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3,198,236

FLAME DETECTING DEVICES

Filed April 29, 1963

2 Sheets-Sheet 1

Fig. 1

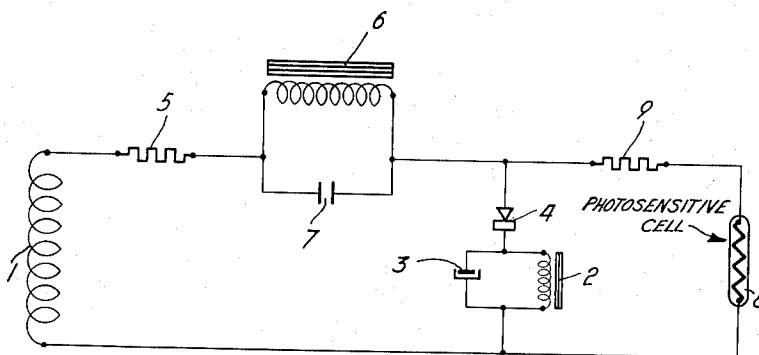
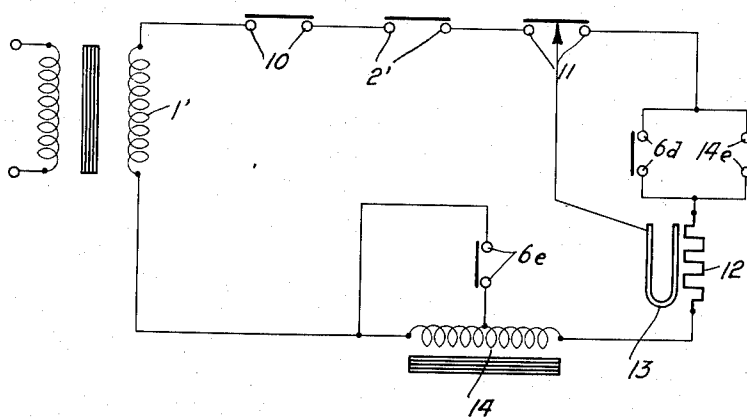


Fig. 2



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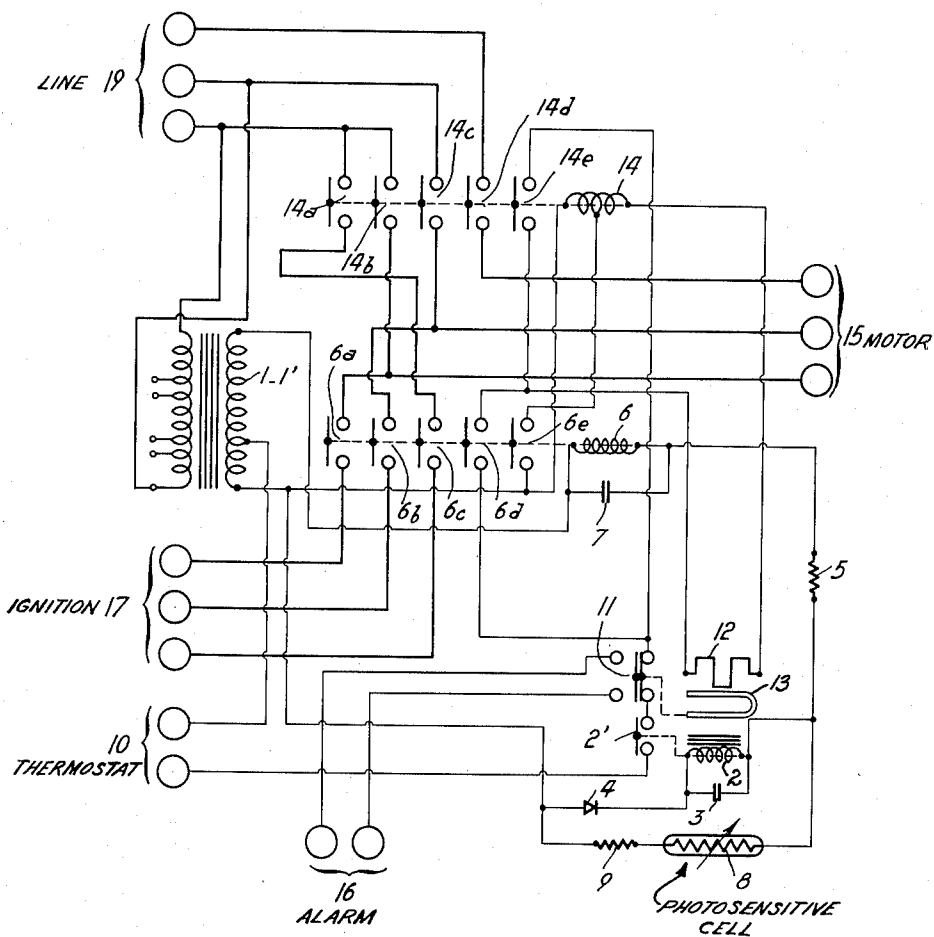
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Fig. 3



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FLAME DETECTING DEVICES

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Claims priority, application France, Apr. 13, 1963, 931,905

5 Claims. (Cl. 158—28)

The present invention relates to a device for detecting a luminous flux and is particularly adapted to the control of flames such as, for instance, in a fuel-oil burner.

It is known that in central heating systems, with fuel-oil or the like, control and safety devices must be provided for rendering their operation reliable and entirely automatic. The ignition of the fuel is effected through electrodes which provide an electric arc, the heat of which causes the fuel to be ignited. An electric installation must therefore be provided for the control of these electrodes, as well as a device for controlling the electric installation, in order to immediately stop the flow of the fuel, should the flame become accidentally extinguished. A detection system for the flame of the burner must therefore be introduced into the electric circuit, which generally comprises a detection member and a detection relay. If, for some reason, the flame becomes extinguished either upon igniting, or during the operation of the burner, said detection member—a light-resistant cell for instance—will energize the relay, resetting the combustion, or, in case of a disturbance of a more serious nature, cause the fuel flow to be definitely stopped should it prove impossible to relight the flame after a certain predetermined time delay. Besides, every automatically operating installation is equipped with control devices such as thermostats, temperature and pressure-limiting devices, the responses of which are also transmitted through the electric control circuit.

The known devices using photoresistant or photosensitive devices for the detection of flames present however certain drawbacks. In particular, when such cells are very sensitive, the light intensity traversing said cell will be greater for the same degree of illumination, resulting in a rapid ageing of the elements considered. On the other hand, certain refractory material constituting the combustion chamber for the fuel are subjected to the action of the flames and may hence emit luminous fluxes, of sufficient intensity to exceed the operating threshold of the photosensitive cell and give thus rise to unwanted disturbances which may even cause explosions.

The present invention provides a unique electrical circuit construction whereby a detection relay (a flame relay) is controlled directly by means of a photoconductive cell, that is, amplifying devices are not necessary. Furthermore, a safety relay is interconnected with the photoconductive cell to sense and respond to a shorting of the cell, that is, to an abnormally low resistance value of the cell.

Specifically, the present invention utilizes a first circuit having an A.C. source of voltage interconnected with rectification means and a series of connection of the actuators of the detection and safety relays to normally energize these relay actuators in the absence of flame. A photoconductive cell is connected in a second circuit to short the rectification means and the safety relay actuator. Upon a flame being detected, the detection relay actuator is subjected to an A.C. current and as a result is operatively deenergized. However, the safety relay actuator remains operatively energized, so long as the photoconductive cell is not shorted.

Switches which are controlled by the detection relay and by the safety relay are interconnected in a unique fashion to control a control circuit, the control circuit including

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a driving relay whose switches control the burner, and also including a bimetal operated time delay device, such as the well known safety switch.

In the embodiment disclosed, the circuitry is exclusively supplied from the secondary of a transformer, resulting in the isolation of the mains, thus presenting a high reliability in operation.

The voltage delivered by the transformer may be maintained at a substantially constant value by any known type of voltage regulator.

On the other hand, the magnitude of the time delay may be modified according to the operating conditions of the installation, by suitably adjusting the value of the resistance of the thermal switch or the bimetallic-strip curvature.

According to another feature of the invention, a medium-value resistance, connected in series with the photosensitive cell, reduces the sensitivity of said cell, since the detection relay is being actuated only for those values of the luminous flux the order of magnitude of which is substantially that of the flame, resulting in the suppression of interfering effects, due, for instance, to the refractory material of the combustion chamber, and in the reduction of the ageing of the members.

The invention will be described in more detail with reference, by way of example, to a conventional central heating installation equipped with an oil-burner, and to the appended drawings, wherein:

FIG. 1 shows schematically the flame detection circuit according to the invention.

FIG. 2 illustrates the control circuit thereof.

FIG. 3 is a general lay-out of the device according to the invention.

Referring to the drawings, the detection circuit shown in FIGURE 1 is fed by the secondary 1 of a transformer and includes two circuits having in common the safety-relay 2 with its capacitor 3, and a diode 4, the first circuit comprising the resistance 5, of a comparatively high ohmic value, for example 1500 ohms, and the detection-relay 6 shunted by its capacitor 7, the value of which is small (for instance 0.5 μ f.), the second circuit comprising the photoresistant or photosensitive cell 8 and a resistance 9, of a medium value, for instance 150 ohms.

The particular operating features of the detection circuit shown in FIGURE 1 will now be described.

The transformer secondary 1, isolated from the mains, supplies the circuit with a substantially constant potential difference of, say 230 volts, for instance. When the photosensitive cell 8 is not illuminated, as when initiating the ignition of the installation, in the absence of a flame, the detection-relay 6 is energized, and the current flows only in the circuit formed by the components 1-5-6-4-2-1, i.e. the first circuit.

More specifically, half wave rectified D.C. current flows through the above described first circuit to charge capacitors 3 and 7. The D.C. voltage thus established on capacitors 3 and 7 is effective to maintain both of the relays 2 and 6 operatively energized in the absence of flame, that is, in the high resistance state of cell 8.

When cell 8 is illuminated by a flame, the resistance thereof decreases rapidly. Since the A.C. impedance of the coil of relay 6 is high with respect to that of capacitor 7, the relay is de-energized and remains so. Relay 6 is operatively deenergized by virtue of the fact that with cell 8 in a low resistance state, A.C. current flows through capacitor 7 and a D.C. voltage is no longer maintained thereon.

In addition, it should be noted that in case a short-circuit develops on the leads connected to the photosensitive cell 8, the latter being located close to the burner, in the chamber thereof, the voltage across the

safety-relay 2 and the diode 4 drops to zero, resulting in said relay 2 being de-energized and the corresponding contact 2' opened.

On the other hand, the current derived from cell 8, depends on the response time of said cell, sufficiently great to prevent the detection relay to operate in case the flame is flickering.

Finally, the resistance 9 reduces the sensitivity of cell 8, thus enabling the detection relay to be switched in for very low values of the luminous flux—for instance 2 lux—and tripped for corresponding values of the luminous intensity of the flame—15 lux for instance—without being affected by the refractory material.

The control circuit illustrated in FIGURE 2 is fed by the secondary 1' of the transformer and comprises essentially series-connected contact members 10, 2' and 11, cooperating, respectively, with the thermostat (not shown), the safety relay 2 and the time delay device 12. A thermal time delay device having a heater resistance 12 acting on a bimetallic strip 13 cooperates with contact 11. The driving relay 14 connected in the circuit acts on the burner (not shown) and has its coil connected to a contact 6e of relay 6 and, through heater resistance 12 to contact 14e of relay 14 and to another contact 6d of detection relay 6.

The control circuit operates as follows: since the contacts 10, 2' and 11 are connected in series, it is sufficient that one thereof is opened for the driving relay 14 not to be switched in. In the absence of a flame, contacts 6e and 6d of the detection-relay 6 are closed, as previously mentioned. In normal operation, contacts 2' and 11 are also closed, only contact 10 cooperating with the thermostat remaining open. If the thermostat transmits an information corresponding to a heat request, contact 10 will close and the driving relay 14 is energized. The current flows then through resistance 12 of the thermal time delay switch and, since contact 6e is closed, relay 14 is self-energized and will thus behave as an inductance having a portion of its turns short-circuited. The current will thus reach in the thermal switch 12 a high value which causes the heating and extension of the bimetallic strip 13 which, after a time specified by the thermal time delay, will open contact 11, and bring about the setting in the safety position. The structure of the thermal switch also provides for resetting in the case of a defective operation having produced said setting in the safety position, by separately acting on contact 11 by means, for instance, of a manual operation (resetting).

When a flame appears, the previously described photosensitive cell will actuate the detection or flame-relay 6, opening contacts 6e and 6d, thus cancelling the short-circuit on a portion of the coil the driving relay. The current delivered to resistance 12 of the thermal time delay will decrease, since the expansion of the bimetallic strip ceases and causes contact 11 to remain closed.

In FIGURE 3, there is shown a general lay-out of the electric detection and control circuitry of a central heating installation of the type described above, comprising the motor control circuit 15 of the burner, the alarm device circuit 16, the ignition transformer circuit 17 of which the two phases and the neutral are shown, the primary of the low voltage transformer of which the secondary 1, 1' is adapted to supply the previously described circuits, and the three-phase supply system 19. It is emphasized that this arrangement presents a remarkable operation reliability, since the thermostat 10 which is the one mostly handled by the user, is subjected only to very low voltage (24 volts for instance), while the supply voltages of the mains may be as high as 127, 220 or 380 voltages.

The operation of the circuitry forming the arrangement shown in FIGURE 3 has already been described previously, with reference to FIGURES 1 and 2. When the burner is at rest, the photosensitive cell 8 is non conduc-

tive, the detection relay 6 is energized, and the safety-relay 2 is energized. In response to a heat request, the thermostat 10 closes its contact, the driving relay 14 closes, bringing motor 15 and the ignition transformer under voltage, whereas the time delay resistance 12 is also under voltage.

When the ignition is correctly effected, the resistance of cell 8 decreases and the A.C. current flows through the detection relay 6, causing relay 6 to be deenergized and causing the ignition to be stopped and the resistance 12 to be switched off.

In case of an ignition failure, relay 6 remains energized and resistance 12 of the bimetallic strip 13, after a time interval equal to the time delay, will de-energize the driving relay 14 and the burner will stop, whereas, simultaneously, contact 11 opens and then closes causing the alarm device 16 to respond. This requires the manual switching in or resetting of the thermal switch.

In case of an extinction of the flame, the resistance of the cell 8 increases, the detection-relay 6 is energized and the ignition transformer is brought under voltage.

When the flame is extinguished, relay 6 is energized and consequently relay switch 6e closes, resulting in applying voltage to thermal delay resistance 12. If the flame is not re-established during the thermal time delay, relay 14 will be de-energized causing burner 15 to be stopped.

In case of a current interruption, the three relays 2, 6 and 14 will open. When the current is restored, burner 15 is restarted normally.

I claim as my invention:

1. Control apparatus comprising:

first relay means including actuating means constructed and arranged to be operatively energized only by D.C. voltage,

second relay means having actuating means, a source of A.C. voltage,

circuit means connecting the actuating means of said first and second relay means in series with said source of A.C. voltage, said circuit means being constructed and arranged to apply a voltage having a D.C. component to said first and second relay means to thereby operatively energize the actuating means of both of said relay means,

photoconductive means having a normally high resistance and a low resistance when subjected to light energy,

and circuit means connecting said photoconductive means in a parallel circuit to the actuating means of said second relay means and to said source of A.C. voltage whereby the presence of light energy is effective to apply a voltage to said first relay means actuating means having an A.C. component to thereby operatively de-energize the actuating means of said first relay means, the actuating means of said second relay means being operatively de-energized only in the event that said photoconductive means experiences an abnormally low resistance.

2. Control apparatus as defined in claim 1, wherein further control means is energized upon concurrent operative energization of the actuating means of said first and second relay means and is maintained energized for a prolonged time period only upon subsequent operative de-energization of the actuating means of said first relay means in response to the presence of light energy.

3. A flame detector, comprising:

a source of A.C. voltage,

first relay means having means including a winding constructed and arranged to be operatively energized only by D.C. voltage,

second relay means having a winding, unidirectional current conducting means,

first circuit means connecting the windings of said first and second relay means in series with said unidirectional current conducting means to said source of

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A.C. voltage to thereby operatively energize the windings of said relay means,

a photoconductive cell having a normally high dark impedance and adapted to be illuminated by a flame to be detected,

and second circuit means connecting said photoconductive cell in parallel with the series connected second relay means winding and unidirectional current conducting means, said second circuit means being effective upon said photoconductive cell detecting a flame to apply an A.C. voltage to said first relay means winding to thereby operatively de-energize the same, and to substantially short circuit and operatively de-energize said second relay means winding only upon a substantial short circuit of said photoconductive cell.

4. A flame detector, comprising:

a source of A.C. voltage,

a first impedance element of a relatively high impedance value,

first relay means having a winding and having a first capacitor connected in parallel therewith,

a unidirectional current conducting device,

second relay means having a winding and having a second capacitor connected in parallel therewith,

first circuit means connecting the windings of said first and second relay means in series with said unidirectional current conducting device and in series with said first impedance element to said source of A.C. voltage to thereby cause pulsating D.C. current to flow in said first circuit means and to operatively energize the windings of said first and second relay means,

a second impedance element having a relatively low impedance value,

a photoconductive cell having a normally high dark impedance and adapted to be illuminated by a flame to be detected, whereupon the impedance of said photoconductive cell drops to a lower impedance,

and second circuit means connecting said photoconductive cell through said second impedance element in parallel with the series connected second relay means winding and unidirectional current conducting device, said second circuit means being effective upon said photoconductive cell detecting a flame to apply an A.C. voltage to said first relay means winding and thereby operatively de-energized the same, and to substantially short circuit and thereby operatively de-energize said second relay means winding only upon an advertent short circuiting of said photoconductive cell.

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5. Burner control apparatus, comprising:

a source of A.C. electrical energy,

flame relay means including switch means and including actuating means constructed and arranged to be operatively energized only by D.C. electrical energy,

safety relay means having switch means and having actuating means,

first circuit means connecting the actuating means of said first and second relay means in series to said source of A.C. electrical energy, said first circuit means being constructed and arranged to apply a voltage having a D.C. electrical energy component to the actuating means of said first and second relay means to thereby energize the same,

photoconductive means having a normally high dark resistance and a low resistance when subjected to flame illumination,

second circuit means connecting said photoconductive means in a parallel circuit to the actuating means of said safety relay means and to said source of A.C. electrical energy through the actuating means of said flame relay means whereby the presence of flame is effective to apply electrical energy to said flame relay means actuating means having an A.C. component to thereby operatively de-energize the same upon the presence of flame, the actuating means of said safety relay means being de-energized only in the event that said photoconductive means experiences an abnormal low resistance,

and control circuit means including means adapted to energize a fuel burner upon a need for operation of the same, said control circuit means including switch means of said flame relay means and switch means of said safety relay means and effective to render said control circuit means operative only upon continued energization of said safety relay means and upon said flame: relay means indicating the absence of flame at a time co-incident to a need for operation of the fuel burner.

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