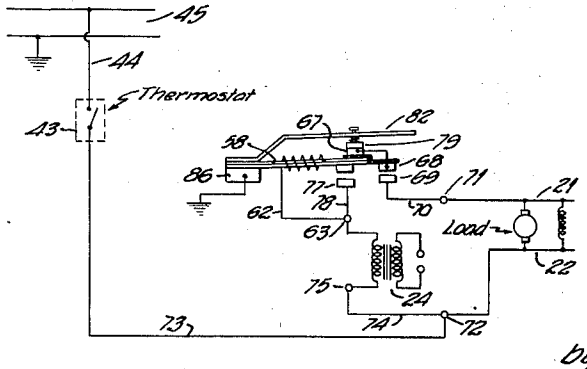

FIG. 13

INVENTOR
William C. Mason
by R. V. Craddock
ATTORNEY

Patented Sept. 9, 1941 2,255,672

UNITED STATES PATENT OFFICE

2,255,672

ELECTRICAL CONTROL DEVICE

William C. Mason, Albany, N. Y.

Application July 1, 1938, Serial No. 216,911

2 Claims. (Cl. 158—28)

My invention particularly relates to an electrical control which is primarily adapted for use with fluid fuel burners and which is characterized by its simplicity, low cost of manufacture and by the fact that it will completely control the operation of a fuel burner whereby to insure safety in its operation under all conditions.

In the control of fuel burners, for example, oil burners, it is necessary where they are arranged for automatic control to provide means which is operable to shut off the burner in the event that, during an operation thereof, the burner flame is extinguished for some reason or other, or, when the burner is initially placed in operation, following a shut-off period, ignition of the fuel fails to take place. Such means should not only be positive in operation but should also operate very rapidly so that the burner is shut off, in the event of a failure of burner operation, before a sufficient period of time has elapsed to permit a dangerous condition to be created such as the formation of explosive mixtures. Such rapid operation will also shut off the burner, in event of failure, before an appreciable quantity of liquid fuel is deposited in the combustion chamber, an occurrence which would produce uncleanliness and undesirable odor, and would cause smoking when the burner was next placed in operation.

It is therefore a first object of my invention to provide a control device, adapted to be used with a fluid fuel burner, which device, though simple in construction, will completely and positively control the operation of the burner and which device is characterized by its rapidity of operation in that it will shut off the burner in such a short interval of time that all dangers due, for example, to the formation of explosive mixtures are entirely obviated. For example, a burner which is controlled by a control device of the character herein contemplated can be shut off in the event ignition fails to take place or for any other cause combustion fails or does not occur within a period of the order of a few seconds from the time of starting an operation of the burner or from the moment combustion ceases. Therefore, an appreciable amount of fuel will not be deposited in the combustion chamber thereby substantially eliminating any odor of the fuel, smoking and unclean burner conditions.

An important feature of my invention lies in the provision of a thermal-responsive element which will expand and contract rapidly under varying temperature conditions and, at the same time, exert sufficient force to operate a control switch associated therewith, said element being capable of being placed within a combustion chamber or where temperatures of high order exist under burner operating conditions whereby due to the thermal-responsive character of the element it will operate with extreme rapidity to effect a desired operation of the control elements with which it is associated. A further object, therefore, resides in providing a control device which comprises an element of the foregoing character.

Further objects of my invention reside in the provision of a control unit comprising an electrically controlled switch which, preferably, comprises a bimetallic element operable in response to heat generated by electrical means to close or open an electrical circuit. A switch construction of this character entails a low manufacturing cost and yet comparatively slow, predetermined speeds of operation of the switch may be effected so that where such a bimetallic element or a plurality thereof are employed to open or close a circuit through two or more pairs of contacts, as herein contemplated, one of a pair of contacts may be actuated in timed relation to a second movable contact to make or break an electrical circuit therethrough.

A still further object resides in providing, in a control device, a switch element of the above character which is so arranged that the degree to which the bimetallic element may be warped is limited, thereby preventing excessive strains being set up in the element after an electrical contact has been made thereby, which might otherwise produce deformation therein and impair the designed operation thereof with respect to timing.

Another object of my invention resides in the provision of a switch comprising a bimetallic element of the foregoing character which is so constructed that said bimetallic element will operate to close a circuit through a pair of cooperative contacts and exert a force substantially sufficient only to hold said contacts firmly in engagement so that said contacts will be substantially instantaneously parted when the circuit is open to the electrical heating means associated with said bimetallic element.

With these and other objects in view, my invention includes the novel elements and the combinations and arrangements thereof described below and illustrated in the accompanying drawings, in which—

Fig. 1 is an elevation view of one form of my

control device with a portion of one element thereof broken away;

Fig. 2 is a sectional elevation view thereof taken in about the plane 2—2 of Fig. 1;

Fig. 3 is a wiring diagram illustrating the electrical interconnection of my control device with an electrical load;

Fig. 4 is a fragmentary view, partially in section, illustrating the switch element shown in Fig. 2 in an alternative position;

Fig. 5 illustrates one manner of associating the device of Fig. 1 with a thermal-responsive element.

Fig. 6 is a fragmetary plan view of a part of the control panel and illustrating two pairs of contacts in relatively spaced position;

Figs. 7 and 8 are views similar to Fig. 6 but showing the contacts in the relative positions they will assume according to the degree of actuation of a bimetallic element associated therewith;

Fig. 9 is an elevation view of a modified form of control device;

Fig. 10 is a side elevation view thereof;

Fig. 11 is a fragmentary, side elevation view showing the switch arm in an alternative position;

Fig. 12 is a fragmentary plan view thereof, partially in selection; and

Fig. 13 is a wiring diagram illustrating the control device of Fig. 9 electrically interconnected with an electrical load.

The control device illustrated in Figs. 1 to 8 inclusive comprises a panel 1 which may be formed of any suitable electrical insulating material and upon which is mounted a first switch element indicated generally at 2 and a second switch element indicated generally at 3. The switch 2 comprises a bimetallic arm 4 which is preferably mounted upon and secured to an insulating block 5 on the panel 1 which serves predeterminately to space the contacts borne by the bimetallic element from those contacts which are mounted upon the panel in cooperative relation thereto. The arm 4 is, at least in part, surrounded by an insulating sleeve 6 about which is wound a coil 7 of electrical resisting wire forming a heating element adapted when energized to actuate the arm 4 or cause it to warp. One end of the resistor 7 is electrically connected to the arm 4 as indicated at 8 and the other end thereof is electrically connected to a terminal 9 by means of a collar 10, a lead 11, and conductor 12, which may be arranged to extend through the panel to the terminal 9. The bimetallic arm 4, is provided on the underside thereof with a contact 13 (see Fig. 6) and panel 1 is provided with a contact 14 arranged to be engaged by contact 13 when the arm 4, in response to heat generated by coil 7, is warped. Arm 4 is also provided with a laterally extending arm 15, preferably of resilient material, and bearing a contact 16 which is adapted to engage a contact 17 mounted on the panel 1 when arm 4 is warped as above described. For a reason, which will hereinafter be apparent, contacts 16 and 17 are preferably somewhat more closely spaced than contacts 13 and 14 so that an electrical circuit will be closed through contacts 16 and 17 before contacts 13 and 14 engage each other and the resilience of arm 15 permits this operation without producing appreciable torsional stresses in the bimetallic arm. The contact 14 is electrically connected through a conductor 18, which may be imbedded in the panel 1 as illustrated in dotted lines, to terminal 9 and contact 17 is electrically connected through a conductor 19 to a terminal 20.

The various electrically operated parts of a fuel burner are herein referred to as the electrical load of the burner and, by way of example, illustrated as a motor and inductance in the wiring diagram of Fig. 3. One side of this load is adapted to be connected through conductor 21 to terminal 20 and the other side of said load through conductor 22 to terminal 23. Likewise, the primary of an ignition transformer 24 for said burner is adapted to be connected between the terminal 9 and a terminal 25. Hence, it will be seen, generally speaking, that the heating coil 7 is connected in the primary circuit of the transformer 24 and contacts 16 and 17 are designed to control the flow of current to the conductor 21 on one side of the load circuit.

The switch 3 is similar to switch 2 in that it comprises a bimetallic arm 26 surrounded by an insulating sleeve 27 which has wound thereabout a heating coil 28. One end of the heating coil is electrically connected to the arm 26 as indicated at 29 and the other end thereof is connected to terminal 25 through the medium of collar 30, lead 31 and conductor 32. Arm 26 is provided on the inner surface thereof with a contact 33 which is adapted to engage a contact 34 mounted in cooperative relation thereto on the panel 1. Contact 34 is electrically connected with terminal 25 through conductor 35. Arm 26 is also provided with contact 36 which is mounted on the outer surface thereof and designed normally to lie in engagement with a contact 37 which is mounted upon, but electrically insulated from, a movable arm 38 which may be designed to overlie the bimetallic arm 26. Contact 37 is electrically connected with terminal 23 by means of a flex lead 39 and conductor 40.

From the foregoing, it should be apparent that the heating coil 28, like heating coil 7, is included in the primary circuit of the ignition transformer 24 and that contact 37 is connected to one side of the load circuit of the burner.

Assuming, therefore, that terminal 41 of switch 2 which is in electrical contact with the arm 4 thereof is connected through conductor 42, thermostat 43 and conductor 44 to one side of a source of electrical energy 45, that the other side of said source is grounded and that terminal 46 of switch 3, in electrical contact with arm 26 thereof, is also grounded, it will be seen that, if the circuit through thermostat 43 is closed, a closed circuit will exist including in series heating coils 7 and 28 and the primary winding of the ignition transformer 24. Furthermore, with the contacts 36 and 37 of switch 3 normally in engagement, a circuit from the load to ground is completed but contacts 16 and 17 of switch 2 are spaced apart. However, when the bimetallic arm 4 of switch 2 warps due to the heat generated by coil 7, it will close the circuit through contacts 16 and 17 and complete the electrical circuit to the load. At the same time, bimetallic arm 26 of switch 3 will also warp but switch 2 is so designed that when the heating coil 7 thereof is energized it will warp to close the circuit through contacts 16 and 17 before the bimetallic arm 26 of switch 3 is warped sufficiently to open the circuit between contacts 36 and 37 thereof and means are provided, as described in the following, which function to prevent a separation of the contacts 36 and 37 in the event of proper burner operation but which will permit a separation thereof in the event combustion fails to take place.

The free end of arm 38 may be provided with a slot and an opening adjacent thereto as illustrated in which one end of a rod 47 may be secured, the other end of rod 47 being secured, as illustrated in Fig. 5, to the arm 48 of a lever 49 which is pivotally mounted as at 50 in a bracket 51. The other arm 52 of lever 49 has adjustably connected thereto by means of a nut 53 a thermal-responsive element or wire 54, the threaded end of which passes through an opening in the arm 52. Element 54 is adapted to be placed within the combustion chamber indicated generally at 55 or in those spaces where temperatures of high order exist during the operation of a burner. One end of wire 54 may be bent over as at 56 to secure it to one side of the combustion chamber so that the wire extends thereacross with its opposite end connected to arm 52 of lever 49. A spring 57 is preferably connected between the arm 48 of lever 49 and bracket 51 whereby normally to urge the contact 37 carried by arm 38 into engagement with contact 36 and the degree to which the arm 38 may be moved by spring 57 is dependent upon the thermal-responsive element 54. In the absence of combustion in the combustion chamber, element 54 will permit spring 57 to maintain contact 37 of arm 38 in engagement with contact 36 during a portion only of the movement of the bimetallic arm 26 when it warps under the influence of heat generated by the coil 28. That degree of movement of arm 38 which will maintain contacts 36 and 37 together for a predetermined time interval during operation of the switch 3 may be adjusted by means of the adjusting nut 53. Hence, assuming that the burner is placed in operation and that the fuel fails to ignite, bimetallic arm 26 will warp and, after a predetermined interval of time, contacts 36 and 37 will part, as illustrated in Fig. 4, thereby opening the electrical circuit to the electrical load of the burner. However, should combustion take place, element 54 will instantly expand thereby permitting spring 57 to maintain the contacts 36 and 37 in engagement and the circuit to the electrical load wil be preserved.

The element 54, for example, may be formed of a 16-gauge wire, preferably nichrome wire, and of a length of about 9 or 10 inches. When an element of this character is subjected, as herein contemplated, to temperatures of about 1400 to 1500° F., expansion thereof occurs with extreme rapidity and so quickly that switch 3 may be designed to break the circuit to the burner in the event combustion does not occur within a period of the order of 3 or 4 seconds after an operation of the burner has been initiated, or, assuming that the burner is operating, within a like period of time after combustion ceases. Furthermore, by employing a thermal-responsive element of the character above described it not only responds quickly to temperature changes, that is, to either an increase or decrease in temperature, but it is also capable of exerting sufficient force to actuate the arm 38 associated with the switch 3.

Other thermal-responsive devices such as bimetallic elements cannot be subjected to temperatures of the high order herein contemplated without being practically destroyed and such elements when designed for quick operation can exert only a comparatively small force and one insufficient for practical purposes to effect a positive control or actuation of a switch element. On the other hand, if such elements were designed to exert the required degree of force, sufficient for positive and accurate control purposes, the speed of operation thereof would necessarily be extremely slow. Such thermal-responsive elements are, therefore, of practically no value in a control device where quick response and direct, positive control thereby are desired.

I have also provided means for limiting the degree to which the respective bimetallic elements of switches 2 and 3 may be warped while maintaining a circuit to the electrical load of the fuel burner. These means comprises electrical contacts which serve, when the bimetallic arms have been warped to a sufficient degree, to shunt the heating coils associated therewith. Upon shunting of the heating coils, the bimetallic arms immediately begin to cool and return to their normal position. However, in so doing, engagement between the contacts which serve to shunt the coils is broken and, the coils being again energized, will again cause the bimetallic arms to warp. The contacts 13 and 14 of switch 2 effect this intermittent energization of the heating coil 7 and the resilient arm 15 serves to maintain contacts 16 and 17 in engagement during this operation. Likewise, contacts 33 and 34 of switch 3 serve to provide intermittent energization of coil 28. The electrical circuit of these contacts hereinbefore described, should be apparent from an examination of Fig. 3.

The intermittent operation of the heating coils 7 and 28 perform two functions. First, it prevents excessive strains or stresses being set up in the bimetallic elements due to prolonged heating thereof and, secondly, as, for example, in the case of switch 2, it serves to cause the bimetallic arm to move a distance sufficient only to hold the contact 16 in engagement with contact 17 so that the arm 4, when it starts to return to its normal position, will substantially immediately separate these contacts. For example, if the bimetallic arm were continuously subjected to heat from its heating coil during burner operations, it would require a much longer period to cool sufficiently to separate the contacts.

Fig. 6 illustrates switch 2 in open position; Fig. 7 illustrates the arm 4 actuated to a position wherein contact between the respective pairs of contacts is made, thereby closing the circuit therethrough to the electrical load and shunting the heating coil 7, and Fig. 8 illustrates contacts 13 and 14 separated due to a shunting of the heating coil with arm 15 maintaining the contacts 16 and 17 in engagement. The bimetallic arm of switch 3 functions in like manner intermittently to engage contacts 33 and 34 while the circuit through contacts 36 and 37 is maintained.

In conjunction with the foregoing, the operation of the foregoing described embodiment of my invention should be apparent from the following brief description thereof with reference to the wiring diagram of Fig. 3. Bearing in mind that switch 2 is normally open and switch 3 normally closed and assuming that thermostat 43 closes, the heating coils of switches 2 and 3 are placed across the source of supply and in series with the primary of the ignition transformer. Both bimetallic elements of switches 2 and 3, therefore, commence to warp and it will be understood, in order to engage contacts 16 and 17 of switch 2 before contacts 36 and 37 of switch 3 are opened, the arm 4 of switch 2 is preferably designed to warp more quickly than the arm 26 of switch 3. Of course, this result may be effected by properly arranging the spac-

ing of the contacts of the respective switches and permitting the arms thereof to warp substantially at the same rate. When the circuit is closed through switch 2, the fuel burner commences to operate and ignition of the combustible mixture is produced by the spark gap in the secondary circuit of the ignition transformer. If proper combustion occurs, contacts 36 and 37 of switch 3 will be maintained in engagement, as hereinabove described through the expansion of wire 54. However, assuming combustion fails to take place, contacts 36 and 37 of switch 3 will be parted thereby breaking the circuit to the electrical load. It will be understood that the operations of switches 2 and 3 may be so relatively timed, due to the extremely quick control action obtainable with my device, that the circuit through switch 2 to the load may be effected for the brief period of about 3 or 4 seconds before switch 3 operates to open the circuit therethrough in the event combustion fails to occur.

It will be understood that if ignition fails due, for example, to an opened secondary of the transformer, insufficient current will flow through the primary thereof to energize the heating coils sufficiently to effect warping of the bimetallic elements of the switches.

In the embodiment of my invention illustrated in Figs. 9 to 13, inclusive, I have illustrated a control device comprising a single bimetallic arm which device functions positively to control a circuit to the electrical load of a fuel burner in substantially the same manner as the device hereinabove described. In this embodiment, the bimetallic arm 58 has associated therewith a heating coil 59, one end of which is connected through the collar 60, lead 61 and conductor 62 to one terminal 63 to which one leg of the primary winding of the ignition transformer is adapted to be connected. The bimetallic arm 58 carries a laterally extending, preferably resilient, arm 64 which is insulated therefrom by means of insulators 65 but electrically connected through a yoke 66 to a contact 67. A contact 68 on arm 64 is adapted to engage the contact 69 mounted on the panel 1a. Contact 69 is connected through conductor 70 to one terminal 71 to which one leg of the electrical load may be connected. A second terminal 72 is provided to which the other leg of the load circuit may be connected and conductor 73 from the thermostat 43 is also adapted to be connected to terminal 72. A conductor 74 connects terminal 72 with terminal 75 to which the other leg of the primary of the ignition transformer may be connected.

Bimetallic arm 58 also carries a contact 76 which is adapted to engage contact 77 mounted on the panel 1a and contact 77 is connected through conductor 78 to terminal 63. These latter contacts serve intermittently to shunt the heating coil 59 in the manner hereinabove described and contacts 68 and 69 serve to close the circuit to the electrical load in the manner above described with respect to switch 2.

Contact 67 carried on the bimetallic element and electrically connected with contact 68, however, is designed normally to engage a contact 79 which is carried on a movable, preferably resilient, arm 80, one end of which is suitably secured to the insulating blocks 81 which serve to hold the respective switch elements in proper relationship. A movable arm 82, generally similar to arm 38 of switch 3 and operable substantially in like manner, is also secured at one end to the supporting blocks 81 and the free end thereof is designed to be connected with the element 47 associated with the thermal-responsive element 54. The arm 82, however, is provided with an opening 83 through which a threaded stud 84 is adapted to extend. The stud is preferably threaded through openings in the spaced, overbent end of the arm 80 and the head 85 thereof is somewhat larger than the opening 83 so that arm 80 may be moved relative to arm 82 but the extent of such movement is adjustably limited by means of the stud 84.

The fixed ends of bimetallic arm 58, resilient arm 80 and arm 82 are electrically connected together at the insulating blocks 81 and to the terminal 86 which may be connected to ground as in the case of switch 3.

In operation, assuming the thermostat 43 closes, the circuit through heating coil 59 is closed thereby causing arm 58 to warp toward the right, as viewed in Fig. 10. As this occurs, resilient arm 80 will follow arm 58 maintaining contacts 67 and 79 in engagement. The contacts are so arranged that contacts 68 and 69 will engage before arm 58 has moved a sufficient distance to separate contacts 67 and 79, assuming arm 82 is held stationary, and, of course, the extent of movement of arm 80 carrying contact 79 is limited by the engagement of the head of stud 84 with the arm 82. The resiliency of lateral arm 64 permits contacts 68 and 69 to be made before completion of the warping movement of arm 58 without producing appreciable strains therein. Hence, after contacts 68 and 69 are brought into engagement, arm 58 continues to warp and the contacts are so relatively arranged that, assuming arm 82 is held stationary, contacts 67 and 79 will be maintained for a predetermined interval of time, for example of the order of 3 or 4 seconds, after the engagement of contacts 68 and 69. Therefore, inasmuch as the circuit to the load is made through these contacts, the fuel burner will begin to operate. However, if combustion does not occur, arm 83 controlled by the thermal-responsive element 54 will not be actuated to maintain contacts 67 and 79 in engagement and, after the head of stud 84 engages arm 82, these contacts will be parted because continued warping of arm 58 will carry contact 67 away from contact 79. If combustion occurs, however, arm 82 will be moved, as by spring 57, to maintain contacts 67 and 79 together and the circuit to the load will be continued. Fig. 11 illustrates the relative positions assumed by the various parts of the control device when the control device is operated to effect an operation of the fuel burner but combustion fails to occur.

It will be noted that contacts 76 and 77 produce an intermittent energization of the coil 59 thereby preventing excessive straining of arm 58 as would occur if the coil were continuously energized but, at the same time, arm 58 is maintained in a position wherein engagement between contacts 68 and 69 and 67 and 79, respectively, may occur.

From the foregoing, it is believed apparent that my control device is extremely simple in construction, may be manufactured at a very low cost, and serves positively and accurately to control the operation of a fuel burner. It should also be noted that, in the event combustion fails to take place for any reason whatsoever, the

control device will operate to shut off the burner in such a short interval of time that danger due to the production of explosive mixtures and also the production of odors and smoking due, for example, to the deposition of fuel in appreciable amounts within the combustion chamber is entirely obviated.

Furthermore, it will be seen that the dual switch feature of my control device positively prevents reoccurrence of attempted burner operations if, for example, combustion does not occur. In the absence of this feature, a control circuit would repeatedly function, assuming the thermostat associated therewith closes, to start the burner in operation and, if combustion fails, to open the circuit and thereafter to close said circuit again. Obviously, under such control, the burner would intermittently deposit fuel in the combustion chamber thereby forming not only a very undesirable, odorous and unclean condition but also a dangerous one.

While I have described my invention in its preferred embodiments it is to be understood that the words which I have used are words of description rather than of limitation. Hence, changes within the purview of the appended claims may be made without departing from the true scope and spirit of my invention in its broader aspects:

What I claim is:

1. In a control circuit for a liquid fuel burner comprising an electrical load and an ignition transformer, a source of electrical energy, a thermostat, a first, normally closed switch and a second, normally open switch connected in series with said thermostat and electrical load across said source of electrical energy, and electrical means, in series with said transformer and thermostat across said energy source, for effecting the opening of said first switch and the closing of said second switch, said first switch having associated therewith a thermal-responsive element acting, when thermally actuated, to prevent the opening of said first switch.

2. In a control circuit for a liquid fuel burner comprising an electrical load and an ignition transformer, a source of electrical energy, a thermostat, a first, normally closed switch and a second, normally open switch connected in series with said thermostat and electrical load across said source of electrical energy, said switches having thermal-responsive, switch-actuating elements, and electrical heating means associated with said switch-actuating elements and in series with the primary of said transformer and said thermostat across said energy source, said heating means being operable, when energized, to effect a closure of said second switch and an opening of said first switch, and said first switch having associated therewith a thermal responsive element, adapted to be placed within the combustion chamber of said burner, acting, when thermally actuated, to prevent the opening of said first switch.

WILLIAM C. MASON.