Table 2. Return-Air Duct System Combinations of Parts Selected as Standard

Combination No.	Return-Air Intake Size, In.		Riser Size, In. Where Stack Is Used in Stud Space	Branch Pipe Size, In.		When Joist Lining Is Used[b] Number of Joist Spaces Lined and Minimum Depth of Space Required	Required Increase in Width of Trunk Duct (for 8 In. Depth of Duct), In.
	Baseboard	Floor[a]		Round	Rectangular		
1	2	3	4	5	6	7	8
51	10 x 6	6 x 10 or 4 x 14	10 x 3¼[c]	6	4 x 8	1 space of 3 in. depth	1
52	10 x 6	6 x 10 or 4 x 14	10 x 3¼[c]	6	4 x 8	1 space of 3 in. depth	2
53	12 x 6	6 x 12 or 6 x 14	12 x 3¼[d]	7	5 x 8	1 space of 4 in. depth	3
54	14 x 6	6 x 14	14 x 3¼[d]	8	6 x 8	1 space of 5 in. depth	4
55	24 x 6 or 30 x 6	6 x 30	Two stacks each 10 x 3¼[c]	9	8 x 8	1 space of 6 in. depth or 2 spaces of 3 in. depth	5
56	30 x 6	6 x 30	Two stacks 12 x 3¼[d]	10	10 x 8	1 space of 7 in. depth or 2 spaces of 4 in. depth	7
57	—	8 x 30	—	12	15 x 8	1 space of 9 in. depth or 2 spaces of 5 in. depth	12

[a] Use these items only when building construction, or capacities, require the use of floor intakes. The sizes listed correspond to standard sizes for gravity installations, except floor box collars. The use of standard blind boxes is suggested.

[b] Based on 14 in. space between joists. Use full depth of joist, except when joist depth is less than minimum depth required, in which case a *drop pan must be used*. This may occur when two or more return ducts are connected to the same joist space.

[c] If it is desired to use 14 in. x 3¼ in. stud space, it makes no difference whether this space has protruding keys or not.

[d] If it is desired to use 14 in. x 3¼ in. stud space, the plaster base must be smooth, without any protruding plaster keys to interfere with the flow of air.

STANDARD COMBINATIONS OF PARTS

The combinations of parts selected as standard by the *National Warm Air Heating and Air Conditioning Association* are shown in Tables 1 and 2. A method for selecting these combinations is indicated in the following section *Simplified Method of Design*.

SIMPLIFIED METHOD OF DESIGN

A simplified method for selecting the combinations of branches, boots, stacks, and registers, is given in Manual 7 of the *National Warm Air Heating and Air Conditioning Association*. In this method the sizes of the branch ducts are obtained from two tables giving their Btu capacities. The proper combination of parts for each branch can be determined if the following information is available.

a. Location of room, that is, whether on first or second story.

b. Actual length of duct from bonnet to boot, in feet.

c. Btu loss from room to be heated.

d. Equivalent lengths in feet of all fittings and of the register. Fig. 3 shows the values of equivalent lengths of fittings commonly used for domestic systems.

This simplified method is applicable to structures having heat losses not in excess of approximately 120,000 Btu per hour. The capacities shown in Tables 3 and 4 are based upon the most reliable data pertaining to friction losses and temperature drops in ducts. They are also based upon a 100 deg temperature rise of the air, and a static pressure available for overcoming friction losses in the external duct system alone of 0.20 in. water gage. The use of this method assumes that the fan in the fan-furnace assembly will be capable not only of overcoming the resistance of the external duct system alone, but also the resistances imposed by the blower inlet, the filter, and the furnace casing. The combination numbers shown in the right hand column of Tables 3 and 4 correspond to those given in Tables 1 and 2. Tables 3 and 4 are also applicable for the selection of the return air branches. A depth of 8 in. has been adopted as the standard for the trunk ducts. The width of a trunk duct serving two branches is determined by adding to the width of the remote branch the value shown in column 7 of Table 1, or column 8 of Table 2.

AUTOMATIC CONTROLS

Air stratification, high bonnet temperatures, excessive flue gas temperatures, and heat overrun or lag in a properly designed system can be largely eliminated through proper care in the planning and installation of the control system[3]; desirable controls usually employed are:

1. A *thermostat* located in a living room where maximum fluctuation in temperature can be expected, in order to secure frequent operation of fans, drafts, and burners. The thermostat location should not be on an outside wall, in a bedroom, bathroom or sun room, or in a location where it will be affected by direct radiant heat from the sun or from a fireplace, or by direct heat from any warm air duct, register or chimney.
2. A *fan switch* control located in the bonnet to start blower operations at temperatures between 110 and 130 F, and to stop the blower at about 25 to 30 deg below the cut-in point. The lower settings are used for high side wall register installations, and the higher settings for baseboard register installations. For most satisfactory results these settings should be as low as is feasible.
3. A *protective high limit switch* located in the bonnet to stop the system independently of the thermostat if the bonnet temperature exceeds 175 F.
4. On oil and gas burner installations, a protective control should be included which will stop the system if the fire is extinguished or if there is a failure of the ignition system.
5. On automatic stoker installations, a control is usually included which will start the operation regardless of thermostat settings whenever the bonnet temperature indicates that the fire is dying, or a time interval contactor is used that will start the stoker to run a few minutes out of each hour.
6. A *humidistat* to regulate the moisture supplied to the rooms, located either in one of the rooms or in the main return duct near the furnace.

DESIGN PROCEDURE FOR LARGE SYSTEMS[4]

For buildings having a heat loss in excess of 120,000 Btu per hour the design procedure given in Manual 9 of the *N.W.A.H. & A.C.A.*, may be used except where ventilation air volume exceeds volume required to supply calculated heat loss. This procedure consists of:

1. Calculation of design heat losses from individual spaces in the structure. (See Chapter 11).