

board or floor type with the former location preferred. No first floor register should require a register box more than 14 in. wide, although it may be longer than 14 in.

### AIR SUPPLY DUCTS

Ducts for recirculating air from the house or for bringing in outside air should be as short and direct as possible. The areas of such ducts should never be less than the combined areas of all warm-air leaders and ducts of the recirculating type may be made even larger than the total leader area. The importance of running the air supply ducts as direct

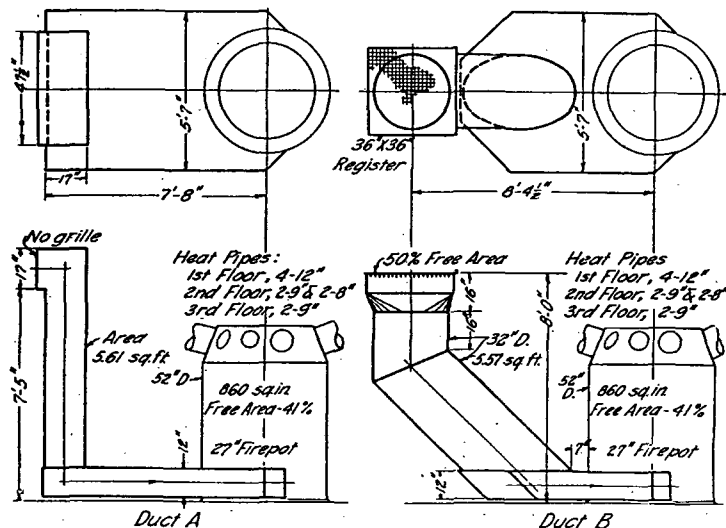


FIG. 53. TWO TYPES OF RECIRCULATING DUCT TESTED

as possible without sharp elbows is shown by the comparative performance on the same plant of two ducts (Fig. 53), as presented in Table 81.

In both cases a very wide low shoe was used for connecting the ducts to the back of the furnace casing. The top of this shoe should never enter the casing above the level of the grate in the furnace, and to accomplish this the shoe must be wide. The superior performance of

TABLE 81. HEAT AVAILABLE AT REGISTERS FOR TWO TYPES OF RECIRCULATING DUCTS

| REGISTER<br>AIR TEMPERATURE<br>DEG. FAHR. | HEAT AVAILABLE AT REGISTERS ABOVE<br>70 DEG. FAHR. B.T.U. PER HR. |            | PER CENT INCREASE<br>FOR ROUND DUCT |
|-------------------------------------------|-------------------------------------------------------------------|------------|-------------------------------------|
|                                           | Rectangular Duct                                                  | Round Duct |                                     |
| 130 (Low)                                 | 47,000                                                            | 54,000     | 15.0                                |
| 160 (Moderate)                            | 81,000                                                            | 94,000     | 16.0                                |
| 190 (High)                                | 120,000                                                           | 138,000    | 15.0                                |

the round duct using two 45 deg. instead of two 90 deg. elbows is very apparent. Values given in Fig. 48 are based on such a duct. Outside duct connections, if used, should be made to a window frame the full area of duct and such window should be in a wall exposed to prevailing winter winds. The inside type of recirculating duct or ducts is always preferred for residence installations.

### RECIRCULATING REGISTERS

The register through which the air in the building is returned to the furnace should always be placed in a central position in the first floor, usually in the main hall if one exists. Air from the upper floors must have free access to this register through the stairway of the building. Sometimes more than one return air register is found desirable, and such multiple returns are often justified. The recirculating registers should have a free area at least equal to the duct to which they connect, and their free area should never be less than 50 per cent of their gross area.

### 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 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 deg. fahr. 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. 54) 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 approximate nearest to the 175 deg. register warm-air temperature are—combustion rate 7 lb., warm-air register temperature 173 deg., efficiency of the furnace 58.5 per cent. The third factor is efficiency, which, in turn, is a function of the combustion rate varying with it as shown by the efficiency curve of Fig. 54. The fourth factor is the heat value per pound of fuel burned, which was 12,790 B.t.u., but is not shown on the curves since it was constant for all combustion rates.

From the relation existing between these factors it is found (Fig. 54) that the capacity of the furnace under test is 147,750 B.t.u. per hour for the total grate, which gives the capacity at the furnace bonnet per square foot of grate as 51,300 B.t.u. and per square inch of grate as 356 B.t.u. per hour.

Suppose it is desired to select a furnace to deliver air to the rooms at a register temperature approximating 160 deg. rather than 175 deg. Referring to the curves, the relation is—combustion rate 5.5 lb., register warm air temperature 160 deg. and efficiency of the furnace 62 per cent.