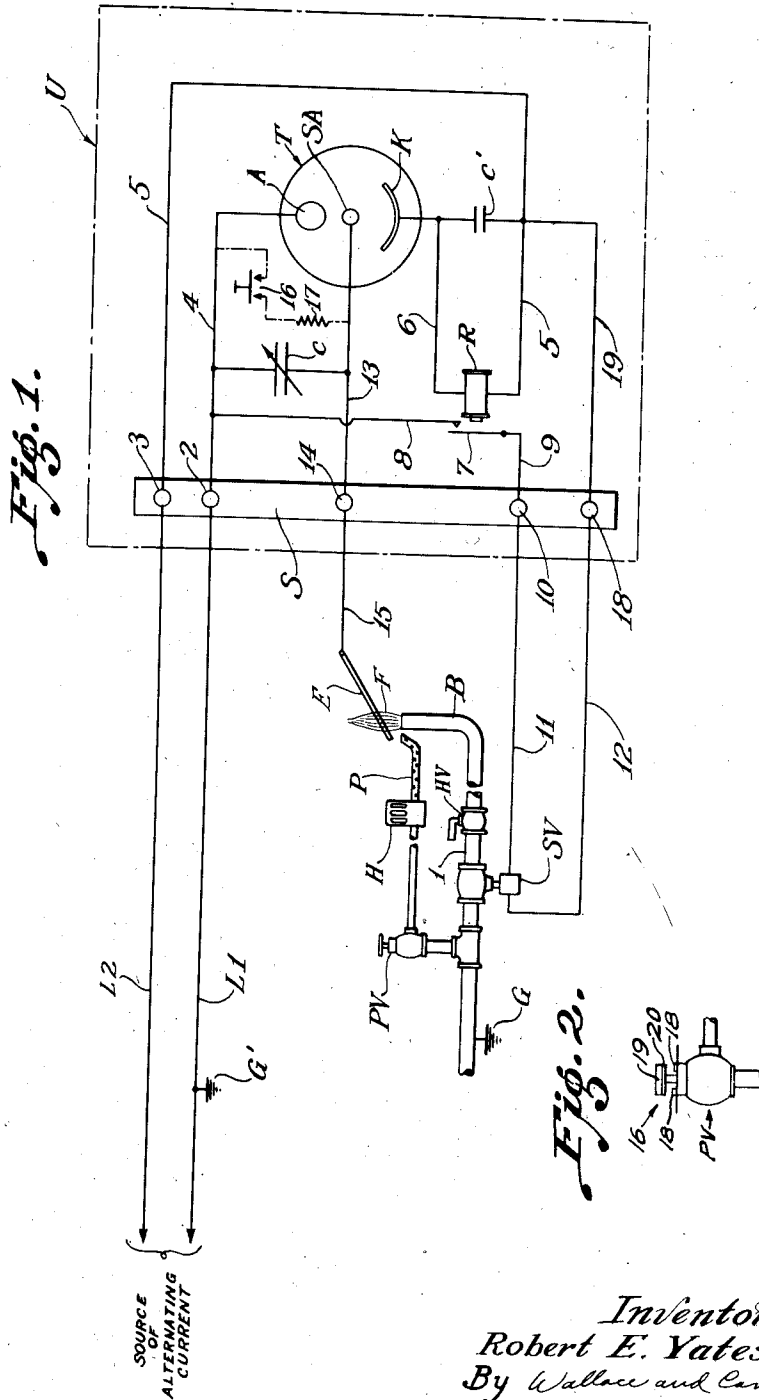


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CONTROL APPARATUS
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CONTROL APPARATUS

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1 Claim. (Cl. 158—28)

This invention relates to control apparatus for fuel burners and particularly to safety controls for single burner installations such as domestic burner installations.

In my co-pending application, Serial No. 245,173, filed December 12, 1938, there is disclosed a safety control apparatus that is adapted to be used in conjunction with multiple burner installations and which is operative to sense the presence or absence of flames at the burners and to accordingly control the fuel supply to such burners in dependence upon the conditions thus detected. While this apparatus has proved to be quite practicable in industrial applications, it would not usually be economical to utilize such apparatus in single burner installations such as domestic heating units because the cost of the control unit in proportion to the total cost of the heating unit would be objectionably high.

It is, therefore, a primary object of this invention to simplify the construction of control units of the aforesaid character to the greatest extent consistent with reliability of operation and to thereby afford an economical, yet efficient, control unit.

It has been proposed heretofore to employ electron tubes of a type known commercially as grid glow tubes in electrical circuit arrangements for effecting control operations in dependence upon combustion conditions in fuel burners, one of the advantages of such tubes being that they do not have filaments and it is, therefore, not necessary to provide a filament voltage supply. Tubes of this character, however, require rather high operating voltages and cannot be operated directly from the ordinarily available service lines, so that a transformer must be provided to step up the line voltage where a grid glow tube or the like is to be used.

Hence, another object of this invention is to eliminate the need of a transformer or like equipment in control apparatus of the aforesaid character to thereby decrease the cost of such apparatus.

A further object is to utilize a novel electrical circuit arrangement to determine the need for a control operation with respect to the fuel supply to a fuel burner when the flame has been accidentally extinguished and thereby avoid the risk of explosion or other hazards which arise if the burner emits fuel while no flame is present, such novel arrangement essentially comprising an electrode for sensing the presence or absence of a flame at the burner, a gas-filled, cold cathode type of electron tube responsive to the effect of a

flame on a flame-sensing electrode, and an electrically operated means, such as a relay, under control of the tube and operative to bring about interruption of the fuel supply to the burner or otherwise indicate the need for a control operation.

Other and further objects of the present invention will be apparent from the following description and claim and will be understood by reference to the accompanying drawing which, by way of illustration, shows a preferred embodiment and the principle thereof and what I now consider to be the best mode in which I have contemplated applying that principle. Other embodiments of the invention embodying the same or equivalent principle may be used and structural changes may be made as desired by those skilled in the art without departing from the present invention and the purview of the appended claim.

In the accompanying drawing:

Fig. 1 is a diagrammatic view of the novel control apparatus, and

Fig. 2 is a detailed fragmentary side elevational view of a control valve employed in connection with the present invention.

My novel apparatus is preferably constructed in the form of a control unit U which is adapted to be utilized in conjunction with a heating device of a character such as that shown in the drawing. Such a heating device may comprise, for example, a main burner B, a pilot burner P, a pilot flame protecting housing H, a manually operable pilot valve PV which when actuated causes the pilot flame to be extended from the housing H and emitted from the tip of the burner P, a hand valve or cock HV for the burner B, and a solenoid valve SV so located in the supply pipe I of the burner B that it may control the supply of fuel therethrough without affecting the pilot fuel supply. The solenoid valve SV is under the control of the unit U and depending upon whether or not a flame as F is present in the combustion zone of the burner B, the valve SV is adjusted to an open or closed position, respectively, by the control unit U, as will be explained. For the purpose of sensing the presence or absence of a flame as F, an electrode E is mounted in position to be contacted either by a flame F of the main burner B, or by the pilot flame of the burner P when the pilot valve PV has been actuated as aforesaid. The burners B and P are grounded as indicated at G and the tips of these burners thereby constitute grounded electrodes which are so disposed with respect to the

electrode E that the presence of a flame such as F may serve to establish electrical contact of either of these electrodes with the electrode E through a flame extended between either burner tip and the electrode E.

The control unit U is preferably connected to a source of alternating current comprising the line wires L1 and L2 which are respectively connected to the terminals 2 and 3 that are mounted on a terminal strip S included in the unit U. The line wire L1 is grounded as indicated at G' so that this side of the line is in electrical contact with the pipes of the burners B and P at all times. The terminal 2 is connected by a conductor 4 to the anode A of a gas-filled cold cathode electron tube T. The terminal 3 is connected by a conductor 5 to one end of the winding of a relay R, the other end of this winding being connected by a conductor 6 to the cathode K of the tube T. Thus, substantially the entire line voltage is applied across the elements K and A of the tube T, except for such voltage drop as may exist in the winding of the relay R. This voltage is selected to be insufficient to initiate a discharge between the cathode K and anode A but to be sufficient to sustain such a discharge once initiated, as will be explained.

The relay R has a contact 7 which is normally open when this relay is deenergized but which is closable when the relay is energized to establish an electrical connection between a conductor 8 connected to the conductor 4, and a conductor 9 leading to a terminal 10 on the strip S. A conductor 11 connects the terminal 10 to one side of the winding of the solenoid valve SV and the other side of this winding is connected by a conductor 12 to the terminal 18 on the strip S, from which a conductor 19 leads to the conductor 5 that is connected to the line wire L2. When the tube T is rendered conductive, in a manner to be described hereinafter, to permit the flow of current therethrough, the relay R is energized to close its contact 7 and this completes the just described energizing circuit for the solenoid valve SV to thereby cause this valve to open. When, however, the tube T becomes non-conductive, the relay R is deenergized and opens its contact 7 to break the energizing circuit to the solenoid SV, and this valve thereupon closes.

The tube T includes a starter-anode SA which is positioned intermediate the cathode K and anode A and which is connected by a conductor 13 to a terminal 14 on the strip S, from whence a conductor 15 leads to the electrode E. Thus, whenever a flame as F plays on the electrode E, the starter-anode SA is connected through the flame resistance to the grounded line wire L1 and the anode A and a portion of the line voltage is, therefore, impressed across the cathode K and the starter-anode SA, which voltage is ordinarily sufficient to initiate a glow discharge between the cathode K and the starter-anode SA and thereby cause a glow discharge to take place between the cathode K and the anode A.

To initiate operation of the burner B, the cock HV of this burner is opened and the pilot valve PV is actuated so that a pilot flame is emitted from the tip of the burner P and plays upon the electrode E. The arrangement is such that this is effective to initiate a discharge between the cathode K and the starter-anode SA of the tube T, as aforesaid, and the tube T

thereupon becomes conductive to enable current to flow between the cathode K and the anode A. The tube T conducts current only during that portion of the alternating-current cycle in which the cathode K is negative with respect to the anode A, and hence a rectified current passes through the circuit comprising the line wire L2, terminal 3, conductor 5, winding of relay R, conductor 6, cathode K, anode A, conductor 4, terminal 2 and line wire L1. A condenser C' connected in parallel with the winding of the relay R functions to smooth out the pulsating current which would otherwise be passed through this winding; or, instead of resorting to a condenser C' to thus modify the effect of the pulsating current, the relay R can be of the slow-to-release type having a release time greater than the time required for a half-cycle in the alternating current. Relay R, therefore, energizes to close its contact 7 and a circuit is thereupon completed from line wire L1, terminal 2, conductors 4 and 8, contact 7, conductor 9, terminal 10, and conductor 11 to the winding of the solenoid valve SV and thence through conductor 12, terminal 18, conductors 19 and 5, and terminal 3 to the line wire L2. Hence, valve SV opens and enables fuel to flow through the supply pipe 1 and the open valve HV to the burner B from which it is emitted and is ignited by the pilot flame of the burner P. When a flame from the burner B so ignited plays on the electrode E the pilot valve PV may be released to enable the pilot flame to retract back to the housing H.

As has been explained hereinabove, the tube T is able to pass current only during that half of each alternating-current cycle in which the cathode K is negative with respect to the anode A. During the other half of each such cycle no discharge takes place within the tube. Therefore, to initiate a discharge between the elements K and A during each conductive half-cycle, the starter-anode SA must first function to establish a discharge between itself and the cathode K, and thereupon tube T becomes conductive for the remainder of such half-cycle. If the flame F should be accidentally extinguished during a non-conductive half-cycle to thereby break the electrical connection from ground to the electrode E and starter-anode SA, the tube T will not be rendered conductive during the succeeding half-cycle in which it would otherwise have been in a conductive condition, inasmuch as practically none of the line voltage is now impressed across the cathode K and starter-anode SA. Discharge can therefore no longer take place between the cathode K and anode A, and the winding of the relay R in circuit with the cathode and anode is deenergized. This causes relay R to release its contact 7 to break the energizing circuit to the winding of the solenoid valve SV, which valve thereupon closes and shuts off the supply of fuel to the burner B so that unburned fuel will not be emitted by this burner. If the flame F should be extinguished during a conductive half-cycle of the tube T, discharge continues between the cathode K and anode A during the remaining portion of such half-cycle but thereafter discharge is prevented so that the tube T quickly becomes non-conductive with the result just described. In either event, when flame F is extinguished, operation of the burner B is suspended until the pilot burner P has again been

operated to cause a flame to play upon the electrode 7.

It has been found advantageous to connect a variable condenser C across the conductors 4 and 13 so that it is in parallel with the flame gap between the burner B and electrode E, this condenser being preferably of the type employing air as a dielectric and having a relatively low range of capacities. The capacity of the condenser C is adjusted to a value at which it will enable the starter-anode SA to be effective to render the tube conductive when a flame is present at the electrode E, but will not be sufficient to enable the tube to be rendered conductive if no flame is present. Once the condenser C has been adjusted, it is installed in the heating unit in such a manner as to be inaccessible to unauthorized persons, but may be reached by authorized persons if necessary.

It has been noted that under some conditions, particularly where certain types of fuel are being employed in the burner, it is somewhat difficult to obtain an optimum adjustment of the condenser C, and in such instances I prefer to keep the value of the capacity relatively low, or to dispense with the condenser C altogether, so that the tube T and the relay R will remain inoperative when flame is absent. In this event it will be desirable to employ a starting switch such as 16 (see Fig. 2) which is operable to close circuit between the conductors 4 and 13 through a protective resistor 17. The switch 16 is preferably constructed as part of the pilot valve PV and includes spaced contacts 18 which are adapted to be bridged by a contact strip 20 on the valve plunger 19 so that the circuit through the resistor 17 will be momentarily closed at the time when the pilot burner P is being operated, thus insuring that a sufficient potential will be impressed upon the starting anode SA to initiate a discharge in the tube T. After such preliminary igniting of the tube T has taken place, the operation of the circuit is the same as described hereinabove.

It is believed to be apparent from the foregoing that I have provided a device which is of simple and economical construction and which functions to insure against dangers which might attend improper combustion conditions such as failure of a flame at a burner such as B. My invention is particularly applicable for use on single burner installations such as domestic heat-

ing units and because of the small number of parts utilized it can be assembled in a compact unit. The relay as R can conveniently serve to operate a signalling device as well as the means regulating the supply of fuel to a burner or, if it is not desirable to use a separate signalling device, the tube T can be employed as a signal inasmuch as it produces an appreciable glow discharge when rendered conductive. Thus, the presence of a glow discharge in the tube T would denote the presence of a flame at the burner, and the absence of such a discharge would mean that a flame was not present.

While I have illustrated and described a selected embodiment of my invention it is to be understood that it is capable of variation and modification and I, therefore, do not wish to be limited to the precise details set forth but desire to avail myself of such changes and alterations as fall within the purview of the following claim.

I claim:

A control system for a burner including a solenoid-actuated fuel supply valve, a solenoid therefor having a winding adapted when energized to open the valve, a circuit for energizing said winding including a relay-actuated switch and a relay circuit therefor adapted when energized to close the switch, said relay circuit including a gas-filled glow tube having a cathode, an anode and a starter-electrode, a source of alternating current of relatively low voltage, means connecting said anode to one pole of said source, means connecting the cathode to the other pole of said source, a starter-electrode circuit including a flame-sensing element normally insulated from said burner by an air space and adapted to be impinged by flame from the burner to establish a relatively high resistance connection to the latter, means connecting said burner to the pole of said source to which the anode is connected, means connecting the starter electrode to said flame-impinging element, a normally open starting switch connected in parallel with said flame-sensing element and burner and adapted to be closed to initiate a discharge in said tube for rendering the latter responsive to a flame in said burner, and a pilot valve for said burner operatively connected to said switch for movement from a closed to an open position when said starting switch is closed.

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