secondary air will not react with any unburned gases unless the mixture is subjected to high temperatures.

The air requirements of oil and gas burners are discussed in Chapter 17, Automatic Fuel Burning Equipment.

## DRAFT REQUIREMENTS

The draft required to effect a given rate of burning the fuel is dependent on the following factors:

1. Kind and size of fuel.
2. Grate area.
3. Thickness of fuel bed.
4. Type and amount of ash and clinker accumulation.
5. Amount of excess air present in the gases.
6. Resistance offered by the boiler passes to the flow of the gases.
7. Accumulation of soot in the passes.

Insufficient draft will necessitate additional manipulation of the fuel bed and more frequent cleanings to keep its resistance down. Insufficient draft also restricts the control that can be accomplished by adjustment of the dampers.

The quantity of excess air present has a marked effect on the draft required to produce a given rate of burning. If the excess is caused by holes in the fuel bed, or an extremely thin fuel bed, it is often possible to produce a higher rate of burning by increasing the thickness of the bed. The thickness of the fuel bed should not, however, be increased too much because the increased draft resistance will reduce the rate of primary air supply and the rate of burning.

For amount of draft required see Chapter 19, Chimneys and Draft Calculations.

## DRAFT REGULATION

Because of the varying heating load demands present in most installations it is necessary to vary the rate of fuel burning. The maintenance of the proper air supply for the various rates of burning is accomplished by regulation of the drafts. Correct and incorrect methods of draft regulation are shown in Fig. 3. The air enters through the ashpit draft door, firing door and by leaks in the setting, whereas the gases leave only through the uptake. By throttling the gases with the damper in the

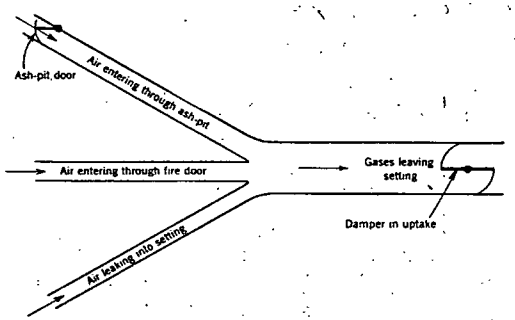



FIG. 3. CORRECT AND INCORRECT METHODS OF DRAFT REGULATION IN A HAND-FIRED FURNACE



uptake all the air entering by each of the three intakes is reduced in the same proportion. If the ashpit draft door is closed, the air admitted through the ashpit is reduced, while it is increased through the other two intake openings.

Methods of control of draft conditions when burning oil or gas are noted in Chapter 17, Automatic Fuel Burning Equipment.

## CLASSIFICATION OF COALS

The complex composition of coal makes it difficult to classify it into clear-cut types. Its chemical composition is some indication but coals having the same chemical analysis may have distinctly different burning characteristics. Users are mainly interested in the available heat per

TABLE 5. CLASSIFICATION OF COALS BY RANK[a]

Legend: F.C. = Fixed Carbon. V.M. = Volatile Matter. Btu = British thermal units.

| CLASS | GROUP | LIMITS OF FIXED CARBON OR BTU MINERAL-MATTER-FREE BASIS | REQUISITE PHYSICAL PROPERTIES |
|---|---|---|---|
| I. Anthracite | 1. Meta-anthracite | Dry F.C., 98 per cent or more (Dry V.M., 2 per cent or less) | Non-agglomerating[b] |
| | 2. Anthracite | Dry F.C., 92 per cent or more and less than 98 per cent (Dry V.M., 8 per cent or less and more than 2 per cent) | |
| | 3. Semi-anthracite | Dry F.C., 86 per cent or more and less than 92 per cent (Dry V.M., 14 per cent or less and more than 8 per cent) | |
| II. Bituminous[d] | 1. Low volatile bituminous coal | Dry F.C., 78 per cent or more and less than 86 per cent (Dry V.M., 22 per cent or less and more than 14 per cent) | Either agglomerating[b] or non-weathering[f] |
| | 2. Medium volatile bituminous coal | Dry F.C., 69 per cent or more and less than 78 per cent (Dry V.M., 31 per cent or less and more than 22 per cent) | |
| | 3. High volatile *A* bituminous coal | Dry F.C., less than 69 per cent (Dry V.M., more than 31 per cent); and moist[c] Btu, 14,000[e] or more | |
| | 4. High volatile *B* bituminous coal | Moist[c] Btu, 13,000 or more and less than 14,000[e] | |
| | 5. High volatile *C* bituminous Coal | Moist Btu, 11,000 or more and less than 13,000[e] | |
| III. Sub-bituminous | 1. Sub-bituminous *A* coal | Moist Btu, 11,000 or more and less than 13,000[e] | Both weathering and non-agglomerating[b] |
| | 2. Sub-bituminous *B* coal | Moist Btu, 9500 or more and less than 11,000[e] | |
| | 3. Sub-bituminous *C* coal | Moist Btu, 8300 or more and less than 9500[e] | |
| IV. Lignitic | 1. Lignite | Moist Btu less than 8300 | Consolidated |
| | 2. Brown coal | Moist Btu less than 8300 | Unconsolidated |

[a]This classification does not include a few coals which have unusual physical and chemical properties and which come within the limits of fixed carbon or Btu of the high-volatile bituminous and sub-bituminous ranks. All of these coals either contain less than 48 per cent dry, mineral-matter-free fixed carbon or have more than 15,500 moist, mineral-matter-free Btu.

[b]If agglomerating, classify in low-volatile group of the bituminous class.

[c]Moist Btu refers to coal containing its natural bed moisture but not including visible water on the surface of the coal.

[d]It is recognized that there may be non-caking varieties in each group of the bituminous class.

[e]Coals having 69 per cent or more fixed carbon on the dry, mineral-matter-free basis shall be classified according to fixed carbon, regardless of Btu.

[f]There are three varieties of coal in the high-volatile *C* bituminous coal group, namely, Variety 1, agglomerating and non-weathering; Variety 2, agglomerating and weathering; Variety 3, non-agglomerating and non-weathering.

Adapted from *A.S.T.M.* Standards, 1937, Supplement, p. 145, *American Society for Testing Materials*, Philadelphia.