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.

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.
Ques. Describe the differential mechanism.

Ans. In the elementary diagram fig. 1, it consists of a link A, pivoted at one end and engaging a spring B, at the other end, forming the knuckle joint. A connecting link C, is pivoted to the switch link D. A bellows E, and operating spring F, provide two opposing forces for the operation of the switch.

Ques. How does it work?

Ans. In the position shown, the circuit is closed (switch on). The operating spring F, tends to keep the switch in the on position, as shown. The pressure of the operating spring is opposed by the steam pressure tending to expand the bellows E. When the steam pressure becomes high enough to overcome the spring F, pressure, link A, will turn on its pivot in direction indicated by arrow G, and after passing the dead center axis, knuckle spring B, will "snap" the mechanism over to position where link A, contacts with the stop H'. This movement tilts the mercury switch, shifting the mercury to the other end and opening the circuit as shown in fig. 2.

It should be noted that the extent of movement between the stops H and H', (fig. 1) is exaggerated to emphasize the basic principle of the knuckle joint.

Ques. What is missing in fig. 1?

Ans. The mechanism has no provision for adjusting the dif-
The Differential period, that is, the time interval between start and stop of the burner.

Ques. What is provided to make this adjustment?
Ans. Means must be introduced to change the tension of the knuckle spring B (fig. 1) in order to increase the opposing steam pressure necessary to swing the knuckle joint over to the other side of the dead center axis.

Ques. How is this done and why?
Ans. Either by lengthening the link A, or the knuckle spring anchor I. The object of either method is to compress the spring so as to increase its tension.

The adjustable anchor method and how it works, is shown in figs. 3 and 4.

How the Differential is Adjusted in Practice.—To illustrate, a Twin Contact Series 100 thermostat is selected, as shown in fig. 5.

The following are instructions for regulating burner operations.
The thermostat, as it comes to you, will give close temperature control without the need of any field adjustment. However, where adjustment is necessary, it is a simple matter to adjust the differential as desired.

This thermostat has a simple device for regulating burner operations. The thermostat comes from the factory with the copper slotted regulating arm C, set at B. This is the average setting which will give satisfactory operation on most installations. If there be over-shooting of the room temperature or “cold 70” move the slotted arm counter-clockwise to A, which decreases the differential.

To obtain longer “burner on” periods move the slotted arm clockwise toward E, one division at a time which increases the differential.

Ques. What should be noted about longer “burner on” periods?
Ans. The longer “on” periods help to heat remote rooms, especially radiators fitted with cheap inferior air valves.

Boiler Safety Automatic Limit Controls

The controls described in this Chapter depend for the operation of the various devices upon:

1. Pressure of the steam.
2. Temperature of the water or steam.
3. Height of the water in the boiler.

Abnormal or faulty operation of a burner sometimes occurs, due to causes beyond the ability of the controls already described to correct. To protect the boiler and furnace in such cases limit controls are provided.

Ques. What are limit controls?
Ans. Special “stand by” or emergency controls whose function is to shut off the burner in case of any abnormal action not corrected by the regular control system.

Limit controls are fundamentally safety controls, although they are sometimes also used for other purposes.

Ques. Where is a limit control located electrically?
Ans. In the main supply line to the burner.