The majority of installations today are using the motor driven forced draft blowers of the direct connected type. The variable speed type permits of a flexible control over the fires. A regulating device conveniently located at the boiler front can be adjusted from time to time to correspond to the prevailing thickness of fire bed rather than have the fireman go some distance to adjust the draft.

Enclosed types of motors are preferable, in order to reduce the wear on the bearings and brushes.

Where high pressure steam is available, there is an advantage in either steam engine or turbine driven units, if the exhaust steam can be led into the feed water heaters or steam heating system.

Forced draft blowers may be put in individually, one for each boiler or in multiples. The controlling of the motors may be either manual or automatic. In the case of the latter a pressure regulator from the main steam header is connected electrically in relay to a magnetic switch of sufficient capacity to carry the forced draft unit.

For small forced draft installations using the fine grades of Buckwheat coal, this applies more particularly to house heating, schools, etc., the accompanying Table 3 (based on 40 c.f.m. per square foot of grate) and Tables 4 and 5 are convenient to use.

A satisfactory arrangement, for such units, is to connect the blower discharge to the ashpit by means of a blast gate and control it in parallel with the stack damper. A room thermostat, preferably placed in the living quarters regulates the blast of air by cutting in and out the blower simultaneously as the thermostat calls for more or less heat from the boiler. In order to compensate for the time element between the generation of heat in the boiler and its delivery to the radiation in the living quarters, there should be a device such as a pressurestat or aquastat on the boiler proper in order to limit the top pressure or temperature of the boiler by cutting out the blower when it reaches that limit irrespective of the room thermostat referred to previously.

INDUCED DRAFT

Induced draft may be used where the stack, boiler and furnace resistance are such that the average stack becomes overloaded for a given rating on the boiler. The induced draft fan might then be placed near the base of the stack for handling smoke and gases leaving the furnace, whereupon a high stack would not be needed, the necessary draft being created by the fan. Induced draft fans should not create an excessive vacuum through the fuel bed as this increases the air leakage through the breeching and stack causing unnecessary heat loss. In the larger boiler plants where economizers and air preheaters are used, the duty placed upon the chimney becomes very great and, particularly where boilers are being operated at a high percentage of over rating, the induced draft fan becomes a desirable part of the plant equipment. The induced draft fan has to handle a large volume of air at a high temperature and for stack gas at 550 deg. temperature which is an average figure, there will be required approximately 40 cu. ft. per minute per boiler hp. to be handled, allowing 100 per cent excess air for hand fired installations. In case of stoker fired furnaces not over 50 per cent excess air is calculated.

CHAPTER VIII

GRAVITY WARM-AIR FURNACE HEATING

Data on Furnaces, Leader Sizes, Stack Sizes, Air Temperatures, Register Sizes and Locations, Recirculation, Layouts, Standard Installation Code.

HEATING WITH AIR

THERE are several typical systems of warm-air heating in common use today. An analysis of the systems mentioned in the following list will show that warm air may be employed as the heating medium in almost all types of heating requirements: (1) Gravity warm-air furnace systems, with or without booster fans for forced circulation and combination air and water systems for isolated rooms; (2) Fan-furnace heating systems (see Chapter IX); (3) Fan-blast heating systems (see Chapter X); (4) Unit heating systems (see Chapter X); (5) Indirect radiation systems (see Chapter II).

Each system has its particular application: No. 1 is intended particularly for residences and small structures; No. 2 for large residences, small theatres, churches, schools and stores; No. 3 for large buildings, theatres, schools, churches and factories; No. 4 for shops, factories and other large enclosures and No. 5 for homes, hotels, schools, etc.

In this chapter of THE GUIDE, consideration will be given to the design of gravity circulating warm-air heating systems. For fan circulating systems see Chapters IX, X, XXIV, XXV and XXVIII. Complete engineering data, including the procedure to be followed in designing a typical system, are presented in the first part of this chapter, while the last part of the chapter presents a Standard Code Regulating the Installation of Gravity Warm-Air Heating Systems in Residences, approved by the *National Warm Air Heating Association*, AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS and the *National Association Sheet Metal Contractors*, as a workable Code for furnacemen.

DEFINITIONS

In general, warm-air furnace heating plants consist of a fuel burning furnace or heater enclosed in a casing of sheet metal or brick, which is placed in the basement of the building. The heated air, taken from the

---

For this edition the chapter has been revised and edited by Prof. J. D. Hoffman, Director of Practical Mechanics Laboratory, Purdue University.

Material for this section was originally prepared for THE GUIDE by A. C. Willard, Professor of Heating and Ventilation and Head of the Department of Mechanical Engineering, University of Illinois, Urbana, Illinois.

All figures and much of the engineering data which follow are from Bulletin No. 141, "Warm Air Furnaces and Heating Systems," Part II, by Professors A. C. Willard, A. P. Kratz and V. S. Day, Engineering Experiment Station, University of Illinois.