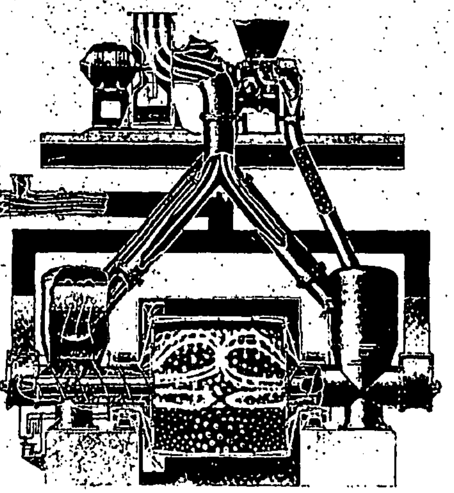
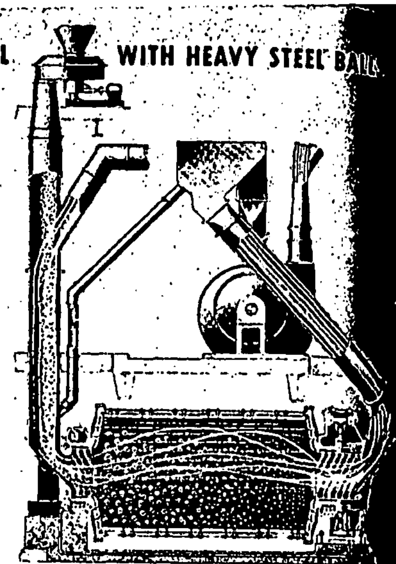
THESE PULVERIZERS TUMBLE COAL WITH HEAVY STEEL BALL

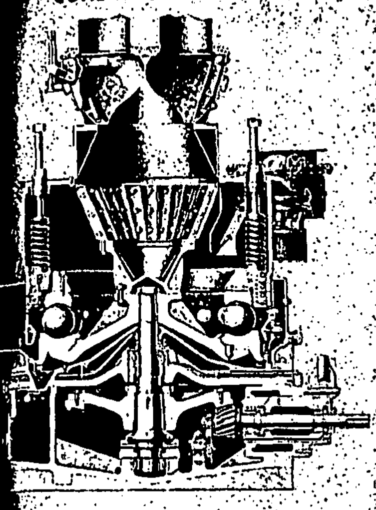


3 Ball-mill pulverizer resembles a tumbling barrel with its rotating drum filled with coal and many heavy steel balls

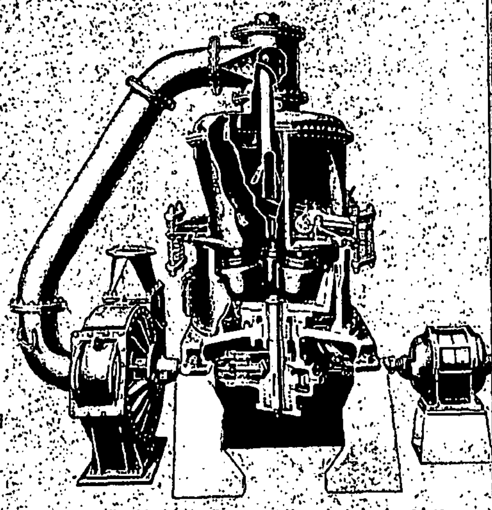


4 Coal enters air-swept tube mill through feeder, upper [illegible] leaves at right end of mill under pull of exhauster, [illegible]

COAL IS GROUND BETWEEN MOVING SURFACES IN THESE MILLS



5 Pulverization takes place between balls and grinding rings. Adjustable springs maintain grinding pressure and fineness



6 Whirling bowl and rollers mounted on pivoted axles reduce to a powder coal thrown between them by centrifugal force

uninterrupted and uniform supply of raw coal is a magnetic separator somewhere ahead of the pulverizer feeder. It removes tramp iron, which might block the feeder.

Usually a pulverizer does its job best when supplied with raw coal having definite size limits. These vary somewhat with mill size. In general, small mills do best on coals up to about ¾ in. top size. For medium and large mills, best top size goes up to about 1 in. and 1¼ in., respectively. For any specific mill the manufacturer's recommendations should govern.

Fineness. Quality of mill output, or *fineness*, is a highly important factor. It is normally expressed as the percentage of pulverized coal passing through a sieve with openings of a specific size. Commonest sizes for pulverized-coal testing are 50-mesh for determining oversize, and 200-mesh for powdered dust. Number of openings per lineal inch fixes the mesh of a screen. The 50-mesh sieve, for instance, has 50 openings to the inch, or 2500 to the square inch.

Fineness of pulverization obtained from a mill depends on a number of factors: Grindability, ash content and moisture of the coal may be some of these. The fineness desired likewise depends to a great extent on coal characteristics and the way they affect behavior in the furnace. For example, coking coals, when exposed to furnace temperature, swell and form lightweight, porous coke particles. These can easily float out of the furnace before they are burned. As a result, carbon loss can run high unless pulverization is very fine. Free-burning coals do not have the same swelling characteristic and hence do not require the same fineness.

Effect of Volatile. Again, high-volatile coals ignite more readily than low-volatile. And since ease of ignition dictates somewhat the degree to which fineness is carried, it follows that high-volatile coals as a class need less-fine pulverization than do low-volatile coals. On the other hand, low-volatile coals, with the single exception of anthracite, have higher grindabilities, because they are softer. The balance of these compensating factors determines results in any given case.

Before turning to any consideration of fineness specifications, it would pay to see more exactly what the term means. Coal from a pulverizer consists of a continuous band of particle sizes from coarsest to infinitely fine, distributed according to laws of probability. Plotting amount of each size yields a typical frequency curve, with a peak at some particular size. Shape of the curve and size occurring in greatest amount depends on the coal and the pulverizer.

In power plants, prime purpose of pulverizing is to eliminate oversize. No matter what the percentage of coal that will pass 200-mesh, as little as 5% over the 50-mesh limit may result in slagging and increased combustible loss. That is why most specifications call for at least 98% through 50-mesh.

Economical fineness may be defined as the point where total cost per lb of steam, including fuel, operating and capital costs, becomes a minimum irrespective of boiler efficiency. This recognizes the fact that reduction of a small percentage of coarse particles, to obtain complete combustion in the furnace, may require an increase in operating and capital cost that is out of proportion to the value of the gain in efficiency.

Mill Capacity. What about factors affecting mill capacity? Just as with fineness there are several. Mill capacity does not vary in direct proportion to grindability. Ash and moisture content of the coal, and fineness desired, may play important parts.

A basic premise in setting mill capacity is the assumption that enough heated air will be available to dry the coal. If this is not the case, it is the drying operation that limits mill output, not grinding. Thus it may be possible to obtain more capacity with a dry coal of lower grindability than with a wet high grindability coal.

Nevertheless, a knowledge of grindability properties is helpful information in rating a pulverizer. In recent years manufacturers have developed correction factors that take into account influence of coal properties.

Drying Coal. Let's look at one more problem common to all pulverizing before examining specific mills. That common problem is moisture and specifically *surface* moisture. *Inherent* moisture, that is, moisture actually held within the coal, does not greatly affect pulverization. Drying of coal undergoing pulverization, then, need only be enough to remove objectionable surface moisture.

The extent of drying that can be done within a given mill depends somewhat on its design. For example, most mills are arranged so incoming wet coal mixes immediately with the drier coal inside. Without this quick mixing mill feed end may plug with wet coal.

Primarily, though, the amount of heat that can be introduced measures the success or failure of the drying step. Where air flow acts as the drying medium (the most usual arrangement) the mill must be able to handle fairly large volumes of high-temperature air. Conditions within the mill should be held at a relative humidity below that of saturation at mill outlet temperature, roughly 150-160 F.

Air Supply. With today's steam-generating units, a supply of preheated air at about 500 F or higher, depending on coal moisture, can be obtained readily. The mill should be so constructed that it can handle air at this temperature without need for tempering to avoid preignition with dry coals.

We are now ready to look at typical current pulverizer designs. These employ three basic forces, singly or in combination: (1) impact (2) attrition, and (3) crushing. The nature of these forces becomes apparent when their application is seen.

Ball Mills. The ball mills of Fig. 3 and 4 are essentially horizontal rotating cylinders somewhat longer than they are round. This physical shape leads some to describe them as tube mills. Usual design employs cast liners for the interior. Steel or special alloy balls, ranging from 1 to 2 in. in diameter, are dumped into the drum and fill it to just under half full. The mill rotates slowly, depending on tube diameter, but speed is of the order of 20 rpm. The balls carry part way around the cylinder circumference, then slide back toward the bottom. Coal, intermingled with the balls, undergoes impact from falling balls and attrition and crushing from the sliding mass.

Classifying Action. Hot air passes through the mill to dry coal, classify it after grinding, and transport finished product to burners. Operation of a typical classifying arrangement can be seen in Fig. 3. Passing through main vertical body of classifier, coal-air stream undergoes sharp change in direction, which throws out oversized particles. These *tailings* reenter the mill with incoming raw coal. Coal-air stream leaving classifier carries only coal that meets desired fineness limits. Opening the bypass damper in the scroll of the classifier increases coal output and reduces fineness.