

dampers more closely in order to prevent the fire from burning too rapidly. A deep fuel bed always should be maintained when burning coke. The grates should be shaken only slightly in mild weather and should only be shaken until the first red particles drop from the grates in cold weather. Since coke weighs only about half as much as anthracite coal per cubic foot, and therefore only about half as much can be put in the firepot, it will be necessary to fire oftener; but during the greater part of the heating season this will not be an item of importance. The best size of coke for general use is that which passes over a 1 in. screen and through a $1\frac{1}{2}$ in. screen; for small firepots where the fuel depth is not over 20 in. For large firepots where the fuel can be fired over 20 in. deep, coke which passes over a 1 in. screen and through a 3 in. screen can be used but a uniform size of coke is always more satisfactory. Large sizes of coke should be either mixed with fine sizes or should be broken up before using.

Hand Firing

Hand firing is the oldest and the most widely used method of burning coal for heating purposes. To keep the fuel bed in proper condition where hand firing is used, the following general rules should be observed:

1. Remove ash from fuel bed by shaking the grates whenever fresh fuel is fired. This removes ash from the fire, enables the air to reach the fuel and does away with the formation of clinker (which is melted ash).
2. Supply the boiler with a deep bed of fuel. Nothing is gained by attempting to fire a small amount of fuel. A deep bed of fuel secures the most economical results.
3. Remove ash from ashpit at least once daily. Never allow ash to accumulate up to the grates. If the ash prevents the air from passing through, the grate bars will burn out and much clinker trouble will be experienced.

The principal requirements for a *hand-fired furnace* are that it shall have enough grate area and combustion space. The amount of grate area required is dependent upon the desired combustion rate, recommendations for which are given for various kinds of coal in Table 1, Chapter 14.

The furnace volume is influenced by the kind of coal used. Bituminous coals on account of their long-flaming characteristic require more space in which completely to burn the gases of combustion than do the coals low in volatile matter. For burning high volatile coals provision should be made for mixing the combustible gases thoroughly so that combustion is complete before the gases come in contact with the relatively cool heating surfaces. An abrupt change in the direction of flow tends to mix more thoroughly the gases of combustion.

Hand-fired furnaces may be classed as follows: Up-draft, smokeless arch (inverted bridge wall) and down-draft furnaces.

The *up-draft* furnace is the usual type provided in heating boilers and is used generally with all kinds of coal. While it is suitable for use with anthracite, coke, and semi-bituminous coal, the up-draft furnace is decidedly inadequate for burning bituminous coals from a standpoint of economy.

The *smokeless arch* is an inverted baffle placed in the ordinary up-draft furnace toward the rear. Its purpose is to aid in mixing the gases of combustion. By the aid of the smokeless arch, high volatile coals can be

TABLE 2. STANDARD ANTHRACITE SPECIFICATIONS APPROVED AND ADOPTED BY THE ANTHRACITE INSTITUTE

	TEST MESH (ROUND) INCHES	OVERSIZE MAXIMUM (PER CENT)	UNDERSIZE	
			Maximum (Per Cent)	Minimum (Per Cent)
Broken.....	Through $4\frac{3}{8}$ Over $3\frac{1}{4}$	5	15	$7\frac{1}{2}$
Egg.....	Through $3\frac{1}{4}$ Over $2\frac{7}{16}$	5	15	$7\frac{1}{2}$
Stove.....	Through $2\frac{7}{16}$ Over $1\frac{5}{8}$	5	15	$7\frac{1}{2}$
Nut.....	Through $1\frac{5}{8}$ Over $1\frac{1}{16}$	5	15	$7\frac{1}{2}$
Pea.....	Through $1\frac{1}{16}$ Over $\frac{9}{16}$	10	15	$7\frac{1}{2}$
Buck.....	Through $\frac{9}{16}$ Over $\frac{5}{16}$	10	15	$7\frac{1}{2}$
Rice.....	Through $\frac{5}{16}$ Over $\frac{3}{16}$	10	15	$7\frac{1}{2}$
Barley.....	Through $\frac{3}{16}$ Over $\frac{3}{32}$	10	20	10

burned with practically no smoke at moderate rates of combustion, provided the firing of the coal and the manipulation of the fuel bed are done correctly.

The *down-draft* furnace (originally known as the Hawley down-draft furnace) consists of an upper grate of water tubes located above the usual rocking grate. The draft draws down through the upper grate and up through the lower grate. Coal is fired above the fuel bed on the upper grate and after the ash and some coke have been worked down on the lower grate a lively fire is maintained on both grates. The volatile gases pass down through the upper fuel bed and become highly heated as they meet in the combustion chamber between the grates, with the heated excess air from the lower fuel bed.

Mechanical Stoker Firing

For information on mechanical stokers, refer to Chapter 17.

Sizes of Solid Fuels

There is no general standardization of the sizes of coal and coke. The size of anthracite is standardized as per Table 2. The nomenclature generally used in the Illinois and Mid-Western field is given in Table 3.

Storage Space for Coal

The storage space required for coal or coke is dependent upon the frequency of fuel purchases during the heating season, as well as upon the rate at which the fuel is burned.

In general, the size of the storage space can be determined on the basis of burning $3\frac{1}{2}$ tons of coal or coke per heating season per 100 sq ft of attached equivalent heating surface, based on a heat emission of 240 Btu per square foot. Anthracite coal weighs approximately 52.5 lb per cubic foot; bituminous, 45 lb per cubic foot; and coke, 28 lb per cubic foot.