Boiler Control Devices.—These are also known as limit switches.

Ques. Name two kinds of limit controls.
Ans. 1, Temperature control; and 2, water level control.

Ques. What is the reason for temperature limit control?
Ans. It takes time to heat a room and even if all the radiators are filled with steam, the thermostat will keep calling for more heat until the room has become warm. During this interval the limit control will shut down the furnace before the steam pressure or temperature reach an unsafe degree, that is, the pressure or temperature for which the device has been set.

Hot Water Switch.—On some outfits there is a thermostatic device which holds the temperature of the water in the hot water or steam boiler within pre-determined limits—usually between 160° and 180°. Heat is transferred from the boiler to the domestic hot water storage tank by means of an indirect water heater. The location of the domestic hot water switch is shown in fig. 13.

CHAPTER 19

Burner Radiant Heat Control

According to Kennedy Van Saun: “It is agreed by those who are familiar with combustion that radiant heat is most desirable and that it is about eight times as good as heat by convection in the combustion chambers.”

Some of the burner manufacturers appreciating the efficiency of heat transmission by radiation have utilized radiant heat for the automatic control of their burners, calling it “electric eye” visaflame, sometimes erroneously electronic control, and what not of a non-descript or questionable nature.

Ques. Why do they call it electric eye?
Ans. Because it works when it can “see” the flame.

Ques. How do they utilize radiant heat for burner control?
Ans. The device used is a hermetically sealed glass bulb

*NOTE.—Anyone even a thermal dumb-ball who doubts this, need only open up the bathing season by spending two or three hours on the beach under the blazing sun and experience the usual results the next day—sunburn.*
(similar to an electric light bulb, but containing a thermomercury switch) whose operation depends on the concentration of radiant heat and unequal expansion of a bimetal element.

**Ques.** Describe its make up and operation.

**Ans.** Fig. 1 shows the bulb and its parts and fig. 2, illustrates principle of operation. *In operation*, as the light passes through the front side of the glass bulb, it is intercepted on the other side by the concave mirrored reflector B, which in turn concentrates these light waves on the small bimetal coil G. Since this coil is not transparent, but opaque, it transmits the light waves into heat and causes the coil to expand, that is, move in an openward direction, carrying the movable electrode D, into the pool of mercury E.

![Burner radiant heat control bimetal coil bulb, as described in the text.](image)

**Ques.** Why does the heat cause the coil to move?

**Ans.** It is due to unequal expansion of the two dissimilar metals of which it is composed.

**Ques.** What is the result of the movement of the coil?

**Ans.** When the movable electrode D, contacts with the pool of mercury E, it closes the circuit between the fixed electrode F, and the movable electrode D.

**Ques.** As for further explanation, what can the action of the concave reflector B, be compared?

**Ans.** It may be compared to a sun glass which concentrates light rays from the sun on a small area. The concentrated rays greatly increasing the temperature on the small area, as compared with the temperature that would exist if the light followed a straight path and covered a large opaque area.

Due to the fact that only the small sensitive coil is subjected to the concentrated light, it reaches a temperature in excess of its surrounding or ambient temperature and responds quickly to actuate the contact mechanism to close the circuit.

**Ques.** How long does the circuit remain closed?

**Ans.** It remains closed until the concentrated light disappears, the contact mechanism responding quickly to actuate the contact mechanism to open the circuit.

In other words, when the bimetal coil or "eye" of the device can "see" the flame, (that is, when the flame comes on) it heats up and closes the circuit. Again, when it cannot "see" the flame (that is, when the flame goes out) it cools off and opens the circuit.

**Ques.** What provision is made to compensate for changes in ambient temperature, that is, changes in temperature surrounding the bimetal coil?

**Ans.** A large outer compensating bimetal coil H, is provided.
Ques. How does it work?
Ans. As ambient temperature changes occur, both bimetal coils are equally affected. As a result of this compensation, the movable electrode D, does not change its position regardless of whether the ambient temperature increases or decreases.

Ques. When the burner stops after prolonged operation and the bricks of the combustion chamber are close to white heat, what are the effects of this incandescence?

Ans. The walls of the combustion chamber are more remote from the bimetal coil than the flame. Accordingly, since the intensity of light varies as the square of the distance, the light due to the incandescence is not as intense as the light produced by the flame, hence after the burner shuts down, the light due to incandescence is of relatively low intensity and will have little or no effect on the bimetal coil.

Ques. Name two control units designed to operate with the radiant heat control bulb?

Ans. A combination transformer relay and a safety mechanism.

Ques. Describe the transformer-relay unit.
Ans. It consists of two independent insulated heavy duty coils which are mounted on a laminated iron yoke. The primary coil is fixed in position and is connected across the high voltage line. The secondary coil is movable and is connected to the low voltage thermostat circuit.

Ques. How do these two coils act?
Ans. As a transformer, the low voltage is induced in the secondary coil when the primary is energized.

Ques. What causes the device to function as a relay?
Ans. It is due to repulsion action. When the low voltage thermostat closes its circuit, the secondary coil moves upward and closes the mercury switch contact and starts the burner motor.

Ques. What is the function of the safety mechanism?
Ans. It determines the period the burner shall operate without flame.

Ques. Of what does it consist?
Ans. It consists of a low voltage heater coil combined with a bimetal thermostatic strip.

Ques. How does it work?
Ans. It acts as a tripping device to shut down the burner in case of flame or ignition failure.
Ques. For what kind of ignition are the above units adopted?

Ans. For either intermittent or constant ignition.

Ques. What other “tube” method may be used for burner control?

Ans. By employing electronic circuits it is possible to detect the presence or absence of flame.

![Diagram of oil burner control system with labeling: Transformer, MERCOID "Visa Flame" Bulb (Photo Electric Cell), Electrode Insulation Tubes, Electrodes, Fuel Unit.]

**Fig. 3.**—Herco oil burner. Sectional view showing "visaflame" control. The light actuated visaflame bulb is mounted inside the burner directly on the hinged transformer as shown. Wiring between visaflame bulb and relay panel is fully enclosed.

**Chapter 20**

The Differential

It's perhaps a safe assertion to state that when they speak of the “differential” in connection with automatic control devices for oil burners, most people don't know what they are talking about—they are certainly not talking about the differential calculus.

Ques. What are they talking about?

Ans. They refer to an important phase or pause in the operation of an automatic control device, upon the extent of which, depends the resulting difference in temperature or pressure, accruing, that is, from the time the burner stops till it starts.

The differential part of the mechanism is adjustable so that the temperature or pressure differential may be varied, that is, it is provided with adjustments to set the operating range to start the burner on “low” and stop the burner on “high”.

Ques. What are the basic principles involved in the differential mechanism of an automatic control device?

Ans. A system of linkage forming a “knuckle” joint which snaps to one side or the other by the action of a spring, which in turn is governed by the action of another spring and a variable opposing force due to pressure or temperature changes.