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CONTROL OF COMBUSTION FURNACES

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FIG. 1.

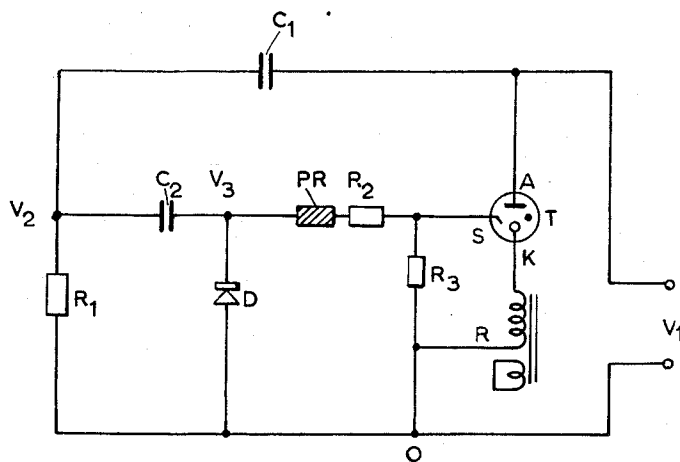
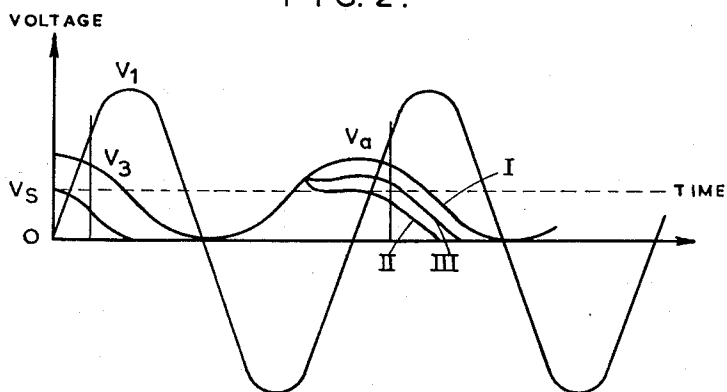


FIG. 2.



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CONTROL OF COMBUSTION FURNACES

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2 Claims. (Cl. 317-130)

This invention concerns a protective circuit for oil burning furnaces or the like in which a photoresistor is used to detect the presence of flame which photoresistor is connected to a fuel controlling relay through a discriminating circuit which will allow operation to the fuel relay only under conditions corresponding to safe operation of the furnace and the flame detector.

The object of this invention is to provide such a protective circuit which is simple and of low cost, possesses inherent safety features, and gives immediate action without the delay associated with hot cathode thermionic tubes.

The invention is hereinafter described in conjunction with the accompanying drawing in which Figure 1 is a circuit diagram including the photoresistor and fuel controlling relay and Figure 2 a graphical display of the voltage conditions of the circuit.

The circuit comprises as main elements an electro-magnetic relay, a cold cathode trigger tube and a small photoresistor. It is an important feature of the circuit, that the supply voltages of the main anode and of the control electrode (starter) are A.C.-voltages, the one of the control electrode having a phase difference of about 90° to the voltage of the main anode, that the supply voltage of the starter is applied through a capacitor and a photoresistor in series and that the electromechanical fuel controlling relay, is included in the circuit of the main gap (anode-cathode) of the tube.

Referring to the figures, a cold cathode tube T has three electrodes namely a cathode K, an anode A and a control electrode S which in this circuit is used as a starter anode with a breakdown voltage V_s . The mains voltage V_1 is applied between anode A and cathode K of the tube but the main discharge between A and K occurs only if the voltage V_1 exceeds a value V_a and if at the same time there is a current in the control gap S—K. The capacitor C_1 and the resistance R_1 provide an A.C. voltage V_2 of much smaller peak value and having a phase advance of about 90° with respect to the main voltage V_1 . The voltage V_2 is fed to the starter anode S through a series connection of a capacitor C_2 , a photoresistor PR and a resistor R_2 , serving as protection for the photoresistor PR and the cold cathode tube T. The diode D restores the initial condition after every cycle of operation, i.e. during the negative part of the voltage V_2 . In order to understand the resistance-discriminating action of the circuit, and the safety features associated with it (consider three different conditions of operation I, II and III).

(I) If the resistance of PR is high, which means no illumination or open circuit of the cell PR, there is no discharge in the control gap S—K, consequently no discharge in the main gap A—K and no current in the electro-magnetic relay R. Protection is therefore given against failure of the cell or its associated circuit in that energisation of the fuel controlling relay is required to maintain the fuel supply to the furnace.

(II) If on the contrary the resistance of PR is low,

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which means very high illumination or short circuit of the cell PR, there will occur a discharge in the control gap. This discharge will stop soon after the voltage V_2 decreases after having reached its positive peak value. As this happens before the mains voltage V_1 has reached the critical value V_a , there will be no discharge in the main gap AK. Protection is again obtained under fault condition by the non-energisation of the fuel controlling relay.

(III) If the resistance of PR has an intermediate value, the limits being determined by the values of the resistance R_3 and the other circuit parameters, corresponding to a correct illumination of the photoresistor PR, the discharge occurring in the control gap will last until V_1 reaches the value V_a and the main gap A—K will fire, causing the electro-mechanical relay R to attract and allowing the fuel supply to be maintained.

The behaviour of voltage V_5 in connection with the restoring action of diode D is shown on Figure 2 and indicated by I, II and III respectively.

The electro-mechanical relay R is provided with a short circuited copper winding to provide an electrical release delay, in order to prevent chattering of its armature. It is connected into the cathode lead of the cold cathode tube so as to produce a positive feedback.

If a current pulse has passed through the relay, a small voltage of opposite sign (compared to the voltage during the current pulse) is maintained for a certain moment across the winding. In such a way during the next period the cathode C will have a small negative bias sponsoring a new discharge of the main gap. This positive feedback prevents a chattering of the relay near the low illumination limit of the device.

One suitable example of values for the components of the circuit shown is as follows:

$C_1=30,000$ pf.	$R=J$ 53, 1×1600 ohm
$C_2=3,000$ pf.	25% Cu (Erni)
$R_1=100K$, 1 w.	D=Selen E 250 C 30
$R_2=100K$, $\frac{1}{2}$ w.	(AEG)
$R_3=5M$, $\frac{1}{2}$ w.	PR=F1f. (Heimann)
T=GR 16 (Cerberus) or	$V_1=230$ v., 50 Hz.
ER 21 (Elesta)	

This example is, however, not to be construed in any way as limitative of the invention.

Some modifications of the circuit are possible without changing the principle, for example.

The control electrode of the cold cathode trigger tube may be a starter cathode instead of a starter anode which means that in order to have a discharge between starter electrode and cathode, a negative voltage must be applied to the starter exceeding a certain breakdown voltage. To obtain operation of the circuit, the A.C. voltage supplying the starter electrode must consequently have a phase lag (instead of an advance) of about 90° to the main voltages and the polarity of the restoring diode has to be changed. In this case there is not the possibility of introducing a positive feedback in such a simple way as before.

There are also other means of producing the phase shift on the voltage supplying the starter electrode circuit using capacitors, inductances and resistors or even transformers.

In order to reduce the effect of mains voltage variation on the sensitivity, the circuit of Figure 1 can be modified by replacing R_1 by a voltage dependent resistor. The voltage V_2 will then become rectangular instead of sine-shaped and voltage V_3 will change in form too, but this will not in any way change the function of the circuit.

I claim:

1. A protective circuit for oil burners including a

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photoresistor for detecting the presence of a flame, a cold cathode trigger tube having an anode and a cathode and provided with a trigger circuit controlled through the photoresistor, and a fuel-controlling relay having an operating coil and connected with and energized through the cold cathode trigger tube, characterized by including a capacitor connected in series with the photoresistor and the trigger circuit of the cold cathode trigger tube, means connecting the operating coil of the fuel-controlling relay in series in the cathode circuit of the cold cathode trigger tube, means for applying an alternating current voltage to the trigger circuit of the cold cathode trigger tube, means for applying an alternating current voltage to the anode of the cold cathode trigger tube which is approximately ninety degrees out of phase with the voltage applied to the trigger circuit of the cold cathode trigger tube, and a rectifying element separate from the photo-

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resistor connected in circuit with the trigger circuit of the cold cathode tube providing a direct current bias to the alternating current voltage applied to and imposed upon the trigger circuit.

2. A protective circuit for oil burners as claimed in claim 1, characterized by including a resistance connected between the trigger circuit of the cold cathode trigger tube and the end of the operating coil of the fuel-controlling relay remote from its connection to the cathode for determining in part the time constant of the trigger circuit of the cold cathode trigger tube.

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