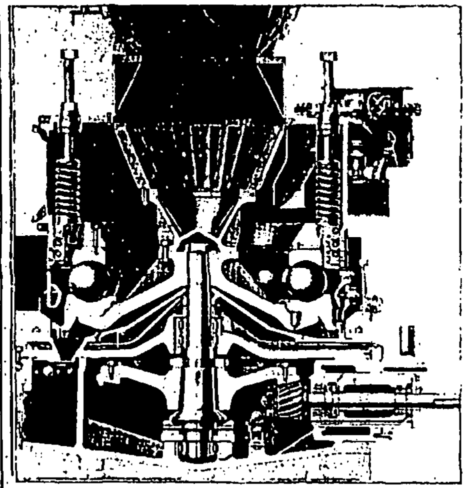
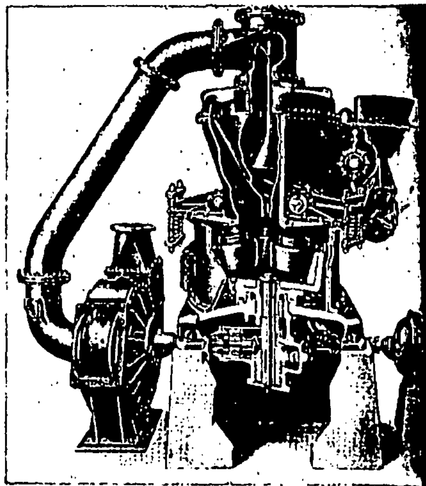
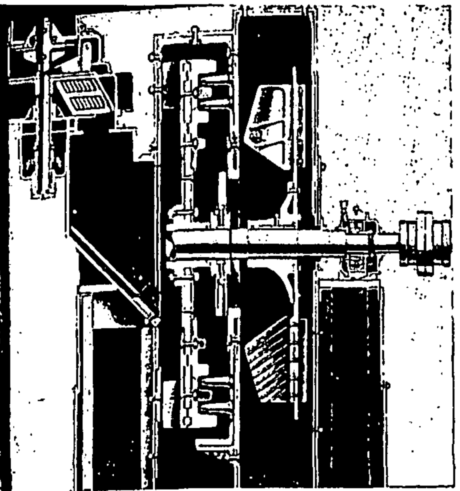


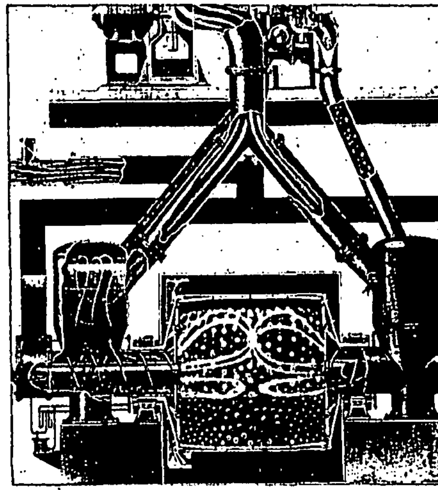
GRINDING OF COAL occurs between balls and grinding rings. Adjustable springs maintain grinding pressure



WHIRLING BOWL AND ROLLERS mounted on pivoted axes grind the coal thrown between them by centrifugal force



IMPACT FROM HAMMERS of first stage and attrition from pegs of second combine forces to pulverize coal



BALL-MILL PULVERIZER resembles a tumbling barrel with rotating drum filled with coal and heavy steel balls

CLEAN AIR

A JOB FOR THE POWER ENGINEER

What Part Does Pulverized Coal Firing Play in Air Pollution?

Atmospheric pollution from pulverized coal comes mostly from flyash. A 200,000-kw plant burning coal of 15% ash can emit up to 10 tons of ash per hr. Here are basic factors affecting the problem from coal preparation to final furnace design

By L N ROWLEY, *Managing Editor*, and J C McCABE, *Assistant Editor*

▶ LET'S LOOK AT the process of firing pulverized coal so we may (1) appreciate the origin and scope of the flyash problem (2) recognize the remedies and their costs in dollars and cents—as much as 5-10% added to steam cost.

What happens when you elect to fire coal in suspension? Within a fraction of a second after a fuel particle in suspension enters the furnace, heat raises its temperature and volatile matter boils off. Air enters the furnace through the burner to mix with distilled gas and complete combustion.

Heat from this combustion process lifts the temperature of the remaining fuel particles to incandescence. Secondary air admitted around the burner opening mixes with the stream of glowing coal particles. It sweeps past them to strip or scrub off successive layers of CO and CO_2 until combustion is complete. First, the coal must be prepared.

Our article, "How Fuels Burn" (POWER, August 1947, pp 71-72) set up the premise that no fuel burns unless, or until, it becomes a gas. Coal, a solid fuel, requires considerable preparation because it is a solid and differs in composition from one mine to another.

Pulverizing Systems. Pulverizing or breaking up raw coal to a powderlike substance is one way of preparing coal for the combustion process. It can be likened to the "atomization" phase of oil burning in that the surface area of the fuel to be exposed is greatly increased. Once fuel is in this form it must be transferred to the furnace, mixed with the necessary air, placed in the proper temperature environment and given time to burn.

The two basic systems for these operations are (1) the bin-and-feeder (2) the unit or direct-fired system. The older of the two, the bin-and-feeder system, has its major importance in firing coals like anthracite.

Its most serious disadvantage is a heavy capital outlay; usually a separate mill house for drying and pulverizing equipment, plus conveyors, bunkers and feeders for fuel delivery.

But the bin system has important advantages: (1) coal preparation is independent of furnace operation (2) pulverizing mills can operate at optimum capacity to give uniform fineness (3) large storage bins act as reservoirs against outages (4) use of many burners, individually controlled, gives a flexible furnace, permits adjustment to give optimum combustion.

What about the second, the unit system? Today's unit does four jobs: (1) pulverizes raw coal (2) dries it in the same operation (3) sifts or separates the already pulverized coal within the mill (4) transports this powdered coal to the furnace. All at a large capital saving.

Secret of this saving is a preheated air sweep admitted to the pulverizing mill. The warm air is the drying element, sifting agent and transporting medium. This 3-fold function is not without disadvantage. Each of these operations has one optimum ratio between air and powdered coal for best performance. The same amount of air for all jobs means simply that the choice is the proverbial happy medium.

Transporting Coal. The bin-and-feeder arrangement for pulverizing generally employs a worm-and-screw feeder to push coal to the burner where it becomes air-borne. The unit system uses air sweeping through the mill for its transporting medium. Air-borne fuel, actually a dispersion of a solid in a gas and not too generally understood, can be likened for practical purposes to a liquid.

Burner design follows the liquid concept. Its job is to mix the fuel and the primary or ignition air (sometimes the secondary air, too) and then introduce them to the furnace with, often, a turbulent motion, not too unlike the function of an oil burner. In addition, burner design has to do with flame shape and combustible travel time.

Once the fuel-air mix reaches the furnace its travel and combustion differs with furnace design. This design follows one of two principles—the dry bottom or the slag tap. The names come from the means by which ash is removed. In the slag tap, employing higher furnace temperatures than dry bottom, ash is kept molten so it flows from the furnace. To keep it molten many designs direct burner flame into or toward the ash. In dry bottom design the effort is directed toward temperatures below slagging range.

Major Equipment. Pulverizers employ impact, grinding, rolling or crushing action to powder coal (see photos). One recent design, reported capable of ratings up to 10,000 lb coal per hr, has a steam jet for the pulverizing force. All strive for uniform fineness at high throughput and low power consumption. High moisture and ash contents for a given size output, plus a low grindability index in the raw coal undergoing pulverization, constitute the limiting factors on mill capacity. The degree of fineness achieved in the pulverizing process directly affects available surface and, in turn, ignition and combustion.

Preheated air dries, classifies and transports powdered coal to the burner, in the direct-fired systems. If it were always possible to use this medium as the primary or ignition air as well, it would simplify combustion. But this is not always the case.

In general, as the volatile content of a coal decreases, the degree of fineness (and often work of the pulverizer) increases while the percentage of primary air for ignition purposes decreases. A rule of thumb places the percentage of primary air equal to that of volatile-content for anthracite. Sometimes this percentage of optimum primary air is so low that any single volume of air capable of performing all the functions of a direct-fired system far exceeds this optimum figure. Only