

made with welded or riveted seams. The proper design of the furnace depends largely on the kind of fuel to be burned, and special units are being made for the use of coal, oil and gas. Each type of fuel requires a distinct type of furnace for highest efficiency and economy, substantially as listed herewith:

1. Coal Burning:
 - a. *Bituminous*—Large combustion space with easily accessible secondary radiator or flue travel.
 - b. *Anthracite or coke*—Large fire box capacity and liberal secondary heating surfaces.
2. Oil Burning:
 - a. Liberal combustion space.
 - b. Long fire travel and extensive heating surface.
3. Gas Burning:
 - a. Extensive heating surface.
 - b. Close contact between flame and heating surface.

A combustion rate of from 5 to 8 lb of coal per square foot of grate per hour is recommended for residential furnaces. A higher combustion rate is permissible with larger furnaces for buildings other than residences, depending upon the ratio of grate surface to heating surface, firing period, and available draft.

Where oil fuel is used, care must be exercised in selecting the proper size and type of burner for the particular size and type of furnace used. It is recommended that the system be designed for blow-through installations, so that the furnace shall be under external pressure in order to minimize the possibility of leakage of the products of combustion into the air circulating system. The *National Warm Air Heating and Air Conditioning Association* has adopted a Tentative Code for Testing and Rating of Oil-Fired Furnaces.

In residential furnaces for coal burning, the ratio of heating surface to grate area will average about 20 to 1; in commercial sizes it may run as high as 50 to 1, depending on fuel and draft. Furnaces may be installed singly, each furnace with its own fan, or in batteries of any number of furnaces, using one or more fans.

Furnace Casings

Casings are usually constructed of galvanized iron, 26-gage or heavier, but they may also be constructed of brick. Galvanized iron casings should be lined with sheet iron liners, extending from the grate level to the top of the furnace and spaced from 1 in. to 1½ in. from the outer casing. Casings for commercial or heavy duty furnaces, if built of galvanized iron, should be insulated with fireproof insulating material at least 2 in. thick. In general, either brick or sheet metal casing should be equipped with baffles to secure impingement of the air to be heated against the heating surfaces. Brick furnace casings should be supplied with access doors for inspection.

For furnace casings sized for gravity flow of air, where a fan is to be

used, some form of baffling must be employed if the desired results are to be expected. Many manufacturers recommend the use of special baffles to restrict the free area within the casing and to force impingement of the air against the heating surfaces. Either square or round casings may be used. Where square casings are used, the corners must be baffled to reduce the net free area and to force impingement of air against the heating surfaces.

The hood or bonnet of the casing above the furnace should be as high as basement conditions will allow, to form a plenum chamber over the top of the furnace. This tends to equalize the pressure and temperature of the air leaving the bonnet through the various openings. It is generally considered advisable to take off the warm air pipes from the side of the bonnet near the top, as this method of take-off allows the use of a higher bonnet and thus provides a larger plenum chamber.

FANS AND MOTORS

Centrifugal fans are the type most commonly used, and these may be equipped with either backward or forward curved blades. Motors may be mounted on the fan shaft or outside of the fan for belt drive. Adjustable pulleys are desirable to provide a factor of safety and to allow for increased air circulation, provided the motor is adequate to carry the load imposed at maximum fan speed. Two-speed motors have given successful operating results.

Special attention should be given to the problem of noise elimination. The metal duct connection to and from the furnace casing and fan housing should be broken by strips of canvas. Motors and their mountings must be carefully selected for quiet operation. Electrical conduit and water piping must not be fastened to, nor make contact with fan housing. The installation of a fan directly under a cold air grille is usually not recommended. (See also Chapter 33.)

FILTERS

Several types of filters are available for mechanical warm air furnace applications and are discussed in Chapter 29. For maximum efficiency and life under operating conditions, filters should not be subjected to a temperature in excess of 150 F. Filters should have at least 80 per cent average efficiency on an 8 hr test made in accordance with the standard code¹. Filter resistance rises rapidly with the accumulation of dirt, and as a result additional motive power is required to circulate the air through the system. For domestic furnaces, the maximum velocity should not exceed 300 fpm based on nominal filter area.

AIR DISTRIBUTION

The conditions of comfort obtained in a room are greatly influenced by the type of register used and the locations of the supply registers and

¹A.S.H.V.E. Standard Code for Testing and Rating Air Cleaning Devices Used in General Ventilation Work (A.S.H.V.E. TRANSACTIONS, Vol. 39, 1933, p. 225).