outdoor thermostat to start circulation of the water whenever the outdoor temperature drops below 35 F. A thermostat in the return water at the boiler can prevent the temperature of the water in the system from falling below 40 F during an extended shut-down of the system. This thermostat would start the burner or other heat source if the temperature of the return water dropped to 40 F.

### System Adjustment

Three methods of determining the effects of capacity adjustment are commonly used: the measurement of space temperatures by room thermometers, the determination of the temperature drop of water flowing through a heating unit or zone by means of a surface contact thermometer, or by thermometers installed in the piping. When adjustment is made by means of water temperature drop, the capacity of the units being adjusted must be closely matched to the heat delivery actually required. The adjustment is then accomplished by making the temperature drop through all units equal.

The procedure for making a permanent adjustment of heat distribution in a larger system should be as follows:

1. Select a time or day when conditions of heat gain are minimum; *i.e.*, night time or an overcast day. Outdoor temperatures should be such as to require at least 50 percent of the system capacity to maintain the design indoor temperature.
2. Place the system in operation and make certain that all valves, adjusting fittings, and dampers are in the open position. Automatic control which might reduce the flow or capacity of any unit should be rendered inoperative. Doors and openings between rooms should be closed.
3. Prepare a form for recording data on temperatures in spaces or at the supply and return of heating elements or of zones.
4. After the system has reached equilibrium a complete record should be made of temperatures throughout the system.
5. An initial adjustment of flow regulating devices in the system should be made on the basis of the record of the original readings. A new set of temperature readings should be recorded after sufficient time has been allowed to establish a new equilibrium throughout the building.
6. Continue adjustments of flow control devices until a satisfactory condition is obtained.
7. When a satisfactory adjustment has been accomplished, it is advisable to *mark the position of each of the adjusting fittings or valves*. This facilitates return to proper control settings if the flow controls are disturbed by accidental or emergency changes at any time.

### Care and Maintenance of Systems

A hot water heating system should last during the life of the building if it is designed, installed, and maintained properly. Maintenance instructions for individual elements of the system such as burners, motors, pumps, and accessories may be obtained from the manufacturers who supply this equipment. Two factors contribute in a most important way to the satisfactory operation and life of the hot water heating system: (1) the proper cleaning of the system when installed; and (2) a minimum change of water in the system, except as required by periodic maintenance of the boiler or draining of the expansion tank.

### Initial Cleaning of System

Rules that should be followed for the initial cleaning of the system are:

1. All equipment and piping should be thoroughly cleaned of iron cuttings and other refuse during assembly and installation.
2. When installation is complete, the system should be filled with a solution of 1 lb of trisodium phosphate per 50 gal of water and should be operated for 24 hr at maximum temperature with all circulating pumps operating. The system should then be drained and thoroughly flushed with water before refilling.



In order to minimize the addition of water to the heating system, the operation of air vent valves, relief valves, and the tightness of the system generally should be subject to continuous inspection. Drips from automatic air vent valves should discharge in places where leakage is readily detected. Continual operation of the pressure relief valve should be a signal for the inspection, repair, or replacement of the relief valve, or a check on the operation of the expansion tank or the automatic water feeder, if one is provided.

## HIGH TEMPERATURE WATER SYSTEM

### General Considerations

The high temperature water system is a form of conveying heat using water as the medium, at temperatures well above 212 F and usually, in current practice, between 300 and 400 F. Water being a most satisfactory heat carrier, will transport heat over long distances with comparatively small line losses and without expensive equipment to maintain or replace.

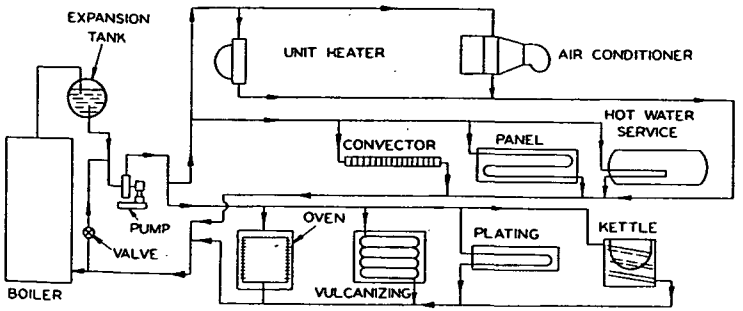



FIG. 21. SCHEMATIC ARRANGEMENT OF TYPICAL HIGH TEMPERATURE WATER SYSTEM

With high temperature water the boiler, instead of generating steam, heats the water to a specified temperature and corresponding pressure. The water thus heated is discharged under pressure from the boiler into the system through a circulating pump designed for the high temperatures involved. The water is thus circulated in a closed circuit from the central station to the extended areas requiring heat and back again to the boiler. In this way the heat, whether for space heating or process work, is distributed efficiently and economically since any heat not usefully employed in the system is returned to the boiler for reheating and redistribution. Fig. 21 illustrates an industrial application of a high temperature water system.

### Fundamental Principles

In high temperature water systems water is heated under pressure and its temperature is raised to that corresponding to the pressure imposed, which is above the evaporation point of water at atmospheric pressure. As the temperature of the water rises, the pressure in the system must also