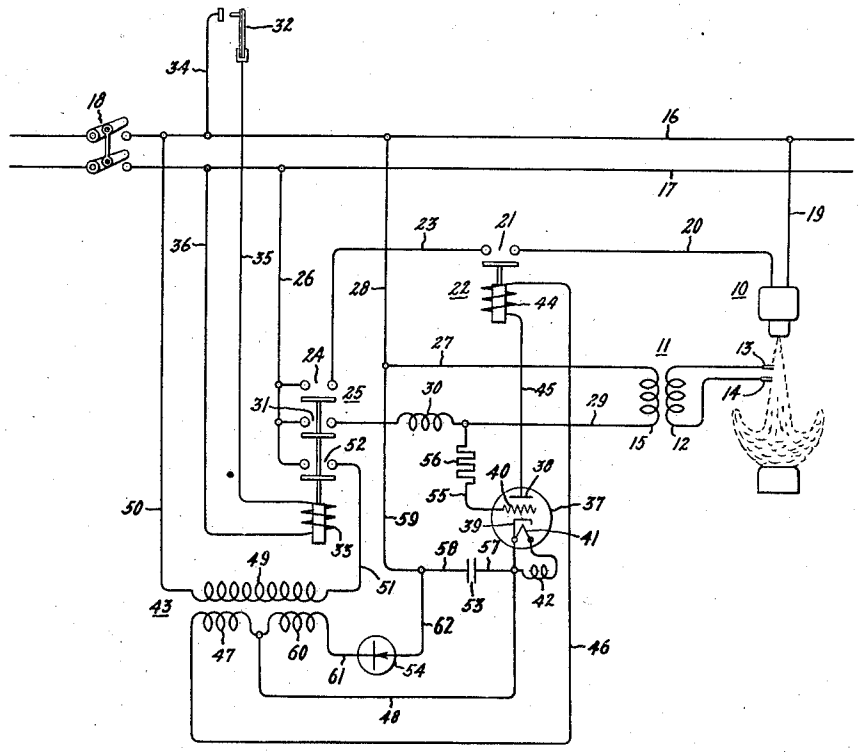
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CONTROL SYSTEM

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CONTROL SYSTEM

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My invention relates to control systems and to a system responsive to the presence of arcing across a pair of electrodes, and although not limited thereto it has application to a control circuit for a fuel burning device.

Oil burner control systems which employ an arrangement for producing an electric ignition for igniting the combustibles of the furnace, may have an arrangement responsive to a call for heat for producing the ignition and for initiating operation of the electric means for producing the combustibles provided that the ignition is functioning properly. In this manner the combustibles will not be pumped into the furnace if the ignition is not present to ignite them. One method of checking the ignition spark includes an arrangement responsive to high frequency impulses which are produced in the ignition circuit if sparking is present across the ignition electrodes. Other safety arrangements include flame detectors for turning off the oil burner provided that the flame is not present in a predetermined time after the burner has been turned on, such a control system being described in Patent 2,136,256 to Sweet, which is assigned to the same assignee as this present invention.

It is, therefore, an object of my invention to provide an improved fuel combustion control system for determining whether a proper spark is present across the ignition electrodes.

Another object of my invention is to provide an improved control system responsive to a predetermined arcing condition across a pair of electrodes.

A further object of my invention is to provide an improved fuel burner control arrangement for initiating operation of the combustible producing means after it has been determined that a predetermined spark is present across the ignition electrodes.

Further objects and advantages of my invention will become apparent from the following description referring to the accompanying drawing, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

The single figure in the drawing illustrates a control system for an oil burner which is provided with an embodiment of my invention.

In the arrangement illustrated in the drawing, I have provided improved means for detecting the presence of an arc across the ignition electrodes which utilizes the phenomenon that the action of the arc upon an inductive alternating current supply circuit for the ignition transformer is such as to produce peak voltages across the transformer primary in excess of the normal alternating current terminal voltage. In order to provide a system responsive to these peak voltages, I connect a control circuit including an electric discharge device directly across the primary of the ignition transformer. To detect the peak voltages the electric discharge device is biased beyond cutoff by a condenser which is included in the control circuit and is arranged to be charged to the normal transformer terminal voltage through a half wave rectifier. The transformer terminal peak voltages, therefore, are impressed upon the control circuit so as to allow the discharge device to be made conductive and to operate a suitable relay in the plate circuit to properly control the fuel burning device, in any suitable manner.

Referring more particularly to the single figure in the drawing, I have illustrated a control system for a domestic furnace which burns fuel, such as oil, the combustibles being provided at the furnace through a burner arrangement indicated generally by the numeral 10. This burner arrangement is of the conventional type and includes an electric motor for operating a compressor and pump, and an ignition transformer 11 having its secondary or high voltage winding 12 connected to arcing electrodes 13 and 14, the latter being placed adjacent the nozzle of the burner arrangement in order to ignite the mixture of fuel and air as it passes out the nozzle. The motor of the burner arrangement and the primary or low voltage winding 15 of the ignition transformer may be energized from a source in any suitable manner. Thus, lines 16 and 17 may be connected to a suitable source through the line switch 18 and one side of the motor of the burner arrangement 10 is connected to the line 16 through a conductor 19, while the other side of the motor of the burner arrangement is connected to the line 17 through a conductor 20, contacts 21 of a relay indicated generally by the numeral 22, conductor 23, contacts 24 of the relay indicated generally by the numeral 25, and a conductor 26. One side of the primary winding 15 of the ignition transformer may be connected to the line 16 through conductors 27 and 28, while the other side of the transformer may be connected to the line 17 through a conductor 29, a reactor 30, contacts 31 of the relay 25 and the conductor 26. The relay 25 is adapted to be energized upon a call for heat, which call may be produced in any suitable manner, such as by

providing a suitable condition responsive device, such as a thermostat 32 within the room to be heated. Operating coil 33 of the relay 25 may, therefore, be energized when the thermostat closes its contacts and calls for heat, and this circuit may be traced from the line 16 through a conductor 34, thermostat 32, a conductor 35, operating coil 33, and a conductor 36 back to the line 17. It will, therefore, be seen that when the thermostat 32 closes its contacts, the relay 25 will pick up and thus energize the ignition transformer. However, the motor of the burner arrangement 10 will not be energized until the contacts 21 are closed upon energization of the relay 22, and this relay is energized upon my improved control system having determined that a proper spark is present across the electrodes 13 and 14.

In order to provide an improved system for detecting the presence of a suitable arc across the electrodes, I employ a detecting arrangement which is responsive to peak voltages which are present in the ignition transformer primary circuit, these voltages being in excess of the A.-C. terminal voltage which is impressed across the lines 16 and 17. These peak voltages result from the action of the arc upon the alternating current supply and apparently arise from the fact that near the current zero the decrease in conductance due to the arc brings about a rapid change of current in the reactance of the supply circuit, which is indicated in the diagram as the lumped inductance element 30, leading to peak voltages of short duration. In a low reactance circuit inductance in the form of a reactor 30 may be added to the circuit. These peak voltages may be detected by any suitable means which are not responsive to the high frequency character of the generated impulse but only to their maximum value, and in the illustrated embodiment of my invention I have provided an electron discharge device 37 which is allowed to become conducting when these peak voltages are present in the ignition circuit. This electric discharge device includes an anode 38, a cathode 39, and a control electrode 40, and the plate and cathode are connected in circuit with any suitable device responsive to current passing through the plate cathode circuit which may in turn accomplish the desired control in the fuel burning circuit. The cathode may be suitably heated by a filament 41 which is connected to a suitable source, such as a secondary winding 42 of a transformer 43. Thus, the cathode 39 and anode 38 are connected in series with an operating winding 44 of the relay 22 through conductors 45 and 46, a secondary winding 47 of the transformer 43 and a conductor 48. The secondary winding 47 provides the necessary potential in the anode cathode circuit to produce the flow of current in the circuit. A primary winding 49 of the transformer 43 is energized, when the thermostat 32 calls for heat, through a circuit which includes a conductor 50 connected to the line 16 and to one side of the primary winding, a conductor 51 which is connected to the other side of the primary winding and which is also connected to contacts 52 of the relay 25, the latter being in turn connected to the conductor 26 which connects with the line 17. It is to be understood that any other suitable source of supply may be provided for producing the flow of current in the anode cathode circuit. To detect the peak voltages the control tube is biased beyond cutoff by a condenser 53 which is charged through a half-wave rectifier 54. Thus, the control electrode is connected to one side of the primary winding of the ignition transformer and to the line 17 through a conductor 55, a suitable current limiting resistor 56, conductor 29, and reactor 30, contacts 31 and conductor 26. The cathode is connected to the line 16 and to the other side of the primary of the ignition transformer through conductor 48, a conductor 57, capacitor 53, conductors 58 and 59, and conductors 27 and 28. The capacitor 53 is shunted by the circuit which includes a half-wave rectifier 54 and any suitable source of supply such as a secondary winding 60 of the transformer 43. Thus, the plate of the capacitator 53 which is connected to the cathode is also connected to one side of the winding 60 through the conductor 48, while the other side of the winding 60 is connected through a conductor 61, half-wave rectifier 54, conductors 62 and 58 to the other side of the condenser.

Operation of my improved control circuit is as follows: Upon call for heat, the thermostat 32 will close its contacts thus energizing the relay 25 so that its three contacts 24, 31, and 52 are closed. The closing of the contacts 31 completes the circuit for energizing the ignition transformer 11, while the closing of the contacts 52 energize the transformer 43 which is in the circuit for producing the negative bias on the control electrode. The circuit which includes the burner motor, however, will not be energized with the closing of the contacts 24, since the contact 21 of the relay 22 must also be closed before this circuit is energized. Before the suitable arcing is present across the arcing electrodes 13 and 14, a charge will be produced on the control electrode and make it more negative than the cathode so that no current will be allowed to flow in the plate-cathode circuit. Or, two voltages will be impressed across the control electrode and cathode in opposite directions, and one having a sufficiently larger magnitude so that the tube will be non-conducting. When, however, suitable arcing is present between the electrodes 13 and 14 peak voltages will be produced across the lines 27 and 29 and these lines are in turn connected between the control electrode and the condenser 53 so that these peak voltages will overcome the negative bias on the control electrode and allow it to become sufficiently positive so as to permit a current to flow in the plate-cathode circuit. When this current reaches a sufficient value the relay 22 will pick up thus closing its contacts 21 and energizing the burner motor circuit.

In view of the foregoing, it will be seen that I have provided an improved arrangement responsive to the presence of an arc for controlling a fuel burning circuit. My improved control circuit is responsive to the presence of peak voltages which are in excess of the A.-C. terminal voltages for producing the desired control. Thus, to detect the peak voltages an electric discharge tube is biased beyond cutoff a sufficient amount. The peak voltages produced by the arc, however, are present in the ignition transformer primary circuit which is connected between the control electrode and cathode so as to overcome the biasing voltage which is proportional to or equal to the peak line voltage, and allow the control electrode to become sufficiently positive so that a current will flow in the circuit including the plate and cathode. The plate-cathode circuit may be connected in circuit with any suitable de-

vice so as to produce the desired control. In the illustrated embodiment of my invention a relay is connected in the plate cathode circuit for completing the motor circuit which produces the flow of combustibles in the furnace. It is to be understood, however, that the plate-cathode circuit may be connected in circuit with any other suitable arrangement responsive to a flow of predetermined current through the plate circuit for producing the desired control. Therefore, instead of connecting my control circuit which is responsive to the arcing, in a control circuit which produces a continuous ignition, my improved circuit may be applied in an oil burner ignition circuit of the intermittent type. It will also be apparent that my improved control circuit which is responsive to the presence of an arc may also be employed in an oil burner control circuit which employs other safety mechanisms or arrangements, such as a device responsive to the presence of a flame and suitable timing mechanism for deenergizing the burner provided the flame does not appear within a predetermined time after the burner is energized. Thus, my arc detection control circuit may be employed in such oil burner control circuits as are described and claimed in Patent 2,058,577 to Eaton or as described in a copending application Serial No. 347,994, Eaton, filed July 27, 1940, both of which are assigned to the same assignee as this present invention. It will also be apparent that although I have described a particular circuit for producing the negative bias on the control electrode when the arcing is not present and for overcoming this negative bias when the arcing is present through the peak voltages, any other suitable circuit may be provided for detecting the presence of these peak voltages which are in excess of the A.-C. terminal voltages.

Modifications of the particular arrangement which I have disclosed embodying my invention will occur to those skilled in the art, so that I do not desire my invention to be limited to the particular arrangement set forth and I intend in the appended claims to cover all modifications which do not depart from the spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. A control for a furnace burner having means for producing a flow of combustibles to the furnace and sparking electrodes for igniting the combustibles including an ignition transformer having an inductance in the primary circuit thereof for connecting said sparking electrodes across a source of alternating potential to cause arcing across said electrodes, an electric discharge device, means responsive to the flow of current through said device for completing the circuit through said combustible producing means, means for biasing said discharge device beyond cutoff, and means responsive to peak voltages present across the primary of said transformer when the arcing is present across said electrodes for overcoming said cutoff means.

2. A control for a furnace burner having electrically operated means for producing a flow of combustibles to the furnace and sparking electrodes for igniting the combustibles including a source of alternating potential, means including an ignition transformer having an inductance in the primary circuit thereof for impressing said potential across said sparking electrodes when heat from said furnace is desired, means including an electric discharge device having an anode, a cathode, and a control electrode for energizing said electrically operated means, means including a capacitor and a rectifier for impressing a charge on said control electrode so as to prevent a current from flowing in a plate circuit including said anode and cathode, the presence of arcing between said arcing electrodes producing voltages across the primary of said transformer of a value greater than that of said source, and means for impressing the last-mentioned voltage on said control electrode in the reverse direction than the biasing voltage so as to allow current to flow in the said plate circuit when arcing is present across said arcing electrodes.

3. In combination, a pair of electrodes, means including a transformer for impressing an alternating potential across said electrodes to produce arcing therebetween, an electric discharge device having an anode, a cathode and a control electrode, a circuit including a condenser for impressing the energizing potential of said transformer across said cathode and control electrode, separate means for charging said condenser to a potential of substantially the same magnitude as said energizing potential but in a fixed direction such that no current will flow in the plate cathode circuit of said electric discharge device, and inductive means in the energizing circuit of said transformer for producing a peak voltage in said control circuit in excess of said transformer energizing potential in response to the presence of a predetermined alternating arcing between said electrodes for overcoming said condenser potential to allow current flow in the anode cathode circuit of said electric discharge device.

4. A control system responsive to a predetermined arcing condition including a pair of electrodes, a source of alternating potential, means including a transformer having a reactor connected in series with the primary winding thereof across said source for impressing a higher potential across said electrodes to produce a predetermined arcing therebetween, an electric discharge device having an anode, a cathode and a control electrode, a circuit including a condenser connected across the primary winding of said transformer for impressing the energizing potential of said transformer primary winding across said cathode and said control electrode, separate means for charging said condenser to bias said discharge device beyond cut-off, means including said transformer and said reactor for producing peak voltages in said circuit in excess of the potential of said source to overcome the bias of said condenser and allow said electric discharge device to become conductive, and means connected in circuit with said anode and cathode to be responsive to the flow of current therebetween.

5. A control system for a burner having a pair of ignition electrodes comprising means including a transformer for impressing a potential across said electrodes to produce arcing therebetween, an electric discharge device having an anode, a cathode and a control electrode, a circuit including a condenser for impressing the energizing voltage of said transformer across said control electrode and said cathode, means for charging said condenser to a potential of slightly larger magnitude than said transformer energizing potential but of fixed polarity to bias said electric discharge device beyond cut-off, means including said transformer for producing peak voltages in said circuit of larger magnitude than said energizing potential for overcomng the bias

of said condenser to allow current to pass between said anode and said cathode when arcing is present between said electrodes, and means connected in circuit with said anode and cathode for controlling the operation of the burner.

6. A control for a burner having supply means for producing a flow of combustibles and a pair of spaced apart arcing electrodes for igniting the combustibles comprising means including a transformer for impressing a high voltage across said electrodes, an electric discharge device having an anode, a cathode and a control electrode, a circuit including a condenser for impressing the energizing potential of said transformer across said control electrodes and said cathodes, means for charging said condenser to bias said electric discharge device beyond cut-off, means including said transformer for producing peak voltages in said circuit of a magnitude greater than said transformer energizing potential to overcome the bias of said condenser and allow current to flow between said anode and said cathode, and means responsive to the flow of current between said anode and said cathode for effecting operation of said supply means.

7. A control for a burner having means for supplying combustibles and arcing electrodes for igniting the combustibles comprising means including a transformer for energizing said electrodes to produce arcing therebetween, and means including an electric discharge device having a control electrode energizing circuit connected to be responsive to the energizing circuit of said transformer to produce peak voltages in said circuit of substantially larger value than said energizing potential upon the establishment of a predetermined arcing condition between said electrodes for effecting operation of said supply means.

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