GAS APPLIANCE ENGINEERS HANDBOOK

SECTION 13A

THERMOSTATS

by Robert W. Newell - Eastern Chapter

The thermostat has been designed primarily to control temperatures within an enclosure or at a particular location. It is the instrument that tells when heat is to be turned on and shuts off the heat supply when satisfied. Thermostats are generally adjustable to suit the particular human need, whether for comfort, cooking temperatures, or temperatures of hot water.

Depending upon its application, a qualifying phrase is used to describe the thermostat's use such as: Room thermostat, hot water thermostat, oven thermostat. A broad definition of a thermostat is: an automatic device actuated by temperature changes, designed to control or start the gas supply to the burner(s), in order to maintain temperatures between predetermined limits.

Room thermostats regulate the temperature of the room in which it is located. The instrument usually has various means of control adjustments to gain the maximum comfort in the home. Of all the controls, it is probably the most flexible in its function to suit the individual's tastes or senses. An average room temperature can be selected, a lag time effect can be set through the preheat adjustment, and some have an adjustment for a short or long cycle of the operation of the equipment. The modern gas heating system is usually controlled by one thermostat and provides suitable comfort in every room throughout the house. Proper selection and location of thermostat will allow the gas heating system to do its work economically and provide comfort regardless of outdoor temperatures.

Location of the thermostat is very important to gain satisfactory performance and comfort. Since this control is not integral with the operating equipment, it is necessary through customer instructions and service manuals to give the installer definite suggestions as to where the room thermostat should be located:

1. A height above the floor should be recommended.
2. Good air circulation, but not drafts should be present.
3. An inside wall is the best location.
4. Select the room of greatest amount of occupancy such as a dining room, living room, den, and preferably the one that has the greatest heat loss or most exposure.

The "don'ts" should be listed in the installation instructions such as:

1. Never mount it on a wall where cold drafts of air from unheated spaces or from outdoors can strike it.
2. Never locate it in a bathroom, kitchen, or entry hall.
3. Never mount it on a wall where the sun can shine on it, even for a short time.
4. Never mount it at the foot of a stairway.
5. Never mount it on an outside wall or any wall that is cold on the other side, or on an inside wall closer than one stud space away from an outside wall.
6. Never mount it where warmed air from a radiator or a warm air register can strike it. Stay away from radiators and any location directly above or opposite a warm air discharge register.
7. Never mount it on a wall that is exposed to heat on the other side from cooking ranges, domestic water heaters, etc.
8. Never mount it on a wall that is directly over a chimney.
9. Never mount it on a wall over a stud space in which there are concealed water, steam, or warm air conduits, and if possible avoid the stud space on either side.
10. Never mount it where the direct rays of heat from a fireplace can strike it. Select a location in a room that has no fireplace, if possible.
11. Never mount it in a concealed space, such as in an alcove or closet, nor on a wall where there is poor circulation, such as behind a door, nor in a corner.
12. Never mount it in a place where it might be close to, or over, a radio, television set, table lamp, floor lamp, or any other electrical appliance that gives off heat.

The home owner should be cautioned to keep such appliances away from the vicinity of the thermostat.

DESIGN CHARACTERISTICS OF ROOM THERMOSTATS

A light mass temperature sensitive element is desirable to adjust rapidly to temperature change. Generally two types of elements are used - bimetal type and bellows type.

The bimetal type is either of a spiral shape (see Figure 2) or leaf spring design (see Figure 3) with one contact moveable on the element and the other stationery.

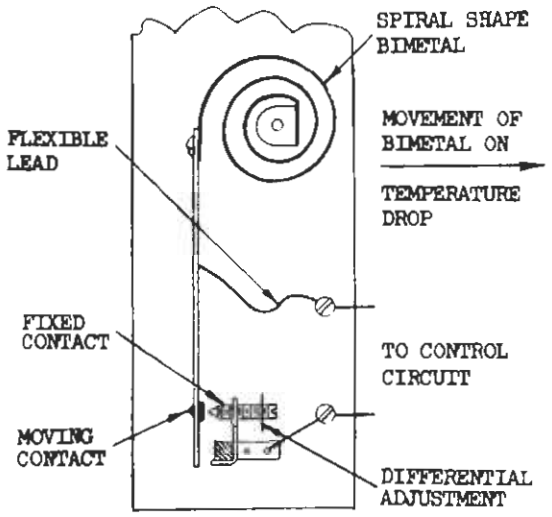

Figure 2 - Spiral Type Bimetal Thermostat

The bellows or diaphram type use the expansion of a gas or liquid to move the electrical contacts.

Snap action in the elements having button type contacts is usually provided by a small magnet strategically located to pull in or release the contact mechanism to prevent erratic operation and less wear on the contacts due to arcing.

Capsule type contacts, actuated by the movement of mercury from one end to the other by tilting of the bulb, are connected through levers to the moving elements of the thermostat.

The thermostat contacts are usually in the electrical circuit of the main control for the gas burners. The electrical circuit can be low voltage obtained through the use

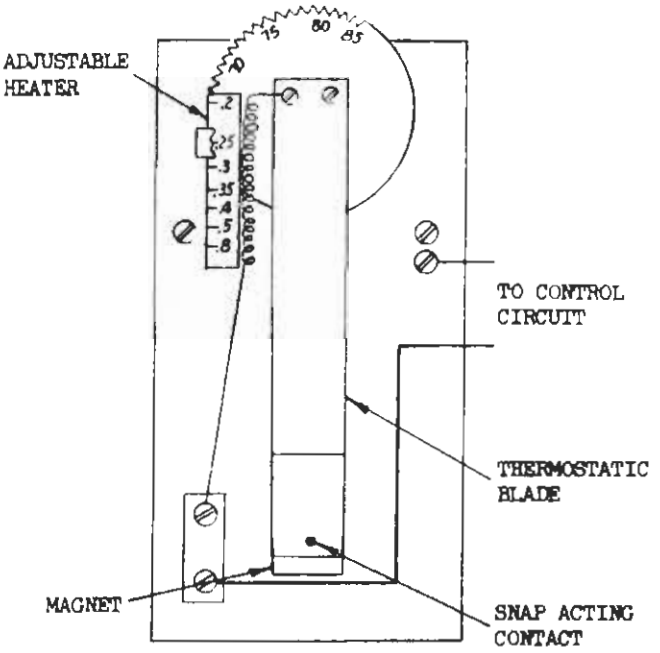

Figure 3 - Leaf Spring Type Thermostat

of a transformer or line voltage. A simple typical wiring diagram is shown in Figure 4. In the low voltage type room thermostat, compensation can be made to prevent the "flywheel" effect with heat anticipation or heater. This resistance type heater placed near the temperature responsive element biases the element with heat to override the room temperature and cause the thermostat to open its contacts just prior to the room reaching its desired temperature. Generally by this method it is easier to maintain what

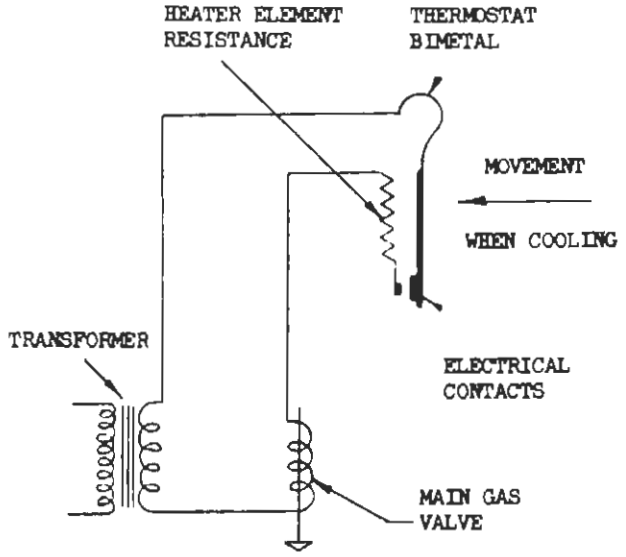

Figure 4 - Typical Wiring Diagram

is considered close to the ideal condition of 1-1/2 degree variation in room temperature. Some heaters are fixed. However, adjustable heaters in thermostats are available to give a more flexible control to room temperature.

A form of thermostat commonly known as an aquastat, is used to maintain the water temperature in hot water heating system boilers between selected limits to provide the desired temperature of the water for heating requirements. Heating requirements for the home generally govern the temperature set on hot water boilers which generally lies between 150° F and 190° F. The sensing element of the aquastat may be a bimetal, usually helical in shape, gas filled or liquid filled bulb enclosed in a water tight tube which is inserted and immersed in the water of the boiler. The common practice is to have the room thermostat control and operate the heating water circulating pump with the aquastat controlling and operating the gas burner controls of the boiler.

All thermostats are considered operating controls and must withstand frequent operation over years of use to give the homeowner satisfactory performance.

OTHER VARIATIONS OF THERMOSTATS FOR HEATING SYSTEMS

Outdoor Thermostats -

Usually used to control heating of large buildings where a single thermostat would not serve adequately. Location of the thermostat, heat anticipation, proper balancing of the heating system, and sensing duty are determining factors for proper selection of the control. The outdoor control can be used with a standard type thermostat to act as a compensation and give closer regulation to room temperatures by following changes in outdoor temperatures.

NIGHT SET BACK THERMOSTAT

Maintains a predetermined temperature during the day and another temperature, generally lower, at night. Using a clock type mechanism, the temperatures are regulated according to the time relationship by the homeowner.

TWO STAGE OR MODULATING TYPE THERMOSTATS

A temperature sensing device that controls gas burners with more than one input depending upon temperature drop in the room. The first contact will bring the burners on through a modulating type main control valve at the lowest input. As the temperature continues to drop, the control continues to operate the main control valve with each step at a higher input until the temperature begins to rise in the space being regulated.

RETURN AIR AND RETURN HOT WATER TEMPERATURE THERMOSTATS

These units sense the temperature of the air or water coming from the occupied spaces. The type is usually a liquid or gas filled bulb that is placed in the return air duct or return water pipe so that it can accurately sense the temperature in the return of the heating system.

SOME PRACTICAL DESIGN TIPS

1. Proper selection of transformer that matches voltage and power rating of the electrical circuit.
2. Proper selection of preheat to match ampere rating of the circuit to give correct heat anticipation to sensing element.
3. Proper selection of contact action to prevent erratic burner operation and low life of contacts.
4. Proper determination of heater value and bimetal characteristics to minimize "droop" effect during maximum operating period. "Droop" is the characteristic of a thermostat using a heater to control room temperatures below the temperature setting on the dial scale. The greater the heat load required, the greater the amount of "droop".
5. Since the room thermostat is the only instrument under control by the homeowner during normal operation of the equipment, it is important that its characteristics and how to operate it is clearly spelled out in the instructions given to the installer and to the user.

GAS APPLIANCE THERMOSTATS

Automatic devices designed for controlling the operation of water heaters, ranges, space heaters and clothes dryers are in the category of gas appliance thermostats and contain the thermostatic valve as an integral part of the assembly. The valve is directly or indirectly actuated by the thermal element which in turn controls the gas flow. The appliance thermostats when used on the equipment listed above shall comply with the American Standards Listing Requirements for Gas Appliance Thermostats Z21.23. These requirements represent minimum standards for the performance, safe operation, substantial and durable construction of the controls. Good design and quality of manufacture are the main determining factors for reliability and long life of the control. The current edition is Z21.23-1961.

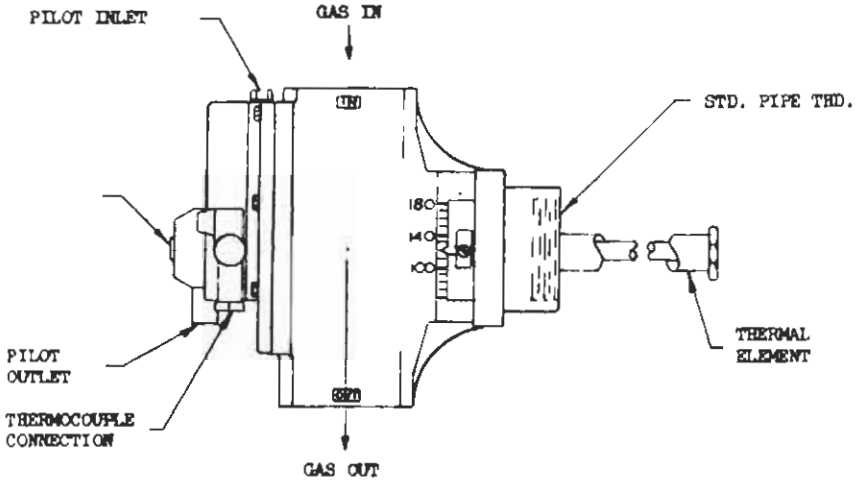

Figure 5a

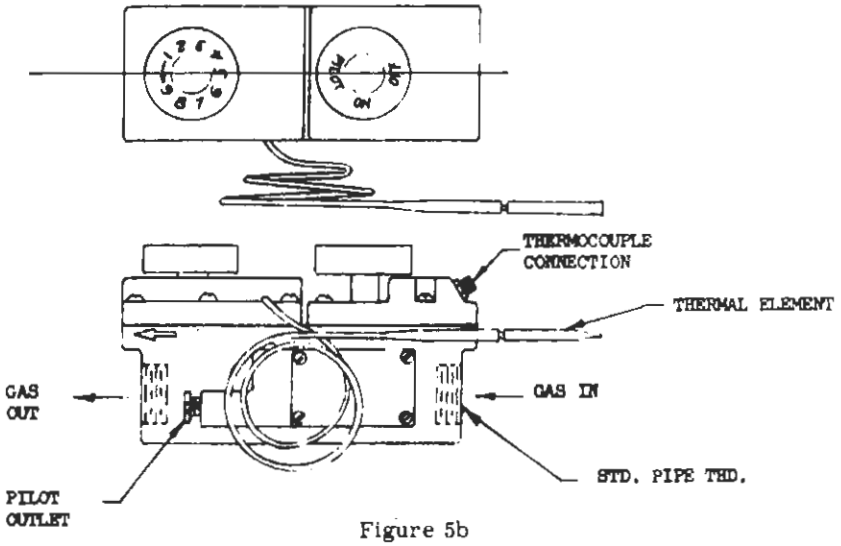

Figure 5b

Thermostatic Valves