Robertshaw
CONTROLS COMPANY
Uni-Line North America A SIEBE COMPANY
Control Tips
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ANTICIPATION IN ROOM THERMOSTATS

An electromechanical room thermostat consists of a bimetal element, and switch contacts. (Figure 1). The bimetal element senses temperature change and deflects accordingly. The switch contacts are opened or closed depending on the direction of the temperature change. With a system selected for heating, a temperature decrease closes the switch contacts. The associated heating equipment comes on, and after a short time lag, heat transfer causes the room temperature to increase.

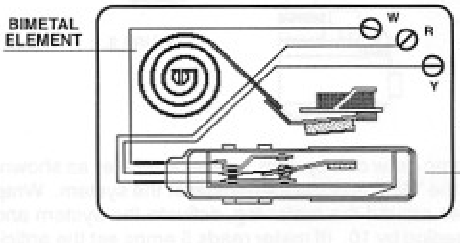

FIGURE 1.

In an unanticipated thermostat, a temperature increase of one to two degrees above that required for contact closure will open the switch contacts and shut down the furnace. After another short heat transfer time lag, the temperature decreases to the "on" value, and the cycle is repeated. During the time lags noted, the room temperature will decrease to slightly below the "on" point, and will increase to slightly above the "off" point. These conditions are known as undershoot and overshoot. (Diagram 1).

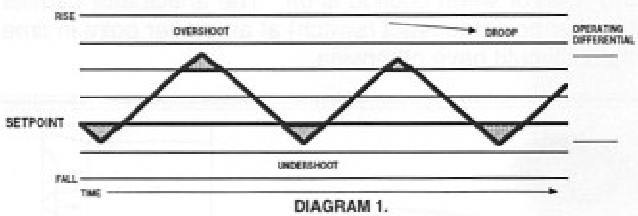

DIAGRAM 1.

The total differential of the system is the temperature difference which includes undershoot and overshoot. The temperature difference between the "on" and "off" points is known as the operating differential of the thermostat. When the system is selected for cooling, the basic operation is the same except that contact functions are reversed. A temperature increase closes the contacts. The same considerations hold for time lags, undershoot, overshoot, and differentials.

An anticipator is a resistive heating element added to the basic thermostat. Its purpose is to create a controllable temperature rise inside the thermostat at the bimetal. This internal temperature rise occurs during the heating "on", and/or during the cooling "off" periods.

Heating anticipators are an adjustable, low resistance, current operated element connected in series with the contacts. **Cooling anticipators** are a fixed, high resistance, voltage operated resistor placed in parallel with the contacts. (Figure 2).

When the thermostat is "on" for heating, a current flows to the heating anticipator. The internal temperature of the thermostat is raised slightly above actual room temperature, an amount determined by the setting of the heat anticipator.

The bimetal senses this rise in addition to room temperature rise and opens the contacts at an earlier time than would have occurred in an unanticipated thermostat. This action "anticipates" thermostat satisfaction, and decreases the room temperature differential required for operation.

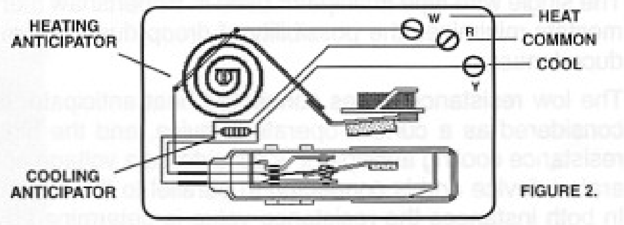

FIGURE 2.

When the cooling operation is selected, and the thermostat is "off" for cooling, a voltage is applied to the high resistance cooling anticipator. The resistor heats and raises the thermostat internal temperature slightly above room temperature. With cooling "off" the room temperature is also rising. The internal temperature rise adds to the room temperature rise and the bimetal "anticipates" the need for cooling. Thus the air conditioner is turned "on" at an earlier time than it would have been and the cooling temperature differential is decreased. With decreased differentials, system lags are less pronounced, and undershoot and overshoot are reduced. (Diagram 2).

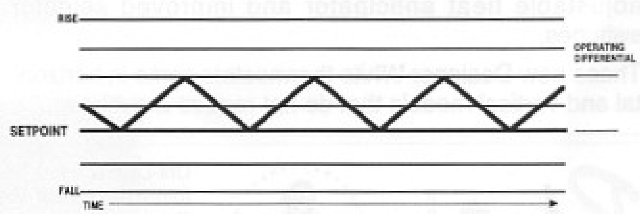

DIAGRAM 2.

In an unanticipated thermostat, the bimetal temperature is room temperature. In an anticipated thermostat, the bimetal is raised above room temperature when current flows in the anticipator. The bimetal on and off temperature at a given setting are defined by the properties of the bimetal. When an anticipated thermostat is used for heating, the thermostat shuts off at a lower room temperature than it would if it did not have anticipation. This acts to lower the operating temperature differential.

Under the conditions of a light heating load and short "on" times, small quantities of internal heat are added, the bimetal has time to cool, and the "on" temperature of the room is not seriously affected. However, under conditions of a heavy heating load, with heating "on" for long periods and the anticipator is also on and relatively large amounts of internal heat may be added inside the thermostat. In order for the bimetal to cool to its "on" point in the time required to maintain the load, the room temperature must be lower than under conditions of light load. Therefore, the thermostat's control point for heavy loads is lowered below the control point for light loads.

This phenomenon is known as "droop". This same physical principle holds for cooling, i.e. - the anticipator is "on" when the room temperature is rising. Since the switching functions are reversed, and the anticipator is "on" when the thermostat is "off" we see more internal heat being added during times of light cooling demands. This result in a condition where the controlled temperature is lower under conditions of light loads than that obtained for heavy cooling loads. Therefore, thermostat "droop" will occur during times of heavy heating loads and light cooling loads. The single wire type anticipator used in Robertshaw thermostats minimizes the possibility of droop due to its reduced mass.

The low resistance series connected heat anticipator is considered as a current operated device, and the high resistance cooling anticipator is considered a voltage operated device and is connected in parallel to the switch. In both instances the resistance value is determined by power required for a specified amount of internal heating.

Care must be taken to match heating anticipator values to system current loads. If the current draw of the system is not know, it must be measured with an ammeter as shown in Figure 3. Older heating systems have small current draws (.2 to .6 amps), while most new, ignition type systems and circuit board units have higher draws (.6 to 1.5 amps). Heat Pumps should be set at approximately 125% of rated value to reduce short cycling. A misapplication or improper setting could result in severe droop, short or long cycles, or excessive differentials. During cooling operation the voltage across the open contacts is almost always about 24 volts. So once a cooling anticipator value is established for a thermostat type, it is not necessary to match it with the electrical load as for heating.

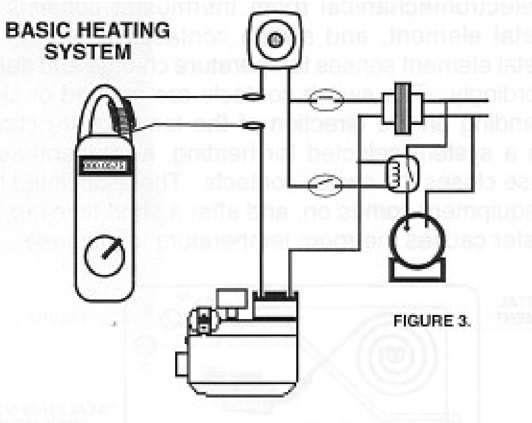

FIGURE 3.

To determine the amp draw of a system, use an ammeter as shown. Place a jumper in the "W" line of the thermostat of the system. Wrap the jumper 10 times around the meter leg, activate the system and divide the meter reading by 10. (If meter reads 5 amps set the anticipator at .5 [5/10=.5]).

To summarize: Thermostats are constructed with a bimetal element, switch contacts, and resistive anticipator elements. Temperature changes actuate the bimetal and contacts. Anticipation adds internal heat and reduces the amount of room temperature differential required for operation. Anticipation is always on during times of rising room temperature. Anticipation is always on when heating is on or when cooling is off. The anticipator causes the thermostat to react (switch) at an earlier point in time than it would have otherwise.

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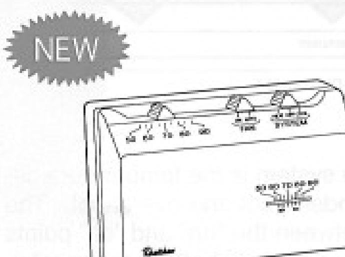

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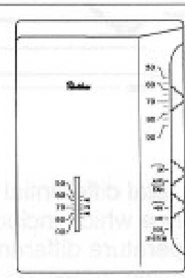

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