

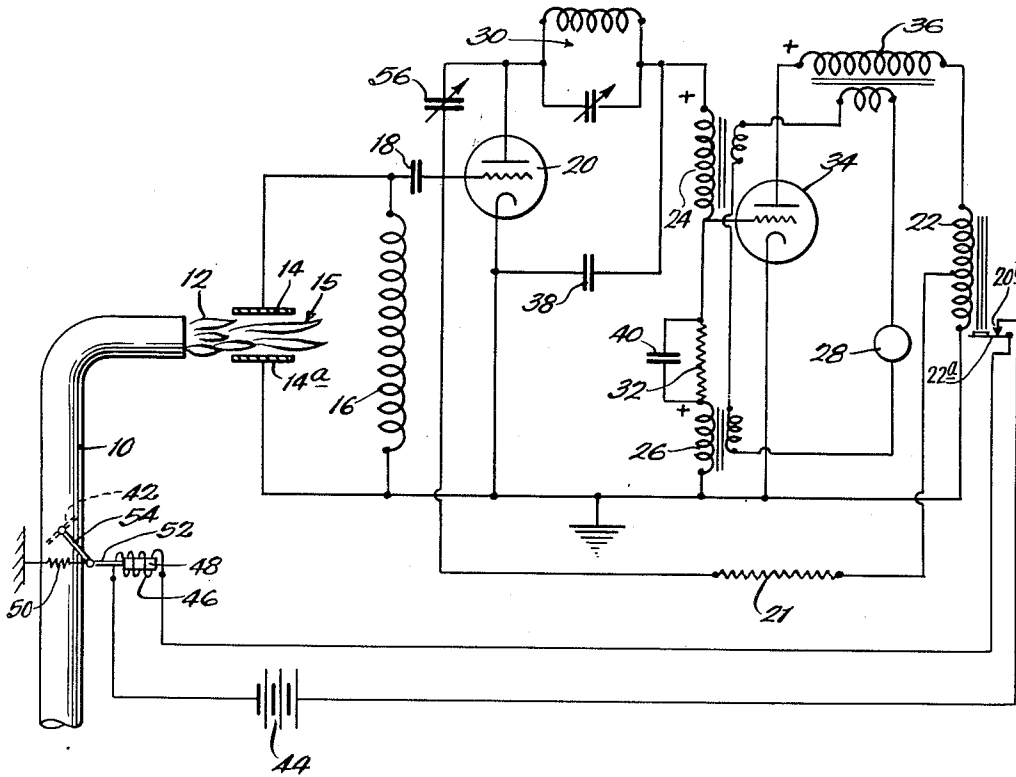
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FLAME DETECTOR

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FLAME DETECTOR

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1

My invention relates to a detector for flame or the like.

Flame detectors are particularly useful as safety devices for furnaces to cut off the fuel supply in the event ignition is lost. Failure to so cut off the fuel may cause an explosion or at least floods the furnace with unburned fuel.

Flame detectors, particularly those intended for furnaces, must be sensitive and should operate rapidly and positively after the flame goes out. Moreover, the detector should not be affected by continued exposure to furnace conditions.

It is therefore a general object of the present invention to provide an improved flame detector.

A more specific object of the present invention is to provide an improved flame detector which is highly sensitive in detecting flame and at the same time operates in a positive manner.

Another object of the present invention is to provide an improved flame detector capable of withstanding furnace conditions for long periods of time.

Still another object of the present invention is to provide an improved method of detecting flame.

It is yet another object of the present invention to provide an improved flame detector of simple and inexpensive construction and adapted for installation in a furnace.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing which is a diagrammatic illustration of one form of the present invention.

Referring now to the figure, there is shown at 10 a pipe through which gas, oil, or other fuel is admitted to a furnace (not shown). This fuel burns at the end of pipe 10 to form a flame 12, the presence or absence of which is desired to be detected.

A pair of condenser plates 14 and 14a are disposed adjacent to and on opposite sides of the flame 12 and facing each other to define a capacitor 15 adjacent the flame. Preferably the flame is centered relative to this capacitor to give a maximum degree of sensitivity and positiveness of operation.

The plates 14 and 14a may be of any suitable conducting material. Preferably they are of non-magnetic metal capable of withstanding the cor-

2

rosive effects of the flame and having good electrical conductivity. These plates constitute the only portions of the flame detector that need be exposed to the flame.

The condenser defined by plates 14 and 14a is connected in a tuned plate-tuned grid-type oscillator of the self-biased type. For this purpose, the capacitor is shunted by an inductance coil 16 to define a resonant circuit. The natural resonant frequency of this circuit is fixed by the capacitance defined by plates 14 and 14a, the inductance of inductor 16, and, to a limited degree, by the energy losses in the circuit. Variations in the impedance of this circuit associated with the presence or absence of the flame 15 are believed responsible for the operation of the flame detector.

The resonant circuit defined by inductance 16 and the capacitor 15 is connected in series with control electrode capacitor 18 across the cathode-control electrode space path of the electron tube 20. Resistance 21 is connected from the control electrode of tube 20 to a tap on relay winding 22 to form a leak for limited current flow from the control electrode 20.

The transformers 24 and 26 have their primary windings connected to a common source of alternating voltage, 28. The secondary windings of these transformers are connected in series to define the series circuit that may be traced through resonant circuit 30, the anode-cathode space path of tube 20, the secondary of transformer 26, resistance 32, and the secondary of transformer 24 back to resonant circuit 30.

The control electrode of electron tube 34 is connected to the resistance 32 and the cathode is connected to the secondary of transformer 26, thereby impressing across the cathode-control electrode space path of that tube the total voltage across resistance 32 and the secondary of transformer 26.

The cathode-anode space path of tube 34 is connected in series circuit with relay winding 22 and the secondary of transformer 36. The primary winding of transformer 36 is connected to source 28.

Capacitor 38 acts as a by-pass to shunt high frequency currents direct from the resonant circuit 30 to the cathode of tube 20. This limits the current flow in resistance 32 and the secondaries of transformers 24 and 26 to low frequency currents. Capacitor 40 further shunts the high frequency currents about resistance 32.

Relay winding 22 actuates the movable arm 22a to establish or break electrical contact with

stationary contact 22b in response to the current flow in that winding. Arm 22a is biased to spaced position relative to contact 22b and assumes the closed position shown when predetermined current flows through winding 22.

Movement of arm 22a selectively opens or closes the butterfly valve 42. When arm 22a is in conducting relation with contact 22b, an electric circuit is established from source 44, through contact 22b and arm 22a to the solenoid winding 46. The resultant current flow causes magnetic plunger 48 to assume a central position in solenoid 46 against the bias of spring 50. Valve 42 is thereby rotated to the open position by links 52 and 54.

When current flow in solenoid 46 is interrupted, plunger 48 is released and valve 42 is rotated to the closed position by the spring 50.

Windings 24 and 26 are poled relative to each other so that their induced voltages are additive as the series circuit through these windings is traced. Winding 36 is poled so that the anode of tube 34 is driven positive simultaneously with the anode of tube 20 as indicated by the positive signs on the drawing. The purpose of winding 26 is to reduce the control-electrode and cathode voltage applied to tube 34 while at the same time making a large voltage available in the series circuit of which the cathode-anode space path of tube 20 forms a part.

Operation

The electron tube 20 and its associated circuits defines a tuned plate-tuned grid type oscillator of the self-biased self-rectifying type. Since source 23 is of relatively low frequency (i. e. 60 cycles per second), this oscillator produces oscillations during the alternate half cycles of the source 23 when the anode of tube 20 is made positive relative to the cathode.

Oscillations build up in tube 20 when the resonant frequency of resonant circuit 30 is substantially equal to the resonant frequency of the inductor 15 and capacitor 15. In this condition the anode-control electrode capacity of the tube and the supplementary capacitor 56, define a positive feed-back path to provide the feed-back necessary for oscillator operation.

As oscillations build up, the control electrode of device 20 receives progressively increased negative voltage in response to charging of capacitor 18 in each high frequency cycle. Under a constant applied voltage, these charges build up to the point wherein the additional charge of capacitor 18 in each successive cycle equals the drain through resistance 21 during each cycle and the control electrode bias thereby assumes a fixed value. Application of alternating voltage from source 23 causes the control electrode bias to vary in spaced sine wave half cycle pulses since the high frequency oscillations build up very fast as compared to the low frequency applied voltage.

The negative bias on the control electrode of tube 20 when oscillations are being produced reduces the component of cathode-anode space current having the frequency of source 28 below the value associated with no bias. The voltage drop across resistance 32 is thereby decreased and the control electrode of tube 34 becomes more positive during each half cycle of source 28 than it otherwise would. This increases the cathode-anode space current in that tube and thereby causes current flow in winding 22 to move

arm 22a to the closed position and hold valve 42 in the open position.

If the flame 12 should go out, the impedance of the resonant circuit defined by capacitor 15 and inductor 16 departs from the value giving oscillations of maximum intensity. The charge of capacitor 18 is thereby reduced and the negative bias on the control electrode of tube 20 accordingly made smaller. This increases the component of space current in tube 20 having the frequency of source 28 and thereby increases the voltage drop across resistance 32.

When the voltage drop across resistance 32 is increased, the control electrode of tube 34 is driven more negative during each cycle of source 28 and the cathode-anode space current flow in that tube made smaller. The current flow in winding 22 then is incapable of holding arm 22a in the contacting position and this arm interrupts the conducting circuit through solenoid 46. Valve 42 then moves to the closed position under the bias of spring 50.

The variation in impedance of the resonant circuit defined by inductor 16 and capacitor 15 when the flame 12 goes out is sufficient to cause a considerable change in the low frequency component of current flow in tube 20. Consequently, the flame detector of the present invention is very sensitive and positively responds to extinguishment of this flame.

Moreover, the response of the unit of the subject invention to loss of flame is substantially instantaneous. This is in marked contrast to bimetallic type flame detectors or other devices requiring elements having considerable thermal capacity and hence slow response to changes in the flame.

While I have shown a simple direct flame control, it will be understood that the mechanism of the present invention is suitable for other arrangements as well. For example, the flame 12 might be a pilot light in a gas furnace and valve 42 might control the main gas supply.

It will be observed that loss of current flow in winding 22 closes valve 42. This gives a fail safe feature to the unit to protect against failures in the flame detector itself.

I have found that the auxiliary feed-back capacitor 56 imparts stability to the operation of the oscillator. When this capacitor is adjusted to the optimum value, the positiveness of flame detection is greatly improved over the action otherwise achieved. In practice, this capacitor is best made variable to permit this critical adjustment to be made under actual operating conditions.

If desired, the three transformers 24, 26 and 36 may be replaced by a single transformer having one primary and three secondaries with secondary polarities as shown.

While I have shown a specific embodiment of my invention, it will of course, be understood that I do not wish to be limited thereto and that I intend by the appended claims to cover all modifications and alternative constructions falling within the true spirit and scope of my invention.

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

1. In a flame detector, the improvement which comprises a pair of conducting plates lying on opposite sides of the flame and forming a capacitor variable in accordance with the presence or absence of the flame, inductance means defining a resonant circuit of which said capacitor forms

a part, an electron discharge tube, elements in-

5

terconnecting said circuit and said tube to define an oscillator of the type wherein a component of current in said tube varies in accord with the impedance of said circuit, and means responsive to said component of current.

2. A flame detector comprising in combination, a pair of conducting plates lying on opposite sides of the flame and forming a capacitor variable in accordance with the presence or absence of the flame, an electron tube having cathode, anode and control electrodes, means defining tuned plate-tuned grid oscillator in which said capacitor forms part of a resonant circuit, said means including elements adapted to bias said control electrode in accordance with the intensity of oscillations in said oscillator, and means responsive to the unidirectional component of cathode-anode space current in said tube.

3. In a flame detector, a pair of conducting plates lying on opposite sides of the flame and forming a capacitor variable in accordance with the presence or absence of the flame, inductance means defining a resonant circuit with said capacitor, an electron tube having cathode, anode and control electrodes, means connecting said resonant circuit across the cathode-control electrode space path of said tube, an auxiliary resonant circuit, a source of potential, means defining a series circuit through the cathode-anode space path of said tube, said source, and said auxiliary resonant circuit, means to bias said control electrode relative to said cathode in accord with the intensity of oscillations in said first resonant circuit, a variable capacitor connected across said control electrode and said anode, and

6

means responsive to the unidirectional component of cathode-anode space current in said tube.

4. A detector for a flame comprising in combination, a pair of spaced conductors adjacent to and in spaced relation on opposite sides of the flame to define a capacitor including the flame, means defining an oscillator having a pair of resonant frequency-determining circuits, the capacitor defined by the conductors forming part of one of the circuits, and means responsive to the amplitude of oscillations in the oscillator.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,809,280	Knowles	June 9, 1931
1,880,871	Denison	Oct. 4, 1932
2,127,977	Lamb	Aug. 23, 1938
2,266,114	Bartlett	Dec. 16, 1941
2,324,330	Smith	July 13, 1943
2,324,821	Campbell	July 20, 1943
2,333,001	Goldstine	Oct. 26, 1943
2,343,001	Cohen	Feb. 29, 1944
2,381,155	Frommer	Aug. 7, 1945
2,433,599	Cohen	Dec. 30, 1947
2,438,550	Ertzman	Mar. 30, 1948
2,468,138	Terry	Apr. 26, 1949

FOREIGN PATENTS

Number	Country	Date
609,988	France	May 25, 1926