prevent drafts. When long ducts of this type are employed they must be made oversize and favored in every way. This precaution is particularly important when long ducts and short ducts are used in the same system. The long ducts must be oversize, if they are to operate satisfactorily in parallel with short ducts.

Return ducts from upstairs rooms may be necessary in apartments or other spaces closed off or badly exposed. Metal linings are advisable in such ducts. It is important that these ducts be free from unnecessary

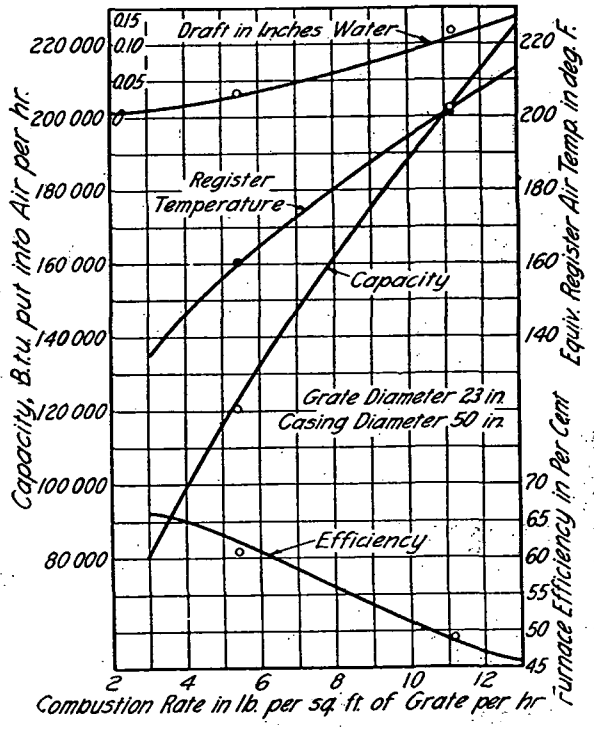

FIG. 6. TYPICAL PERFORMANCE CURVES FOR A WARM AIR FURNACE AND INSTALLATION IN A THREE-STORY TEN LEADER PLANT, OPERATING ON RECIRCULATED AIR

friction and turbulence, and that they be located to prevent preheating of the air before it reaches the furnace.

Return Connection to Furnace

Circulation is accelerated if the drop to the furnace is through a round inclined pipe with, say, two 45-deg elbows rather than through a vertical drop and two 90-deg elbows. The top of the shoe should never enter the casing above the level of the grate in the furnace. To accomplish this the shoe must be wide.

Tests of six different systems of cold air returns, Fig. 7, made at the University of Illinois,[1] resulted in the following conclusions:

1. In general, somewhat better room temperature conditions may be obtained by returning the air from positions near the cold walls.

2. Friction and turbulence in elaborate return duct systems retard the flow of air, and may seriously reduce furnace efficiency, and lessen the advantages of such a design.

3. The cross-sectional duct-area is not the only measure of effectiveness. Friction and turbulence may operate to make the air flow out of all proportion to the various duct areas.

SIZE OF FURNACE

The size of furnace should, of course, be such as will provide the necessary air heating capacity, usually expressed in square inches of leader pipe area, and at the same time provide a grate of the proper

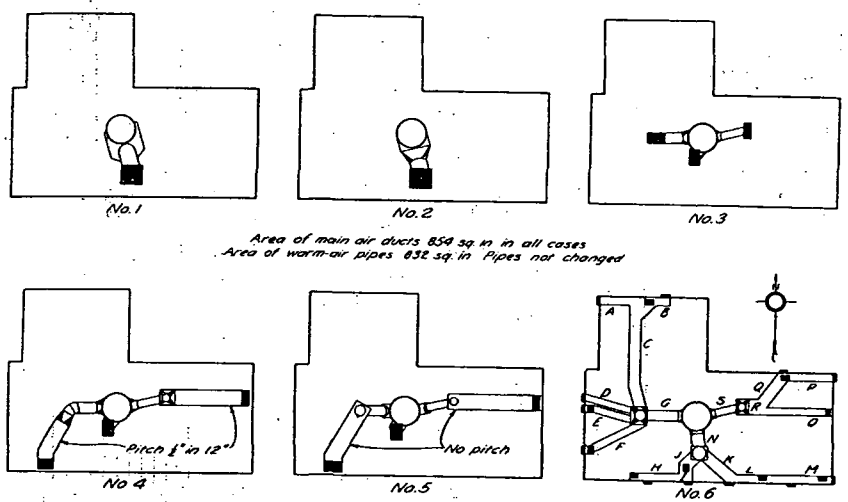

FIG. 7. ARRANGEMENT OF COLD AIR RETURNS FOR THE SIX INSTALLATIONS

area to burn the necessary fuel at a reasonable chimney draft. The total leader pipe area required is easily obtained by finding the sum of the leader pipe areas as already designated.

The grate area will depend on several factors of which four are very important. First of all, the air temperature at the register for which the plant has been designed must be determined. Usually, this temperature is taken as 175 F. Second in importance is the combustion rate, *which must always correspond with the register air temperature*, as is shown by reference to a set of typical furnace performance curves (Fig. 6) for a cast-iron circular radiator furnace with a 23-in. diameter grate and 50-in. diameter casing. The conditions shown on these curves which seem to

[1] *Investigation of Warm-Air Furnaces and Heating Systems*, Part N, by A. C. Willard, A. P. Kratz and V. S. Day (Engineering Experiment Station, *University of Illinois, Bulletin* 189).