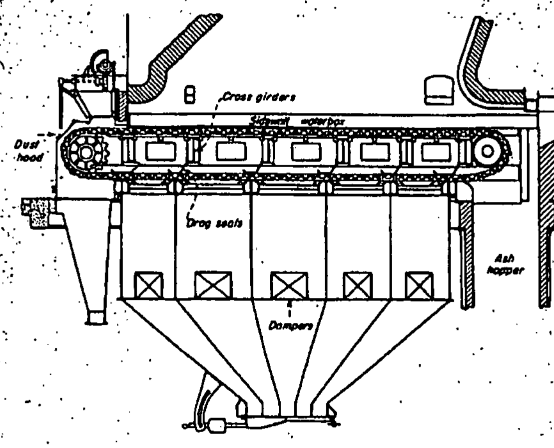
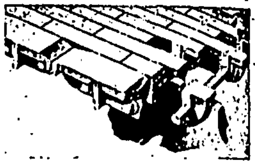
CHAIN GRATE: BOTTOM AIR DISTRIBUTION



11 Chain-grate stoker with bottom air distribution: dampers in individual compartments regulate air flow to each grate section from front to rear

12 Rear of traveling grate shows grate-clip overlap to reduce the siftings



13 Detail of chain-grate construction shows how it differs from one above

however, dependent on maintenance of a thin, level fuel bed.

Chain and Traveling Grates. The grate in these stokers resembles nothing so much as a wide belt conveyor, moving slowly from the feed end of the furnace to the ash-discharge end. Coal feeds from a hopper under control of a gate, which establishes fuel-bed thickness. Furnace heat ignites coal and distillation begins. As the fuel bed moves along slowly, the coke formed is burned and the bed gets progressively thinner. By the time the far end is reached, nothing remains but ash, which falls off the grate as it goes around the end sprocket to begin its return journey underneath.

Grate Construction. Chain grates were originally developed for bituminous coal, and traveling grates for small sizes of anthracite. Structural details differ, but these units perform the same functions, often side by side. As the name implies, the chain grate is in reality a wide chain, with grate bars forming the links. Links are staggered, Fig. 13, and connected by rods extending across the stoker width. In the traveling grate there is a drive chain at each side with crossbars at intervals. The fingers, keys or clips that form the grate surface are attached to these crossbars. They overlap, Fig. 12, to prevent ash sifting through.

It can be seen that stokers of this type are true overfeeds, but the fuel bed differs considerably in appearance from the idealized one shown on p 76. At the feed end, we have virtually all raw coal, with ignition beginning in the top layer. Further along the stoker, distillation has progressed and we have active burning. Then, as distillation is completed, we come to an area where carbon is being burned out and, at the end, we have nothing but ash. Thus, although the steps in the burning process are the same, the location and shape of the various zones differs markedly from the idealized version with clear-cut zones one above the other.

Ignition. With this method of firing on a moving fuel bed, rate of ignition tends to control grate speed and fuel-bed thickness. Otherwise, available time within the furnace may be too short for complete combustion, or too long to permit full use of the grate.

It is radiation, in the main, that ignites incoming fuel. Once the surface layer ignites it warms coal beneath by contact. If the rate of air flow through this part of the fuel bed is about right, surrounding coal ignites in short order. If air flow, including leakage, is far more than needed, over-all result is cooling of the fuel bed and a slower ignition rate.

It can be seen that for best results air-flow rate will differ along the grate, as the burning progresses, and that the gas coming off the bed will differ markedly in composition from feed end to ash discharge. From this point of view, there are three broadly different sections: (1) The part where most volatile matter is distilled off, usually early in the grate's travel. Furnace atmosphere in this region is a reducing one—the gas is rich in combustible volatiles but poor in air. (2) The active burning area, where mixture of air and combustibles comes closest to the ideal. (3) The rear zone where the last chance for burning carbon occurs. Gas from this is usually lean—heavy with excess air.

Air Distribution. Amount and control of air is highly important. So, too, is control of leakage around the grate. Should this occur at the combustion-chamber level it breaks down the pressure difference across the fuel bed. This drop in "pull" through the bed lowers the ignition rate. In units with forced or induced draft, such leakage puts a heavier load on the fans. For this reason, considerable attention is given to sealing arrangements.

To take care of differing air requirements and fuel-bed resistances along the grate length, the stoker is zoned or sectionalized, with a damper in each section to regulate air pressure. Air for combustion can enter from the bottom through both grates, Fig. 11, or from

the side between top and bottom grates, Fig. 14. In the latter, three typical damper and seal arrangements in side-admission units are illustrated.

The difference in composition of the gas coming off the fuel bed calls for definite measures to avoid stratification and insure thorough mixing.

Arches. Earliest and still commonest device for mixing is the furnace arch. Furnace layouts have traced a long pattern of development. Early designs featured a long front arch to reflect heat to the incoming fuel for quick ignition and to direct rich gas from the front end toward the rear. The rear arch has gradually become more prominent, and the front arch shorter. A typical arch design of today, Fig. 15, has a modest front arch, a long rear one, and a relatively narrow "throat" between them. The rear arch directs the lean gas forward and the narrow throat promotes mixing. The excess air from the rear end thus helps to supply the air deficiency of the rich gas from the front end and thereby reduces over-all excess air.

Overfire Jets. Some designers prefer a relatively open furnace with only a short front arch, and depend on high-velocity overfire jets to produce the turbulence and mixing required. They reason that arches as mixing agents give best results at design rating, whereas the jets give positive mixing over the entire load range. A number of such "open" furnaces have been installed and results seem favorable.

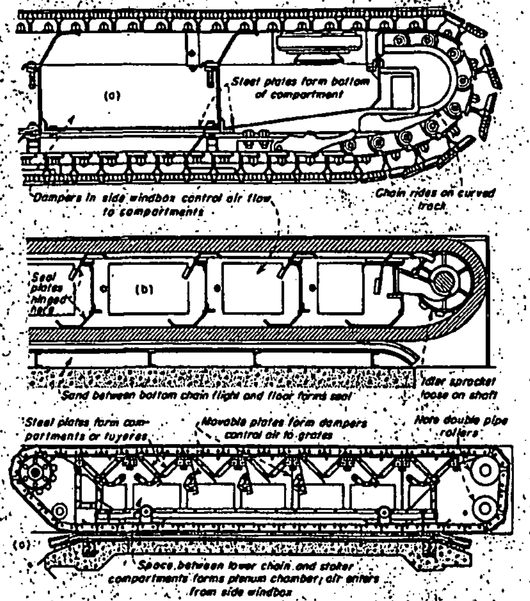
Stoker Drives. Drive can be applied at either front or rear end. A worm and wheel or gear and pinion provide the necessary speed reduction. Power unit can be a constant-speed motor with variable-speed transmission, a turbine or a steam engine.

Chain- and traveling-grate stokers, as a class, have long been considered well suited for high-ash free-burning coals. The reasoning behind this is that the fuel moves in one plane, relatively free from agitation. Coking coals, it is felt, tend to mat over, cut off air supply, and increase fuel-bed resistance.

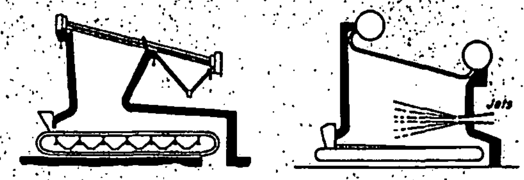
Proper selection of coal size and size consist goes a long way toward assuring satisfactory operation. With natural furnace draft of about 0.1 to 0.15 in., coal having a top size of 1¼ in. and little fines below ⅛ in. gives good results. Heavier draft permits coals of 1½-in. top size, having the range of fines naturally occurring in crushing.

Forced-draft chain grates have about 7 to 10% air space in the grate as contrasted to about 20% for natural-draft units. So coals with an increased percentage of fines and a smaller top size (¾ to 1 in.) can be burned satisfactorily with forced draft.

SEALING OF GRATES, TYPICAL FURNACES



14 Air requirements differ as fire moves from front to rear. Where air is admitted at sides, various methods are used to zone air flow accordingly. At top, cross members and steel bottom plate form tight compartments. Middle design has seal plates hinged from cross members and resting on lower grate. In bottom unit, space between grates forms plenum chamber with dampers above



15 Gas at stoker front is rich, at rear is lean. This makes good mixing vital. Arches may be used to direct flow or furnace may be open, with jets

Compensating Feed. One overfeed stoker employing a moving grate operates on what is known as the compensating-feed principle. The grate is made up of alternate moving and stationary sections that run the full length. Grate is inclined. Moving sections occupy the greater area. Over the grate surface at the rear are cover plates designed to retard ash flow and give a tight rear-end draft seal. As coal moves progressively down the grate, impelled by the moving sections, the stationary sections retard movement and build up a compression force. When cracks and fissures develop this force relieves itself by shifting coal into the open areas of the fuel bed.