passing warm air over the cooler basement walls and floor. In areas of high prevailing dew points, however, this practice may cause objectionable dampness to develop in the basement.

Complete summer air conditioning can be readily combined with forced warm air systems either by using factory-built units incorporating both refrigeration and heating equipment, or in *some cases* by adapting separate refrigeration equipment or well-water coils to *existing* warm air systems.

A more complete treatment of residential summer air conditioning is given in Chapter 13.

GRAVITY WARM AIR SYSTEMS

In *gravity* warm air heating systems the motive head producing flow depends upon the difference in weight between the heated air leaving the top of the furnace casing and the cooled air entering the bonnet of the casing. Hence, the motive head is very small and the system must allow free flow.

A gravity warm air furnace heating plant consists of a fuel-burning furnace or heater, enclosed in a casing of sheet metal, which is placed in the basement of the building. The heated air, taken from the bonnet on the top of the furnace casing, is distributed to the various rooms of the building through sheet-metal warm air pipes. The warm air pipes in the basement are known as leaders, and the vertical warm air pipes which are installed in the inside partitions of the building are called stacks. The heated air is discharged into the rooms through registers which are set in register boxes placed either in the floor or in the side wall, usually at or near the baseboard.

The air supply to the furnace is usually taken entirely from inside the building through one or more recirculating ducts, although in some cases an outside air supply duct is provided.

Gravity warm air heating systems may be designed[16] by following the procedures given in Manual 5 of the National Warm Air Heating and Air Conditioning Association. This publication also gives information on terminology, outlet and return locations, and standard sizes of pipe and fittings. The data underlying this information and the design procedure are given in a circular[17] issued by the University of Illinois, and are based on research conducted there.

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CHAPTER 6

STEAM HEATING SYSTEMS

Classification of Steam Heating Systems by Types; One-pipe, Two-pipe, Subatmospheric and Orifice Systems; Sizing Piping for Steam Heating Systems; Pressure-Reducing Valves; Boiler Connections; Condensate Return Pumps; Vacuum Heating Pumps; Traps; Drips; Connections to Heating Units; Control Valves

STEAM heating systems may be classified according to any one of, or combination of, the following features: (1) piping arrangement, (2) pressure or vacuum conditions obtained in operation, (3) method of returning condensate to the boiler.

Classification by Piping Arrangement

A steam heating system is known as a *one-pipe system* when a single main serves the dual purpose of supplying steam to the heating unit and conveying condensate from it. Ordinarily, to each heating unit there is but one connection which must serve as both the supply and the return, although separate supply and return connections may be used.

A steam heating system is known as a *two-pipe system* when each heating unit is provided with two piping connections, and when steam and condensate flow in separate mains and branches.

Heating systems may also be described as *up-flow* or *down-flow*, depending on the direction of steam flow in the risers; and as a *dry-return* or a *wet-return*, depending on whether the condensate mains are above or below the water line of the boiler or condensate receiver.

Classification by Pressure or Vacuum Conditions

Steam heating systems may also be classified as *high-pressure, low-pressure, vapor*, and *vacuum* systems, depending on the pressure conditions under which the system is designed to operate.

A system is known as a *high-pressure system* when the operating pressures employed are above 15 psig; as a *low-pressure system* when pressures vary from 0 to 15 psig; as a *vapor system* when the system operates under both vacuum and low-pressure conditions without the use of a vacuum pump; and as a *vacuum system* when the system operates under vacuum and low-pressure conditions with the use of vacuum pump.

When automatic controls are employed to vary the pressure conditions in the system in accordance with outside weather conditions, the system may be known as a *subatmospheric, differential,* or *synchronized* system. These latter classifications are proprietary designations.

When orifices are employed on the inlets to the heating units the system may be known as an *orifice system.*

Classification by Method of Returning Condensate

When condensate is returned to the boiler by gravity, the system is known as a *gravity return system.* In this system all heating units must be elevated sufficiently above the water line of the boiler, so that the condensate can flow freely to the boiler. Elevation of the heating units above the water line must therefore be sufficient to overcome pressure drops due to flow, as well as pressure differences due to operation.

Referring to Fig. 1 it will be noted that the boiler and wet-return form a U-shaped container, with the boiler steam pressure on the top of the water at one end, and the steam main pressure on the top of the water at the other end. The difference between these two pressures is the *pressure drop* in the system, i.e., the friction and resistance to the flow of steam in passing from the boiler to the far end of the main, and the pressure reduction in consequence of the condensation occurring in the system. The water in the far end will rise sufficiently to overcome this difference in order to balance the pressures, and it will rise far enough to produce a flow through the return pipe and overcome the resistance of check valves, if installed.

If a one-pipe steam system is designed, for example, for a total pressure drop of 1/8 psi, and utilizes a Hartford return connection instead of a check valve on the return, the rise in the water level at the far end of the return, due to the difference in steam pressure, would be 1/8 of 28 in. (28-in. head being equal to one pound per square inch), or 3½ in. Adding 3 in. to overcome the resistance of the return main, and 6 in. as a factor of safety for heating up, gives 12½ in. as the distance the bottom of the lowest part of the steam main and all heating units must be above the boiler water line. The same system, however, installed and sized for a total pressure drop of ½ psi, and with a check valve in the return, would require ½ of 28 in., or 14 in. for the difference in steam pressure, 3 in. for the flow through the return, 4 in. to operate the check valve, and 6 in. for a factor of safety, making a total of 27 in. as the required distance. Higher pressure drops would increase the distance accordingly.

When conditions are such that condensate cannot be returned to the boiler by the action of gravity, and either traps or pumps must be employed, the system is known as a *mechanical return system.* There are three general types of

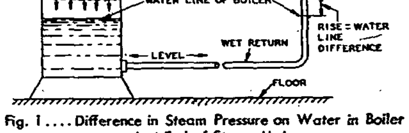

Fig. 1 . . . . Difference in Steam Pressure on Water in Boiler and at End of Steam Main