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FUEL BURNING SAFETY DEVICES

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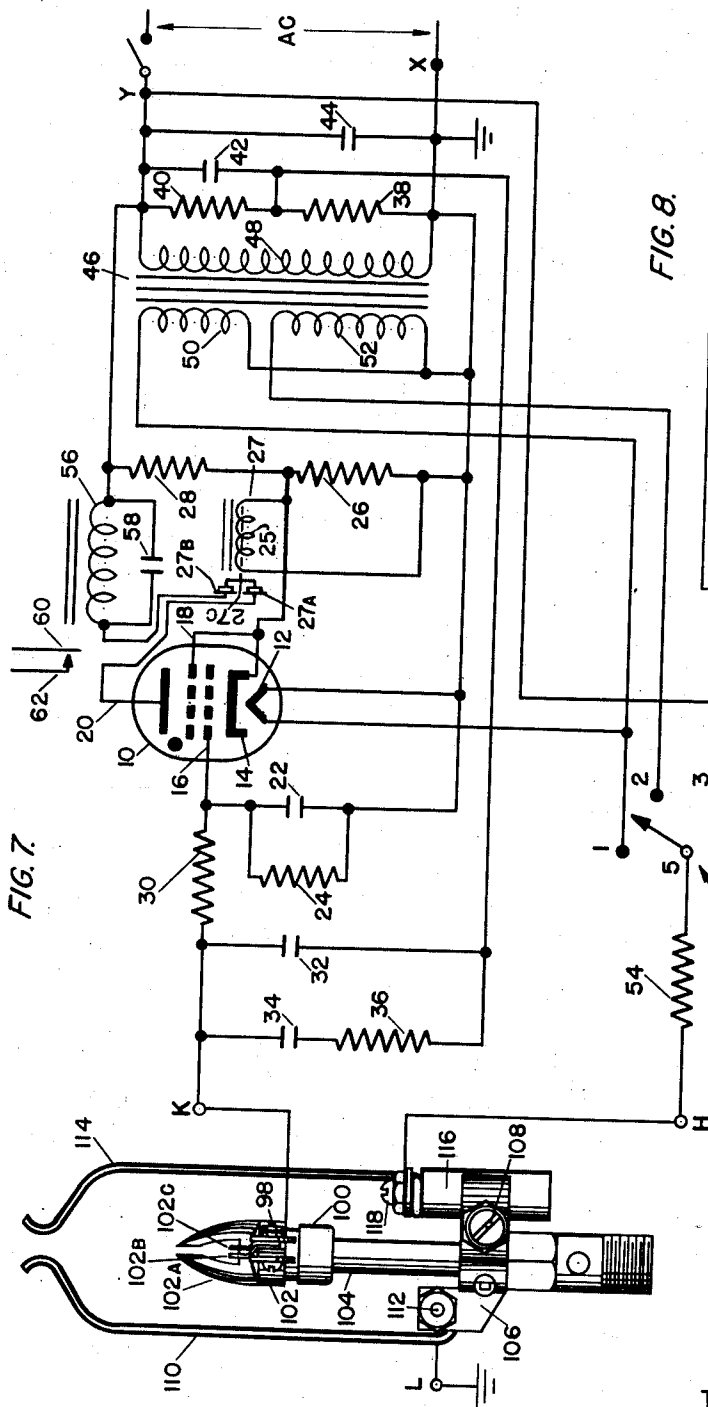
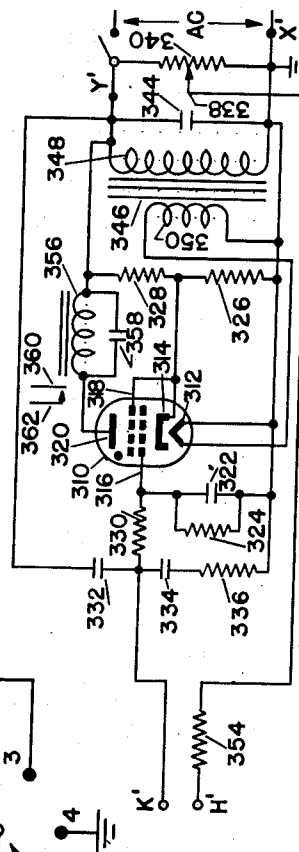


FIG. 8



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FUEL BURNING SAFETY DEVICES

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This invention relates to a fuel burning pilot safety device.

An analysis of fuel pilot safety devices presently employed in the art indicates that these devices in general utilize an auxiliary safety device in conjunction with the main safety device.

A disadvantage in the utilization of these devices resides in the lapse of time between the active cycles of both the main and auxiliary units. The auxiliary is usually of the thermo-couple type, utilizing thermal action cut off times of approximately forty seconds.

The lapse of a substantial period of time when utilizing a fuel safety device may, during a failure in the device, lead to the creation of dangerous and explosive conditions within the fuel burning device.

Other disadvantages of present day devices utilized in the art reside in the possibility of the safety device being actuated by environmental conditions such as capacitive or resistive changes adjacent the electrodes of the devices, carbon deposits and the like.

It is a prime object of the invention to provide an improved fuel pilot safety device which is trustworthy and positive in action.

It is another object of the invention to provide a tri-electrode head for utilization with my improved flame detector to utilize a positive potential as obtained by rectifying an alternating electric current through a flame impinging on two or more of said conductors, but not necessarily on all three.

It is a further object of the invention to provide a tri-electrode head for utilization with my improved flame detector circuit whereby the principle of full wave rectification may be utilized through a flame resulting in a higher control voltage than normally obtained with half wave rectification.

It is another object of the invention to provide a sensitivity switch in the flame detector circuit, whereby the head may be provided with a selection of voltages upon one of the electrodes, as hereinafter more fully set forth.

It is a further object of the invention to provide an improved pilot safety device which positively prevents operation of the device upon failure of the electron tube utilized in the device.

It is another object of the invention to obtain, provide and utilize a directly obtained positive potential through current rectification by means of a flame as the control means for a fuel burning safety device.

It is a further object of the invention to provide a fast action and selectively variable fuel pilot safety device.

Other objects and advantages of the invention will appear obvious to those skilled in the art from a reading of the following description of the invention when taken with the drawing, wherein:

Figure 1 is a plan view of an electrode head utilized with my invention.

Figure 2 is a sectional view of the head of Figure 1, taken along line 2-2 of Figure 1.

Figure 3 is a sectional view of the head of Figure 1, taken along line 3-3 of Figure 1.

Figure 4 is a plan view of an alternate electrode head utilized with my invention.

Figure 5 is a sectional view of the head of Figure 4 taken along line 5-5 of Figure 4.

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Figure 6 is a sectional view of the head of Figure 4 taken along line 6-6.

Figure 7 is a circuit diagram of the electronic circuit and control head of my invention.

Figure 8 is an alternate circuit diagram of the electronic circuit of Figure 7.

Referring to the drawing in detail, the invention comprises an electrode assembly head A, hereinafter more fully described which is electrically connected to an electronic circuit.

The electronic circuit, one embodiment of which is illustrated in Figure 7, utilizes a gas filled electron tube 10 having a filament 12, a cathode 14, a first grid 16, a second grid 18 and an anode 20.

The cathode 14 and one of the grid electrodes is utilized as an input circuit for the gas filled electronic tube 10, and the cathode-anode circuit as an output circuit.

In more detail the input circuit of electron tube 10 includes a first network having a capacitor 22 in parallel with a resistor 24. One extremity of this first network is connected to grid 16, the other extremity being electrically connected to a reference point designated as "X" and utilizing the electrical symbol for "ground." Resistor 24 and capacitor 22 form a grid leak for returning electric charges to grid 16 during the operation of the entire circuit.

The cathode 14 which is directly connected to grid 18 is also connected to the physical center of a resistor network including resistors 26 and 28 and furnishes a biasing potential in a positive direction from a source of supply including terminals X and Y, with respect to grid 16. Resistors 26 and 28 are in series one with the other and have one extremity connected to the reference point "ground," the other extremity connected to the terminal Y.

The input circuit comprising grid isolating and current limiting resistor 30 one extremity whereof is electrically connected to grid 16 and the other extremity whereof is connected to a second input network including a capacitor 32, a capacitor 34, and resistor 36. Capacitor 34 and resistor 36 are in series one with the other, and this series circuit is in parallel with capacitor 32. The series resistor 36, capacitor 34 circuit forms a time delay circuit which varies the lag for cut off time of tube 10 when a flame is absent at electrode assembly head A.

The extremity including connection of resistor 36 and capacitor 32 is connected to a voltage divider circuit across terminals X and Y and includes therein a resistor 38 in series with a resistor 40, resistor 40 being shunted by a capacitor 42.

Terminals X and Y are further optionally connected to opposite extremities of a by-pass capacitor 44.

The circuit further utilizes a power transformer 46 including a primary winding 48, and secondary windings 50 and 52.

The primary winding 48 is connected to terminals X and Y which provides a source of suitable potential and current at the desired frequency for use with the transformer.

Secondary winding 50 and secondary winding 52 each have a single terminus connected to the reference point X, the other extremities of the windings being connected to terminals 1 and 2 respectively of a switch J, a third terminal 3 of switch J is connected to terminal Y, and a fourth terminal 4 is connected to ground. Terminal 5 is a selector contact for this switch.

The selector contact 5 of switch J is further connected to a limiting resistor 54, the other extremity of resistor 54 being connected to terminal H.

Switch J provides a sensitivity selector permitting use

of the invention in a variety of installations, by permitting the choice application of predetermined voltages as obtained from transformer windings 50 and 52, the source terminal Y, or placing electrode 114 at the same potential as electrode 110. Another means of providing this choice of potentials to be applied to electrode 114 is illustrated in Figure 8 wherein a potentiometer 340 having a moveable contact arm 338 is connected across a source of alternating current between terminals X' and Y' and applied through resistor 354 to terminal H', the equivalent of terminal H.

The output circuit including the anode-cathode circuit comprises a relay coil 56 in series with the anode and terminal Y. The relay coil 56 is by-passed by a capacitor 58 and actuates the closing of contacts 60 and 62. Contacts 60 and 62 are utilized for controlling a main fuel supply valve circuit which is not shown and may be of any known type.

As a safety against failure of electron tube 10, the invention incorporates a relay coil 27 across resistor 26. Relay coil 27 is an overload locking type relay having normally closed contacts 27a and 27b by means of a shorting bar 27c. These contacts are in series with the anode 20 and relay coil 56.

In the event a short circuit develops in electron tube 10 between cathode 14 and grid 16 the resultant current of larger than normal amplitude is designed to operate relay 27 to open the anode circuit by moving shorting bar 27c out of contact with contacts 27a and 27b.

The electrode head A comprising three electrodes and forms an integral part of the invention, and although its specific structure may be varied, comprises a cap 100 which is an electrical insulator and has mounted thereon by means of a clamp 98 a first electrode assembly 102.

Non-conductive cap 100 is mounted on tube 104 to which is secured a conductive bracket 106 by means of a mounting screw and nut assembly 108.

A second electrode 110 is secured and electrically connected to bracket 106 by means of a mounting screw and nut assembly 112.

An insulated bushing 116 is clamp mounted on bracket 106, and a third electrode 114 is supported on bracket 106 by means of an insulated bushing 116 to which the electrode 114 is secured by means of a screw 118.

The first electrode 102 includes a shell 102a and fingers 102b and 102c.

An alternate electrode head B more fully shown in Figures 4, 5 and 6 include an insulated cap 200 which is provided with a slit type aperture 201 and has mounted thereon by means of a screw and nut assembly 203 a first electrode in the form of finger elements 202a and 202b.

The cap 200 is mounted on a conductive tube 204, to which is secured a conductive bracket 206 by means of a mounting screw and nut assembly 208.

A third electrode 210 is secured to an insulated bushing member 216 by means of a mounting screw 218. Insulated bushing member 216 is clamped in position by means of mounting bracket 206.

The second electrode 214 is mounted on bracket 206 by means of a mounting screw and nut 212.

The head B is connected to the circuit of Figure 7 in a similar manner as head A at the terminals, K, L and H respectively.

An alternate circuit to that disclosed in Figure 7 is shown in Figure 8. Terminals H' and K' are connected in a manner equivalent to the connections at terminals K and H with terminal L grounded permitting optional operation at half wave or full wave as shown in the drawing.

Referring to the drawing in detail, the circuit comprises a gas filled electron tube 310 including a filament 312 a cathode 314 a first grid 316, a second grid 318 and an anode 320. The cathode 314 and grid 316 are utilized as an input circuit for the electron tube 310, and the cathode anode 314-320 circuit as an output circuit.

In more detail, the input circuit of electron tube 310 includes a first impedance network having a capacitor 322 in parallel with a resistor 324, one extremity of this first network is connected to grid 316 the other extremity being electrically connected to a reference point designated as X' and utilizing the electrical symbol for "ground."

The cathode 314 which is directly connected to grid 318 is also connected to the physical center of a resistor network including resistor 326 and 328 and furnishes a biasing potential in a positive direction under certain conditions from an alternating source of supply obtained through terminals X' and Y', with respect to grid 316.

The input circuit further includes a loading circuit comprising grid isolating and current limiting resistor 330 one extremity whereof is electrically connected to grid 316 and the other extremity whereof is connected to a second impedance network including a capacitor 332, a capacitor 334 and resistor 336. Capacitor 334 and resistor 336 are in series one with the other and this series circuit which acts as a time delay circuit is connected between terminal K' and ground. Terminal K' is also connected to Y' through capacitor 332.

Terminals X' and Y' are further optionally connected to opposite extremities of a by-pass capacitor 344. A potentiometer 340 having an arm 338 is connected across terminals X' and Y' and through arm 338 is further connected through series resistor 354 to terminal H'.

Resistor 354 is a current limiting resistor and is the equivalent in performance of resistor 54 of Figure 7.

The filament 312 of tube 310 is heated by secondary winding 350 of transformer 346 which is provided with a primary 348 having suitable characteristics for connection to the A.C. line. The output circuit for the tube includes relay coil 356 which is by-passed by a suitable condenser 358 and operates to close contacts 360 and 362 upon passage of a pre-determined current through relay coil 356.

It may be noted here that capacitor 332 is connected to terminal Y' instead of X', the equivalent of terminal X. However, this difference in connection is not to be deemed of major significance in view of the fact that the capacitor is connected to one side of the alternating input source.

In operation the tube 10, of the device of Fig. 7, is non-conductive during the absence of a flame at head A. The inoperativeness of the tube under this condition is controlled by means of the grid 16, cathode 14 bias. This bias is obtained from a voltage divider network including resistors 26 and 28, and through coil resistance 25 of relay coil 27.

The grid 16 of the gas type tube 10 is generally sensitive and the same is loaded to a less sensitive state by means of capacitor 22 and resistor 24 and thus make the device less sensitive to influences other than a flame at head A.

To cause the tube 10 to conduct, it is necessary to apply a positive potential to grid 16 and this is accomplished by means of the rectified current obtained between first electrode 102 and second and third electrode 110 and 114 respectively. With a flame impinging on electrodes 110 and 114 and selector switch J connected to terminal Y through switch contacts 5 and 3, it is not unusual to obtain a voltage at terminal K of approximately 30 volts D.C. The presence of a voltage of this magnitude or of lower magnitude such as may be obtained by placing contact 5 in closed circuit with either contact 2 or 1 (providing lower voltages to point H) is sufficient to cause tube 10 to become conductive and pass a current between cathode 14 and anode 20. The anode current passes through relay coil 56 and closes switch contacts 60, 62. As has been previously pointed out switch contacts 60, 62 may be utilized to control a main fuel valve or any circuit associated with the main fuel supply. The unit is provided with appropriate time delay control means by utilizing capacitor 34 and resistor 36 of the input circuit

and this time delay may be varied by changing the time constant of these components.

In operation, an alternating current is applied to terminals X and Y, and the knife switch shown in Figure 7 is closed. Electron tube 10 is thus heated by means of a current of suitable strength passing through filament 12. The cathode is caused to emit an electron charge. An alternating voltage is applied to the anode with respect to the cathode, and the control grid 16 is maintained at a negative potential during the period that a positive potential is applied to the anode. The negative grid potential is obtained from a voltage divider comprising the resistors 40 and 42, and appears upon the control grid through the parallel network of capacitor 32, and resistor 36 capacitor 34. Upon a flame impinging upon the electrodes 102, 110 and 114, simultaneously the flame develops a direct current which is applied to grid 16 through resistor 30, electrode 102 acting as a cathode and electrodes 110 and 114 acting as anodes, the direction of the rectification thus being of proper polarity to decrease the grid potential from a negative potential to a less negative or more positive potential, causing a current to flow through the gas of the tube between the anode and cathode. Any failure of the flame to cause rectification between the electrodes 102 and 110 and between the electrodes 102 and 114, for a period in excess of a predetermined time delay controlled by the choice of capacitor 34 and resistor 36, will permit the grid to become more negative to the point of cutting off the electron flow through tube 10.

When tube 10 is cut off, the relay coil 56 has no effect on the normally open contacts 60, 62 which remain open and in general may be regarded as controlling the main source of fuel supply in contrast to the pilot fuel supply.

Under normal operating conditions with a rectified current obtained through the pilot flame and applied to grid 16, a current flows through electron gas tube 10 between cathode 14 and anode 20 and through relay coil 56 to close contacts 60 and 62, the control contacts for an auxiliary circuit as hereinbefore set forth.

Tube failure or other factors causing an excessive flow of current through the tube 10 are caused to flow through relay 27 which is of the locking type and locks contacts 27a, 27b open under overload conditions. As may readily be seen the contact points 27a and 27b are normally maintained in shorted condition by means of contact arm 27c, and are positioned in the circuit in series with relay coil 56. Opening the contacts 27a and 27b by means of relay 27 under overload conditions automatically opens the anode circuit and prevents possible flow of current through relay 56 thus causing the contacts 60 and 62 to remain open. The optimum results with these arrangements are obtained by utilizing a manual reset relay as relay 27.

An illustrative list of values for a few of the components is given, however I desire it understood that variations from these values may be made within engineering limits without materially affecting the operation of the device.

Component:

Component:	Value
22-----	.005 μ fd.
24-----	22 megohms.
26 and 28-----	50,000 ohms each.
30-----	22 megohms.
32 (not critical)-----	.0005-.001 μ fd.
34-----	.05 μ fd.
36-----	22 megohms.

It is readily apparent that the circuit of Figure 8 functions in a similar manner to that of Figure 7 with corresponding components operating in a corresponding manner. The head B illustrated in Figures 4, 5 and 6 may be substituted for the head A and the function of head B will be similar for similar component parts.

Referring specifically to Figure 8, terminals H' and K' 75

are attached to head A in place of the circuit of Figure 7 at points H' and K'. An effect equivalent to that obtained with switch J is obtained by means of the potentiometer 340 which permits the application of a selectable voltage to electrode 114. In contrast to the tap switch J potentiometer 340 provides a continuously variable source of potential for application to terminal H', permitting any desired voltage to be obtained through flame rectification for application to grid 316. Operation of the circuit in detail is similar to operation of the circuit disclosed in Figure 7, as is obvious to one skilled in the art.

Having thus described my invention I desire to point out that I make use of a positive potential obtained from an insulated electrode to fire tube 10 and that in contrast to many circuits currently employed in the art, I utilize a unitary gas type tube rather than a plurality of tubes or a single multi-purpose tube.

What is claimed is:

1. The combination of a relay, of means for controlling said relay in response to the presence of a flame, comprising a first electrode, a second electrode and a third electrode, said first, second and third electrodes being adapted to be bridged by a flame, said second and third electrodes having means for applying out of phase alternating potentials thereon respective said first electrode, a gas filled electron discharge device comprising a cathode, a grid and an anode, said cathode and grid forming an input circuit and said cathode and anode forming an output circuit, said first of said electrodes being electrically connected to said grid, and said relay being electrically connected in a series electrical circuit comprising said anode, said cathode and a source of electrical potential, circuit means for biasing said grid beyond cut off and circuit means for fullwave rectifying a fluctuating potential applied across said electrodes during bridging of said electrodes by a flame, and circuit means for applying said rectified potential to said input circuit, said rectified potential being of proper amplitude and polarity to bias said input circuit above cut off.

2. The combination of a first relay, of means for controlling said relay in response to the presence of a flame, comprising a first electrode and a second electrode, said first and second electrodes being adapted to be bridged by a flame, a gas filled electron discharge device comprising a cathode, a grid and an anode, said cathode and grid forming an input circuit and said cathode and anode forming an output circuit, one of said electrodes being electrically connected to said grid, and said relay being electrically connected in a series electrical circuit comprising said anode, said cathode and a source of electrical potential, circuit means for biasing said grid beyond cut off, circuit means for applying a pre-determined fluctuating potential to said second electrode respective said first electrode, means for rectifying said fluctuating potential applied across said electrodes during bridging of said electrodes by a flame, circuit means for applying said rectified potential to said input circuit, said rectified potential being of proper amplitude and polarity to bias said input circuit above cut off, a second relay comprising a coil and a pair of contacts, said coil being electrically connected in series between said source of electrical potential and said cathode and having a portion of the cathode current passing therethrough and said contacts being electrically in series with said anode and normally in closed contact one with the other, said second relay being responsive to a pre-determined current passing therethrough to open said contacts.

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