door, and by leaks in the setting, whereas the gases leave only through the outlet. By throttling the gases with the damper in the outlet all the air entering by each of the three intakes is reduced in the same proportion, thus maintaining about the same percent of excess air. If inlet air is controlled by the ashpit draft door, the air admitted through the ashpit is reduced, while it is increased through the other two intake openings, resulting in an increase of excess air. A considerable increase in the efficiency of hand-fired furnaces and boilers can be realized by regulating the air supply by means of the damper in the outlet instead of the ashpit damper. Use of the ashpit damper is required, of course, for low rates of combustion. The cold air check damper is to be used only when chimney draft is excessive. It is normally closed unless closing of the outlet damper and ashpit damper is unable to control the rate of combustion.

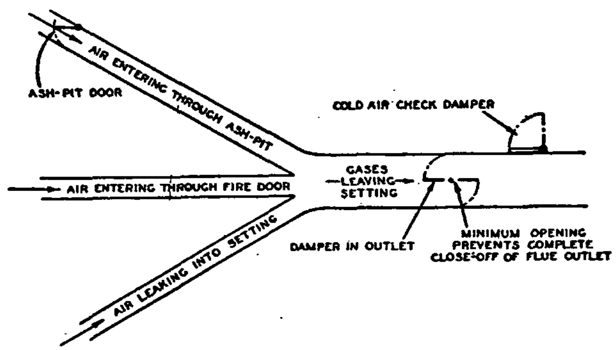

Fig. 2. Methods of Draft Regulation in a Hand-Fired Furnace

Furnace Volume for Coal and Coke

The principal requirements for a *hand-fired furnace* are that it shall have enough grate area and correctly proportioned combustion space. The amount of grate area required is dependent upon the desired combustion rate.

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 to burn the gases of combustion completely 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 the gases of combustion more thoroughly. Anthracite requires comparatively little combustion space.

CLASSIFICATION OF FUEL OILS

Fuel oils are mixtures of hydrocarbons derived from crude petroleum by refining processes designed to produce suitable proportions of naphtha, gasoline, kerosene, fuel oil, and lubricating oil. The processes leave a residue of coke, asphalt, or paraffin depending on the source of the crude oil. In the past, refining processes have been directed toward producing the maximum amount of gasoline, because this product was in greatest demand. The relative proportions of gasoline and fuel oil produced, per unit volume

of crude oil could be varied considerably to suit seasonal changes in demand or gradual trends from year to year. At present gasoline represents about 43 percent and fuel oil (including kerosene) about 22 percent of the yield from crude oil.

Crude oil is distilled in towers at atmospheric pressure to produce gasoline, naphtha, kerosene distillates, and colored distillates, and leave straight-run residues. The colored distillates are distilled further to produce light distillate fuel oils, some lubricating oil, wax, etc., whereas the straight-run residues are distilled under vacuum to produce heavier distillates. The residual fuels remaining can then be passed through cracking plants to produce more gasoline, cracked kerosene, cracked distillates, and cracked residual fuel oils. The exact processes used depend on the proportions of the various end products desired, and to some extent upon the composition and characteristics of the crude oil.

Fuel oils may be described as straight-run fuels, thermally-cracked fuels, catalytically-cracked fuels, or blended fuels depending on the refining process used to produce them. Straight-run fuels are those produced by distillation under atmospheric pressure or a vacuum without decomposition of the hydrocarbons by cracking. Thermally-cracked fuels are those produced by a cracking process involving elevated temperatures (850–1100 F) to decompose some of the heavier hydrocarbons. Catalytically-cracked fuels are those produced with the aid of an alumina-silica catalyst in the cracking process at lower temperatures than those used for thermal cracking. Blended fuel oils are mixtures of any of the above three types. Over 90 percent of all No. 5 fuel oils are blended.

There is no particular problem involved with the burning of a blended oil providing it is blended from two oils which come from the same source. If the oils are not properly blended under heat or pressure, they will exhibit a degree of instability in storage, resulting in sludge formation and a tendency to plug filters and atomizing nozzles in high pressure burners. This is especially true when the oil burning rate is 1 gpm or less.

There is some evidence that the viscosity of blended oils is generally higher than for straight run fuels of the same grade. The viscosity of the oil can change the spray pattern such that smoking and pulsation may result. The adverse effects of high viscosity can be alleviated to a considerable degree in high pressure burners by the use of higher atomizing pressures. In all cases the pressure should be 100 psig or higher and in some cases pressures up to 150 psig have been used to correct difficulties attributed to high viscosity oil.

Analysis of Fuel Oils

Crude oil in its natural state contains primarily paraffin hydrocarbons (chemical formula C_nH_{2n+2}, naphthene hydrocarbons (formula C_nH_{2n}), and aromatic hydrocarbons (formula C_nH_{2n-6}) where n is a whole number. Fuel oils produced by pure distillation, that is the straight-run fuel oils contain essentially these same hydrocarbons. Those produced by cracking processes may contain generally all the hydrocarbon series from C_nH_{2n+2} to C_nH_{2n-14}, and especially do they contain appreciable percentages of the olefin hydrocarbons which are relatively less stable than the paraffin, napthene, and aromatic hydrocarbons. The paraffin hydrocarbons are hydrogen-saturated, are among the most stable, and have the highest hydrogen-carbon ratio of any of the hydrocarbon series. The straight-run fuel oils have the highest paraffin content, the highest hydrogen-carbon ratio and are the most stable of the fuel oils. The thermally-cracked fuel