Ques. How does the snap mechanism float control work?
Ans. The essentials of this arrangement are shown in fig. 7.

The knuckle joint and linkage are the same as previously described, except that the operating link A, is connected to the float lever between fulcrum and float. There is a sliding joint with two stops to limit the travel, and there is no operating spring. In operation, (on rising water level) stop B, pushes arm C, upward until it passes dead center axis, when it snaps into the off position shown in the diagram. This tilts switch to break circuit and stops the feed pump.

Ques. What happens if the water fall to danger low level?
Ans. In fig. 7, stop D, moving downward will push arm C, down past the dead center axis and the knuckle joint will snap the switch to the closed position which starts the pump or sounds an alarm according to the hook up.

Ques. What is the trouble with the non-snap arrangement?
Ans. Lack of differential.

CHAPTER 22
Automatic Control Devices; Construction

The various devices for automatic control, so far, have been shown simply by elementary sketches or diagrams intended to present basic principles and not actual construction. Having learned how they work, next should be learned how they are made and what they look like.

The principle devices to be considered are:
1. Thermostats.
2. Primary controls.
3. Limit controls.
4. So called “operating” controls.

An undue multiplicity of names have been given to these four basic controls by manufacturers and the service man must know: 1. What they are; 2, who made them, 3, how they work, and 4, what they look like.

Practically everybody is familiar with the term thermostat, yet so called sensatherms, chronotherm tectrol acrathems and what not are nothing but thermostats as made by different manufacturers. There are too many -stats, -trols, -therms, and other nondescript compounds.

Terms where possible, should be self-defining. For instance, the basic term “operating control” is stupid — all controls are operating controls and if they don’t operate, servicing is necessary.
The alleged “operating control” is a hot water control (self-defining) and should be called just that.

Referring to the basic controls, when they call them Sensatherm, chronotherm, acratherm, temtrol, etc., they mean thermostat.

Master control, stack switch, protectorelay, saltrol, combustion, safety control, pyrotherm, etc., they mean primary control.

Pressuretrol, vaporstat, aquastat, etc., they mean limit control. Immersion aquastat, hot water supply control, summer and winter control, they refer to the alleged operating control.

**Questions:**

**Ques.** What is the basic principle in the operation of a thermostat?

**Ans.** Different metals, when heated or cooled expand or contract at different rates. Hence, if two different metals be joined together into a bi-metal strip, this strip or “arm” will bend...
as the temperature changes and this bending movement is utilized to open or close an electrical circuit.

**Ques.** How is this principle applied to the actual thermostat?  
**Ans.** The circuit diagram fig. 1, shows the bi-metal strip or arm and the other essential elements and connections. Electric wires lead to the instrument at the terminals R, B, W, (red, blue, white). The terminal W, is fixed and blades attached to the movable arm are arranged to contact (progressively) with contacts B and W.

**Ques.** How does the thermostat work as the room cools?  
**Ans.** In operation, as the room cools, the blades move toward the B(lue) and W(hite) contacts. The circuits are entirely open until the closing of the B, contact which energizes secondary of relay coil D. This causes contact E, to close.

**Ques.** What happens when the temperature of the room rises?  
**Ans.** The bi-metal arm moves away from contacts B and W. The B, contact breaks first, but the circuit is maintained from W, through the transformer secondary relay coil and red terminal R. This energizes the relay coil and holds the circuit through contact E, closed until W, contact opens.

**Ques.** What is the object of the resistor or heating element F?  
**Ans.** When contact W, is closed, current is carried to the small heating coil in the thermostat, that is, when the thermostat is calling for heat. This speeds up the heating of the bi-metal arm and provides closer room temperature control.

The coil F (sometimes called the heat accelerating coil) due to its heating effects causes the thermostat to stop the burner a little before it normally would, shortening the burner operating period before too much heat can be generated.

After the burner has been turned off, the heat accelerating coil F, stops producing heat within the thermostat and this reduces the time before the burner will start again, thus preventing a noticeable drop in room temperature.
Day and Night Twin Type Thermostat.—This is an assembly of two thermostats mounted on a single base with one cover. The electric clock can be set to throw the temperature controls from one thermostat for the day time onto the other for night at a pre-determined time setting, on the clock and vice versa. This conveniently permits a low temperature at night as should be, and normal temperature during the day. Modern heating thermostats are built to incorporate a “heat leveling” or heat anticipation device. A heating coil consisting of a high resistance unit of very low current draw, is automatically connected in the thermostat circuit when the thermostat contacts close as it calls for heat.

Ques. Describe the heat anticipation feature.
Ans. After the burner (or stoker as the case may be) has been in operation a short time, the heating coil warms up slightly which in turn has a warming effect upon the thermostat mechanism, thus causing the contacts to open in “anticipation” of the heat that has been generated in the boiler or furnace, but has not yet reached the room.

Ques. How is the heating coil* mounted?
Ans. It is carried in two spring clips.

Ques. What is omitted on the night thermostat?
Ans. It has no heating coil.

Ques. What is the object of the slotted knob protruding through the clock cover at the bottom?
Ans. It is a convenient switch for manually cutting out the clock control as desired.

*NOTE.—The oil burner thermostat uses a heating coil with a red band on it and the stoker thermostat coil has a yellow band.
The Primary Control

Ques. How is the thermostat connected to the primary control?

Ans. The B, W and R, contacts shown in fig. 1, are connected to the B, W and R, terminals on the thermostat and these are wired to B, W and R terminals on the primary control.

Ques. How do you change the operating point?

Ans. Turn the spring cap, up or down. Turn down to obtain higher pressure (or temperature). Turn up to obtain lower pressure or temperature.

Ques. What happens when all three contacts are closed?

Ans. Turn the spring cap, up or down. Turn down to obtain higher pressure (or temperature). Turn up to obtain lower pressure or temperature.
Ans. The operation of the burner causes a rise in room temperature. This in turn, due to unequal expansion in the bi-metal element, causes the blades to move away from the B and W, contacts. B, breaks first, the relay coil remaining energized until W, opens.

Stack Switch.—The stack element of this control consists of a bi-metal helix which has one end attached to the end of the control mounting tube. The other end of the helix is attached to a rod which extends into the control panel and actuates the stack switch contact with a rise or fall in flue gas temperature.

Ques. Describe operation and construction of the stack switch.

Ans. When the thermostat calls for heat, it closes the relay and starts the burner. The heat of the flue gases in the stack passes over and around the stack element and causes the helix to expand. This drives the rod attached to the helix which travels toward the control and opens the stack switch contact H, (fig. 11) by means of a friction clutch action of the rod sliding through the movable contact arm.

Safety Switch.—If the stack switch fail to open the stack switch contacts in 90 seconds, the safety switch L, fig. 11, “warps out” and opens the control relay G. Another burner start cannot be attempted until the safety switch has been manually reset by pressing and then releasing the button which protrudes from the front of the control.

Ignition Switch.—Cut off of ignition is not dependent upon stack temperature as it is operated by a heating coil attached to the bi-metal arm that carries one of the ignition primary circuit contacts.
**ELECTRICAL HOOKUP AND CONNECTIONS OF PRIMARY CONTROL MASTER CONTROL**

**LEGEND**

1—Line Voltage—Hot
2—Line Voltage—Ground
3—Line Voltage—Hot to Burner Motor
4—Line Voltage—Hot to Ignition Transformer
G—Starting Contacts
H—Stack Switch
J—Line Voltage Contacts

**LEGEND—Continued**

L—Safety Warp Switch
N—Ignition Transformer
P—Primary Winding of Relay Transformer
S—Secondary Winding of Relay Transformer
T—Thermostat
X—Resistor

**Fig. 11**—Electrical circuit diagram of Delco primary (Master control) with connections.
Ques. What happens when the relay closes?
Ans. The heating coil is connected in circuit and the heat generated by it warps the ignition contact arm away from the stationary contact and breaks the line voltage circuit for the ignition.

Ques. How is the metal arm mounted and actuated?
Ans. It swings on a hinge pin and its action is controlled by the opening and closing of the ignition circuit arm as it carries the forked insulation with it.

Fig. 12—Diagram of twin type thermostat showing all wiring connections between clock and primary control.

A small amount of current flows through the heating coil during the burner operation which keeps the ignition contacts K, fig. 13 apart.

Ques. How is the ignition bi-metal arm constructed?
Ans. It has a fork shaped piece of insulation F, fig. 13, attached to a right angle shaped metal arm with the starting switch contact on its outer end.

Ques. Describe the circuit conditions when the ignition contact arm is in a closed position.
Ans. The contact on the small metal arm is touching a stationary contact G, fig. 13, to complete the starting circuit.

Ques. What happens when the ignition arm is warped away from its companion contact?
Ans. The forked insulation is carried with it and likewise the small metal contact arm which breaks the contacts of the starting circuit.

In this way the burner motor can never start until the ignition circuit is completed and due to the unique construction of the combination switch, the ignition circuit always “makes” before the starting circuit contacts touch each other (unless some reason the stationary starting contact bracket has become bent out of position).

Ques. What are the conditions when the burner shuts off (either by normal action of the thermostat or due to power failure)?

Ans. It cannot re-start until the heating coil, fig. 11, has cooled sufficiently to bring the ignition arm back to the contact making position, at which time the starting circuit contacts also close — the burner circuit is then ready to operate.

CHAPTER 23

Inspection and Preparation

1. Inspection

The author is getting tired, very tired, of the mis-application of the word survey* for inspection.

The installation of every oil burner requires careful preliminary thought and study. Conditions encountered are usually different for each installation, all of which must be carefully considered before deciding upon any particular outfit or whether to make an installation.

Ques. What preliminary precaution should be taken?

Ans. Do not recommend the installation of an oil burner (conversion) in a heating plant unless you have reasonable assurance that the plant is suitable for oil burning.

If by questioning the owner, it is apparent that the heating system has been and is satisfactory, it can be taken for granted that a calculation of the connected load is not necessary.

*NOTE.—Some language butcher started it with the usual result. When a Civil engineer with aid of surveying instruments and a rod man locates boundary lines, their lengths and directions on a piece of property, that is surveying. When an oil burner man goes into a basement to see what kind of junk it contains and what he is up against in installing a burner, that is inspection. However, language butchers are always on the job — mark ye, always.