extended plenum connection and allow the equivalent length of one 90-deg elbow. To size the extended plenum, start with a trunk of standard 8-in. depth and the rectangular equivalent of the last branch, and then, proceeding toward the furnace, increase the width of the trunk according to Table 9 for each succeeding branch connected until all branches on that trunk have been considered and the width of the trunk required has been determined.

Follow the same procedure for each trunk. The largest size so determined is selected as the size of the extended plenum for the system.

Return air intakes are to be sized by the same method as for conventional gravity systems.

TABLE 9. RECTANGULAR EQUIVALENTS OF ROUND PIPE AND INCREASE IN WIDTH OF 8-IN. DEPTH EXTENDED PLENUM

Commercial Round Pipe Diameter Inches	Equivalent Rectangular Duct Size Inches	Increase in Width of Trunk Duct Having 8-In. Depth Inches
5	3 x 8	1
6	4 x 8	2
7	5 x 8	3
8	7 x 8	5
9	8 x 8	5
10	11 x 8	8
12	15 x 8	12

Design Examples

Examples 1 and 2 will illustrate the use of the tables in selecting warm-air and return-air system sizes.

Example 1: For a room which has a heat loss of 22,500 Btu per hr, select the size of first story warm-air system. There are three elbows, and the leader is approximately 10 ft long.

Solution: Since 22,500 Btu is beyond the capacities shown in Table 6, it is necessary to select two units of 11,250 each. From Table 6 in 10 ft leader column, and in section for three elbows, find 11,400 as nearest capacity which corresponds to Combination Number 4 in first column. Refer to Combination Number 4 in Table 1 and find that the leader should be 12 in. in diameter, and should be used with a 12 × 14 in. floor register or a 13 × 11 in. baseboard register with a 5½ in. extension.

Example 2: What is the size of a return-air system of Type D which is to service 35,000 Btu per hr?

Solution: From Table 8 find Combination Number 37 which will service 37,800 Btu per hr. Refer to Table 4 to find that Combination Number 37 will require a 22-in. diameter duct, a shoe area of 420 sq in., a metal grille 18 × 30 in., a duct 42 × 10 in. or 36 × 12 in. If joist lining is used the minimum depth should be 15 in. for two 2-joist spaces 14 in. wide, or 10 in. for three joist spaces.

REFERENCES

[1] The engineering data were obtained from *University of Illinois, Engineering Experiment Station Bulletins* Nos. 141, 188, 189 and 246; Warm Air Furnaces and Heating Systems, by A. C. Willard, A. P. Kratz, V. S. Day, and S. Konzo. See also Manual 5: Gravity Code and Manual for the Design and Installation of Gravity Warm Air Heating Systems, 4th Edition, 1950, published by the *National Warm Air Heating and Air Conditioning Association*.

[2] Simplified Procedure for Selecting Capacities of Duct Systems for Gravity Warm Air Heating Plants, by A. P. Kratz and S. Konzo (*University of Illinois, Engineering Experiment Station Circular* 45, Dec., 1942).

[3] Gravity Code and Manual for the Design and Installation of Gravity Warm Air Heating Systems, Manual 5, 4th Edition, 1950, (*National Warm Air Heating and Air Conditioning Association*).

CHAPTER 20

FORCED WARM AIR SYSTEMS

Air Distribution, Standard Combinations of Parts, Simplified Method of Design, Design Procedure for Large Systems, Automatic Controls, Adjustment of System for Continuous Air Circulation, Ceiling Panel Systems, Perimeter Systems, Cooling Methods, Design of Cooling System

IN forced warm air or fan furnace heating systems, the air circulation is effected by motor-driven centrifugal fans, commonly referred to as blowers. The advantages of forced air systems, as compared with gravity systems, are:

1. The furnace need not be centrally located but may be placed in any part of the basement.

2. Basement distribution ducts can be made smaller and can be so installed as to give full head room in all parts of the average basement, or be completely concealed from view where desired.

3. Circulation of air is positive, and in a properly designed system, can be balanced in such a way as to give a greater uniformity of temperature distribution.

4. Humidity control is more readily attained.

5. The air may be cleaned by sprays or filters, or both.

6. The fan and duct equipment may be utilized for a complete cooling and dehumidifying system for summer, using either ice, mechanical refrigeration, or low temperature water for cooling and dehumidifying, or adsorbers for dehumidifying.

7. The use of the fan increases the volume of air which can be handled, thereby increasing the rate of heat extraction from a given amount of heating surface and insuring sufficient air volume to obtain proper distribution in a large room.

8. Ventilation air may be positively introduced and heated.

The construction features of forced warm air furnace units and the function and selection of the various parts of a system are discussed in Chapter 15 and other publications.[1]

AIR DISTRIBUTION

The conditions of comfort obtained in a room are influenced greatly by the type of register used, and the locations of the supply registers and return grilles. In general it has been found that changes in the type, air velocity, and location of the supply register affect the room conditions much more than the changes in the location of the return grilles. One method is to locate the supply register near the floor, or high in the side wall, so that the warm air from the register *blankets* a cold wall, and mixes with the cold air descending from the exposed walls and glass. Another method is to locate the supply openings near the floor, or high in the side wall, on the inside wall, and the return openings near the greatest outside exposure. Still another method is to locate all supply openings around the outside wall, near the source of the greatest heat loss, usually beneath the windows, and to use grilles designed to blanket the cold area. This causes mixing of the warm air delivered with the cool air from the heat loss area and the