that with very large circulating systems, it may be desirable upon occa-
sion to make the most distant flow main larger than otherwise would be
required, because of provision for the return circuit.

There are available mechanical circulation boosters with small electric
motors and loosely-fitted propellers in the hot-water mains. These pumps
will create a rapid and positive circulation of the water and are valuable
especially in correcting existing sluggish systems.

REGULATION OF WATER TEMPERATURE

The regulation of water temperature is an important problem. When
the use of water is small and infrequent, a storage tank may be used and
the heater controlled by a thermostat from the tank temperature. In
large installations, particularly where there are shower baths or other
outlets which are used steadily, adequate storage is impracticable and
the heaters should be large enough to take care of the instantaneous
demand. Where shower baths are used, it is sometimes desirable to pro-
vide, in addition to the usual thermostatic control of the water heaters, a
means for further controlling the water temperature so as to prevent acci-
dental scalding in case the regular thermostat should fail to function.
One device for this purpose is a valve which admits water from the cold
line into the hot line when required.

Chapter 20

AUTOMATIC HEAT AND HUMIDITY CONTROL

Thermostats; Temperature Control Systems; Residences; School and Church Buildings; Office Buildings; Factories; Theaters; Control of Humidity.

HEATING, ventilating and air conditioning systems usually are designed to maintain a specific temperature or relative humidity, or both, in enclosed spaces. Whenever the maximum capacity of equipment installed is not required, some method of limiting or controlling the output is desirable. This chapter contains information concerning the fundamentals governing the operation of automatic temperature and humidity control systems, as well as data relative to the various devices available for the design of such systems. The application of control to specific types of heating, ventilating and air conditioning systems is described in Chapters 7, 8, 9, 16, 17, 24 and 27.

Controls are applied for the following reasons:

1. To maintain conditions required for human comfort and efficiency.
2. To maintain conditions required for industrial processes.
3. To obtain economy in operation.
4. To provide necessary safety measures.

The proper operation of all control systems depends on the selection of the correct type of control instrument, as well as on its correct application within the complete system.

THERMOSTATS

Automatic control of temperature requires the use of an instrument known as a *thermostat* which responds to a change in temperature. Although there are many types of thermostats, the basic principles of operation of practically all types are included in the following classifications:

1. The *diaphragm* type (Fig. 1) which, by means of an expanding liquid or gas within a diaphragm or bellows, furnishes motion; and this motion may be mechanically transmitted in proportion to the rise and fall of temperatures surrounding the diaphragm.

2. The *bi-metallic* type (Fig. 2) which furnishes motion by means of intimately attached metals having dissimilar coefficients of expansion. This type is inherently more sensitive to temperature changes than the first type but lacks in force to transmit or cause motion.

3. The *direct-expansion* type (Fig. 3) which operates by direct expansion and contraction of a substance which has a high coefficient of expansion such as hard rubber. The slight movement of the thermostatic element usually must be multiplied through a system of levers.

4. The *mercury* type (Fig. 4) which usually takes the form of a standard thermometer with electric contacts carried through the glass tube at the degree points where motion