d. Where one warm-air register face is used and separate face or faces for cold air supply are used, then Art. 4, Secs. 5, 7 and 8 shall apply.

ARTICLE No. 5.—Provisions to be made in Buildings under Construction for Reception of Gravity Warm Air Heating Systems

a. The following provisions shall be made by the owner or building contractor, in any building wherein a gravity warm-air heating system is to be installed.

b. Where warm-air register boxes, heads, pipes or stacks are to be installed, joists shall be set not less than sixteen inches (16″) on centers and shall be butted and not lapped. Studding shall be set directly over and under joists, leaving a space of not less than fourteen inches (14″) between studs and joists. Wherever joists are cut, headers must be put in to support joists.

c. All first story single or sub-floors shall be continuous. In all houses having studded exterior walls, these floors shall be extended to the outside sheathing and all spaces between studding shall be closed at the attic line.

Note 9.—It is strongly recommended that the attic be tightly floored or ceilings insulated to reduce heat losses.

d. All partition walls (or sections of these walls) in which heat stacks to second or third floor rooms are to be installed, shall be of sufficient size to accommodate stacks required to heat said rooms.

FORCED OR BOOSTER CIRCULATION

Results obtained in practice, as well as in Laboratory tests, indicate that the capacity and efficiency of furnaces may be raised by the use of fans to increase the velocity of flow over the heating surfaces. The question of how much air may be forced through the furnace, without the added requirements of baffles or deflectors, before the air flows through insufficiently heated has not been determined.

Experiments at the University of Illinois[4] have shown that the capacity of a furnace may be increased nearly three times by an adequate fan, with a constant register or delivery temperature maintained, *provided that the rate of fuel consumption can be increased to provide the necessary heat.* In other words the capacity of a forced circulation system *is limited by the ability of the chimney to produce a sufficient draft.*

Several types of "booster" fan equipment, all intended to stimulate flow over the heating surfaces, are available. It is essential for obtaining increased furnace efficiency that all such devices be capable of increasing the quantity of air flowing above that flowing by gravity.

Fans of this type run at constant speeds and outputs and it is therefore inevitable that the full advantages of forced circulation with proper regulation of air delivery cannot be obtained. As a result the booster equipment is most effective in increasing efficiency at low operating temperatures. According to tests, efficiencies may be advanced from 60 per cent for gravity to 70 per cent with boosters at low operating temperatures, but at high operating temperatures gravity and booster efficiencies are almost identical.[5]

In selecting booster equipment it is important that the frictional losses and static head, against which the fan must operate, be determined and units of adequate capacity be used.

[4]See University of Ill. Eng. Exp. Sta. Bul. 120, p. 129.
[5]See Univ. of Ill. Eng. Exp. Sta. Bul. 141, p. 79.

CHAPTER IX

FAN FURNACE HEATING

Data on Furnace Performance, Temperatures and Velocity of Air, Ratings, Duct Systems.

THIS chapter covers that field of warm-air heating and ventilating in which the air is warmed by direct transmission heaters and the air circulation is maintained at all times during heating periods by means of blowers. Designated, the fan-furnace system, it is strictly mechanical and is comparable to the common steam blast system. For data on booster fans in conjunction with gravity warm-air furnaces (See Chapter VIII) and for direct-fired unit heaters (See Chapter X).

The fan-furnace system of heating provides a positive circulation of either outside air or return air over direct transmission heaters, through ducts to various rooms in the building and thence to the atmosphere by exhaust or back to the fan for recirculation. The use of fans permits warm-air heating and ventilation to be easily provided in larger buildings than could be properly handled by gravity means.

When first introduced, fans were used with the existing gravity furnaces, but gradually the practice developed of building heaters particularly designed for fan service. Due to the fact that the fan could be made to deliver any given volume of air against higher resistances, the free area through the fan duty heaters was reduced by interposing more heating surface in the path of the air and creating a more intimate contact between the air and the heating surface.

Fan furnaces must be designed to secure this increased heating surface, fire travel and grate area within economical space limits. Many of the heaters of larger capacity are designed horizontally to secure these features and to properly care for expansion and contraction.

A furnace system affords a direct transfer of heat from fuel to air, has few parts, gives quick response with high temperatures and contains no water to scale, corrode or freeze.

HEATER ARRANGEMENT

Any number of furnaces can be set in battery; all to be enclosed by an outer casing consisting of either brick or insulated metal. This casing provides space under the heaters for air supply and forms a plenum space above furnaces from which ducts lead to space requiring heat.

The fan is preferably placed at the rear of the heaters to secure equal air distribution over heating surfaces. It is considered best practice to

Material for this Chapter prepared especially for THE GUIDE by the following committee: J. H. Kitchen, *chairman;* Bert C. Davis, Lloyd Howell, E. B. Langenberg and J. C. Miles.