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AUTOMATIC CONTROL OF COMBUSTION FURNACES

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FIG. 1.

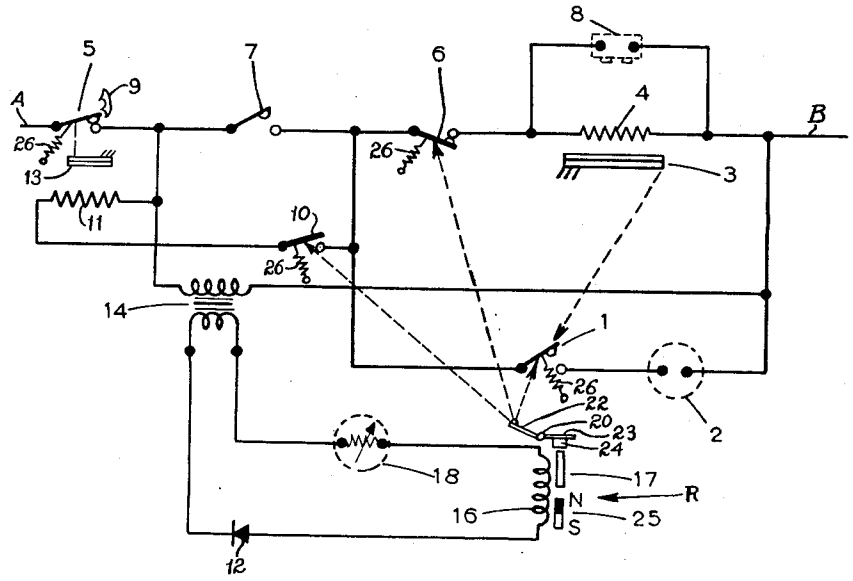
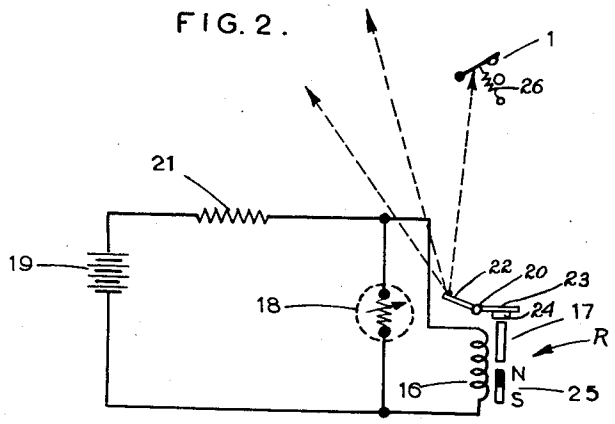


FIG. 2.



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AUTOMATIC CONTROL OF COMBUSTION FURNACES

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This invention relates to a safety device for use in connection with protective circuits for fluid fuel, such as oil burner controls and includes a simple circuit arrangement in which an operating coil of a relay is connected with a photocell employed as the light-sensitive flame sensing means of the circuit.

The invention has for its object an improvement ensuring that if the photocell is short circuited the burner will not continue to run without a flame in the furnace.

In accordance with the invention the safety device includes a relay operating a plurality of switches in which the relay is biased in a preferred direction by a permanent magnet and is operated in opposition to the bias by a current flowing through a circuit comprising the operating coil of the relay and the illuminated photocell and is characterized in that the relay is operated in the same direction as the bias if the photocell be short circuited.

The invention is illustrated in the accompanying drawing in which FIGURE 1 is a diagram of the circuit of the control apparatus. In the diagram is shown a transformer secondary winding and a rectifier providing the direct current supply to the photocell and relay.

FIGURE 2 illustrates a modification. In the latter figure for simplicity of explanation of the protective means of the present invention, a battery has been substituted for providing the D.C. supply to the photocell.

Referring to FIG. 1 of the drawings, which shows the circuit arrangement of the control apparatus in the standby or no-flame condition, current is supplied through current leads A and B at the respective sides of the diagram. A normally open switch **1** is located in the circuit of a motor **2** providing the oil and air supply for the burner, which switch is adapted to be closed by a bimetal strip **3**, which is electrically heated by a heating element **4**. A transformer **8** providing a high tension ignition spark for the burner is connected in parallel with the heating element **4**. The circuit for the heating element **4** and transformer **8** includes a normally-closed lock-out switch **5** adapted to be held open by a conventional type catch **9**, a thermostat switch **7** sensitive to the temperature to be controlled and a normally closed switch **6**. The motor circuit including switch **1** and motor **2** is connected from the supply line B into the connection from supply line A between switches **6** and **7**, as shown.

The flame-sensitive unit consists of a photocell **18**, the resistance of which undergoes great reduction in value when subjected to light, that is, to a flame at the burner. A transformer **14**, the primary winding of which is energized across the supply lines A and B, but through the lock-out switch **5**, supplies the necessary low voltage through the photocell **18** to operate an electromagnetic coil **16** of a relay R. The circuit of the coil **16** from the secondary winding of the transformer **14** includes the flame-sensitive unit **18** and a rectifier **12**.

Means is provided for opening the lock-out switch **5** including a heating element **11** connected between the switches **5** and **7** and through a normally open switch **10** to the connection between the switches **6** and **7**. The heating element **11** is arranged to heat a bimetal actuating strip **13**, which is adapted to move the switch **5** to open locked position as indicated by the dotted line arrow extending from strip **13**.

The relay R, in addition to coil **16**, includes a relay core **17**, a permanent magnet **25** and a pivoted actuating lever having a pivot **20** and arms **22** and **23**, the latter of which carries an armature **24**.

When the control apparatus is in the no-flame, standby condition, as illustrated in FIG. 1, the permanent magnet **25** magnetizes the core **17** of the relay R and attracts the armature **24** holding the pivoted lever in the position, as shown, biasing switch **1** open, switch **6** closed and switch **10** open, as indicated by the respective dotted line arrows extending from the arm **22** to these switches. The switches **1, 5, 6** and **10** are illustrated as being biased by conventional tension springs **26**, as shown. The switch blades of these switches may, however, be flexible spring blades set in the respective positions referred to under no-flame conditions. When the switches **1, 6, 7** and **10** are in the positions shown in FIG. 1, there will be no current flowing through the photocell **18** and the coil **16**.

When the thermostat control switch **7** is closed, current flows through the heater **4** and transformer **8**, the heater **4** heating the bimetal strip **3** which closes the switch **1** in opposition to the bias of the relay R, as indicated by the dotted line arrow leading from the strip **3** to the switch blade of the switch **1**. In this operation the connection between the arm **22** and the switch blade of the switch **1**, as indicated by the arrow, gives, since it may include a spring bias or clutch. Upon the closing of the switch **1**, current flows to the motor **2** to supply oil and air to the burner and as soon as the fuel is ignited by the transformer **8**, the photocell **18** senses the flame at the burner and allows sufficient current to pass to cause coil **16** to demagnetize the core **17** in opposition to the permanent magnet **25**. This releases armature **24** and removes the bias of the relay from switches **1, 6** and **10**, allowing switch **6** to be opened and switch **10** to be closed. This is the normal "run" condition with the switches **1** and **10** held closed and the switch **6** held open.

When the switch **6** opens, current to the transformer **8** and the heater **4** is cut off, so that the bimetal **3** cools and removes its pressure from the switch blade of the switch **1**.

The opening of the thermostat switch **7** opens the circuit of the motor **2** and the flame of the burner goes out, thereby de-energizing the photocell **18**, so that no current flows through the coil **16**, which is thus de-energized. The permanent magnet **25**, therefore, becomes effective and remagnetizes the core **17** to bias the relay R to return the switches **1, 6** and **10** to the standby, no-flame condition, as shown in FIG. 1.

If the photocell **18** should become damaged during the run condition of the device sufficiently to cause the switch **1** to be held closed after the opening of the thermostat switch **7**, then since the switch **10** will also be held closed, current will then flow through the resistance heater **11** via the switch **1** and the motor **2**, and heat the bimetal **13** causing it to push the lock-out switch **5** into the lock-out catch **9**. The lock-out switch **5** will then have to be manually reset in order to resume operation after the fault is corrected. If a short circuit occurs across the photocell **18**, the core **17** will be remagnetized by the coil **16** to place the relay R in the no-flame safety condition.

In the alternative arrangement shown in FIG. 2, the relay R, including the coil **16**, core **17** and permanent magnet **25**, together with other elements shown in FIG. 1 performs the same switching action with respect to the switches **10, 6** and **1**, as that described above in connection with FIG. 1. In FIG. 2 the arrangement of the photocell **18** is somewhat different, however, in that it is connected in parallel with the relay coil **16**, and a ballast resistance **21** is connected in the line to the D.C. supply, which in this instance comprises a battery **19**. The resistance of the ballast resistance **21** is then adjusted so

that when the photocell **18** is illuminated by a flame at the burner, the division of the current between the photocell **18** and the coil **16** just de-magnetizes the core **17** of the relay R, putting the relay in the "run" condition. In the no-flame condition, the high resistance of the photocell **18** causes most of the current passed by the ballast resistance **21** to pass through the coil **16**, magnetizing the core **17** and putting the relay in the no-flame safety condition. A short circuit across the photocell **18**, as mounted in FIG. 2, causes all the current to be diverted from the coil **16** leaving the core **17** of the relay magnetized by the permanent magnet **25**, and the relay and apparatus as a whole in the no-flame standby condition.

I claim:

1. In a fuel burner control apparatus for use with a fuel burner including an electric motor for supplying fluid fuel to the burner, an electric circuit including a normally open switch having means biasing it to closed position for energizing the burner motor, and an electromagnetic relay for controlling operation of the switch in the circuit of the burner motor, the improvement in which said relay comprises a permanent magnet and an electrically-operable operating coil in which the permanent magnet biases the relay in a direction to overcome the bias of said switch to open said switch when the coil is unenergized, an electric circuit for supplying electric current to the operating coil of the relay, and a light-sensitive photocell in the circuit of the operating coil of the relay constructed to be sensitive to the presence of a flame at the burner to permit the flow of electric current to energize said operating coil and overcome the bias applied to the relay by the permanent magnet, thereby removing the bias of the relay from said switch, said operating coil of the relay being constructed to operate the relay in the same direction as the bias applied to the relay by the permanent magnet if the photocell should be short circuited.

2. A fuel burner control apparatus as claimed in claim 1, including a thermostat switch in series with the switch in the electric circuit of the burner motor, and means operable in response to the closing of the thermostat switch for closing said switch in the electric circuit of the burner motor in opposition to the bias supplied thereto through the relay by the permanent magnet, the operating coil of the relay being de-energized by the photocell in the absence of a flame at the burner, thereby making the bias of the permanent magnet effective to bias the relay in the direction to open the switch in the electric circuit of the burner motor.

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