the need for a duct to bring the warm air down from the top of the furnace, or a duct to bring the return air down to the blower inlet.

Several arrangements of perimeter ducts may be used to heat slabs on ground construction, but the most common is the type having a complete loop of a continuous duct around the edge of the slab, supplied by radial feeders extending from the furnace sub-floor plenum to the perimeter duct. A schematic cross-section of the slab construction, with the perimeter duct installed, is shown in Fig. 5.

The slab should be constructed on a well-drained site where drainage is away from the slab, and where there is no standing water at any time of the year. With slab construction, a suitable porous fill and a waterproof membrane as a moisture barrier beneath the slab are required by the *Federal Housing Administration*. They are highly necessary with warm air perimeter heating. Insulation must be placed between the edge of the slab and the foundation, and must extend completely around the slab to reduce the heat losses from the edge of the slab. Fig. 5 also shows many of the essential features of the slab and under-slab construction.

SUMMER OPERATION

During hot summer periods a slight cooling effect may sometimes be obtained by the circulation of basement air through the system. This beneficial effect is due to both the increased air movement in the occupied spaces and the small reduction in dry-bulb temperature brought about by 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 50.

REFERENCES

[1] A Yardstick for Classifying Warm Air Winter Air Conditioning Systems (*National Warm Air Heating and Air Conditioning Association*, Manual 8, 1948).

[2] Performance of a Forced Warm-Air Heating System as Affected by Changes in Volume and Temperature of Air Recirculated, by A. P. Kratz and S. Konzo (A.S.H.V.E. TRANSACTIONS, Vol. 48, 1942, p. 393).

[3] Code and Manual for the Design and Installation of Warm Air Winter Air Conditioning Systems (*National Warm Air Heating and Air Conditioning Association*, Manual 7, Fourth Edition, 1953).

[4] Proposed Design Procedure for Large Mechanical Warm Air Heating Systems, by S. Konzo, R. J. Martin, D. S. Levinson, and R. W. Roose (A.S.H.V.E. TRANSACTIONS, Vol. 53, 1947, p. 177).

[5] Code and Manual for the Design and Installation of Large Warm Air Winter Air Conditioning Systems (*National Warm Air Heating and Air Conditioning Association*, Manual 9, Fourth Edition, 1950).

[6] Automatic Controls for Forced-Air Heating Systems, by S. Konzo and A. F. Hubbard (A.S.H.V.E TRANSACTIONS, Vol. 40, 1934, p. 37).

[7] Service Manual for Continuous Air Circulation Technicians (*National Warm Air Heating and Air Conditioning Association*, Manual 6, First Edition, 1947).

[8] Code and Manual for the Design and Installation of Warm Air Ceiling Panel Systems (*National Warm Air Heating and Air Conditioning Association*, Manual 7-A, Third Edition, 1950).

[9] Warm-Air Perimeter Heating (*National Warm Air Heating and Air Conditioning Association*, Manual 4, Third Edition, 1953).

[10] Small Pipe Warm Air Perimeter Heating (*National Warm Air Heating and Air Conditioning Association*, Tentative Manual 10, Second Edition, 1953).

[11] Work Sheets for Warm-Air Perimeter Systems (*National Warm Air Heating and Air Conditioning Association*, Forms 41a, 41b, 42, 43 and 45).

CHAPTER 21

STEAM HEATING SYSTEMS

Classification of Steam Heating Systems by Types; One-pipe; Two-pipe, Sub-atmospheric 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.

1. *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.

2. *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 *sub-atmospheric*, *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*.

3. *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 ½ psi, and utilizes a Hartford return connection instead of a check valve on the return,