c. The furnace flue must have no other opening for attaching any fireplace, furnace, stove, range, water heater, gas or ventilating connection. The chimney thimble shall be furnished and installed by owner or building contractor, of the size and in the location specified by the Heating Contractor.

d. If necessary to offset the flue, it must be done in such a manner as not to reduce the cross sectional area or create a ledge or obstruction, where loose material may lodge.

e. The narrowest internal dimension shall be not less than eight inches (8″) and no flue smaller than eight by eight inches (8″ x 8″) rectangular or eight inches (8″) diameter round will be considered suitable when hard coal is to be burned, or eight by twelve inches (8″ x 12″) rectangular or ten inches (10″) round for soft coal or wood.

Note 9.—It is strongly recommended that nothing less than 8 x 12 in. internal dimensions be used in any case.

Note 10.—It is recommended that the height above the furnace grate be not less than 26 ft.

Note 11.—It is strongly recommended that all new chimneys be built in strict accordance with the ordinance recommended by the *National Board of Fire Underwriters.*

Furnace Foundation

f. Furnace foundation of brick, cement, or other like incombustible material must be provided. Said foundation shall extend at least fifteen inches (15″) at rear and sides of furnace casing and at least thirty-six inches (36″) in front of furnace casing. Foundation to be level. (See Art. 4, Sec. 2).

Building

g. 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.

h. 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 12.—It is strongly recommended that the attic be tightly floored or ceilings insulated to reduce heat losses.

i. 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

Experiments at the University of Illinois[5] 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.*

Booster fans often may be arranged to operate when the gas and oil burners operate and to stop automatically when the burners shut down. The booster equipment is most effective in increasing output 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.[6]

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

CHAPTER 6

HEATING WITH WARM AIR FURNACES BY FAN PRESSURE

Fan-Furnace Systems for Large and Small Buildings; Ratings, Design, Selection and Arrangement of Heaters; Fuel.

THE fan-furnace heating system described in this chapter is fundamentally a warm-air system in which the air circulation is maintained by means of fans during the period heat is required. For data on booster fans in connection with gravity furnaces, see Chapter 5. For data on direct-fired fan-furnace unit heaters, see Chapter 9.

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 ventilating easily to be provided in buildings larger than those which could be handled properly by gravity alone.

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

Furnaces for use with fans must be designed to secure this increased heating surface, with proper fire travel and with commensurate grate area, within economical space limits. Many of the heaters of larger capacity are designed with horizontal travel of the products of combustion to secure these features and properly to care for expansion and contraction.

A fan-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.

Heaters for fan-furnace systems usually are made of cast iron or of steel. The cast-iron furnaces are made in sections which are cemented and then bolted together on the job, and the steel furnaces are assembled with welded or riveted joints.