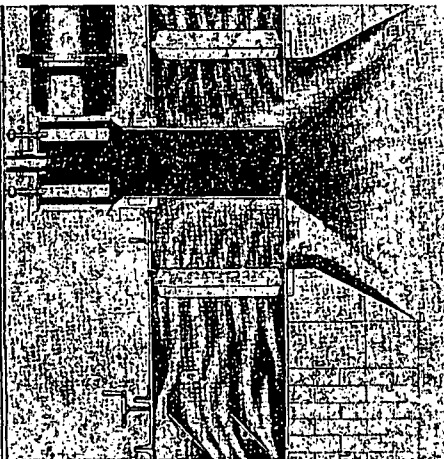
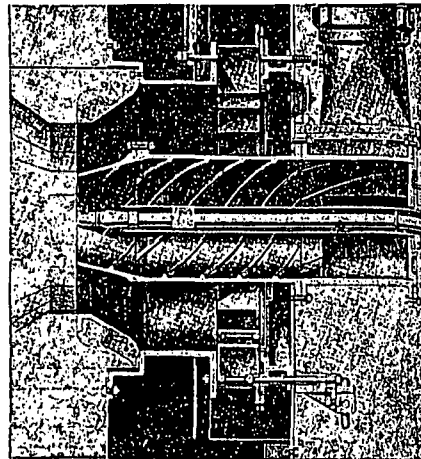
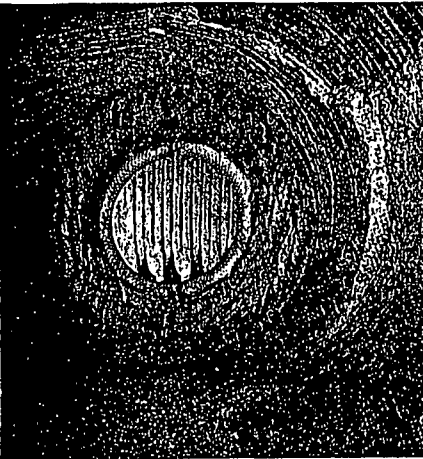




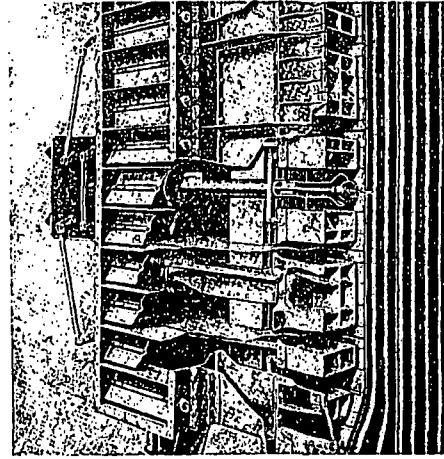
BURNER EMPLOYS A ROTARY IMPELLER mounted on ignition tube as a coal spreader, plus adjustable air vanes



TURBULENT BURNER for coal and oil firing rotates incoming fuel and air mixture as well as secondary air



CRUSHED COAL AND AIR enter cyclone burner with a swirling motion and burn. Slag sticks to the burner wall



TANGENTIAL BURNER directs flame tangential to an imaginary circle in the furnace interior, aids turbulence

in recent years has the unit system been applied successfully to anthracite. Success hinges on removing excess air from the transporting air before it enters the burner to become primary air.

Burners. There are broadly two types of burners for firing powdered coals: (1) nozzle (2) turbulent burner.

The so-called "fan-tail" or U flame issues from a nozzle burner. Mixing of air and entrained fuel occurs within the furnace chamber. Usually the mixing force is secondary air admitted through separate nozzles. Occasionally a tertiary air is directed through inlet vanes

grouped around the primary air and coal inlet.

The turbulent, flare-type burner imparts a rotary motion to (1) the coal-air mixture in a central nozzle (2) the secondary air issuing from a circular chamber around that nozzle—all within the burner. This gives some premixing for coal and air. Turbulence occurs outside the burner.

Burners are further grouped according to location in the furnace, that is, vertical, horizontal, intertube, corner or opposed. Early vertical firing had the primary air and coal nozzle at top of

furnace chamber pointing downward, more or less vertically. Secondary air nozzles in a wall of the furnace directed air horizontally into the chamber.

Horizontal, nozzle-type burners, located in opposite walls, to give "opposed firing" or in corners to give "tangential firing" play the flames against one another in the first case and tangent to an imaginary circle in the second. Several advantages seem apparent from such firing (1) a pronounced turbulence can be set up (2) any unburned combustible in the "tail" of one nozzle flame is caught up in the second.

Cyclone Burner. A very recent entry in the field of pulverized fuel firing is the cyclone burner (Powan, Jan 1947, pp 77-80). This burner receives crushed, not pulverized, coal in a stream of high-velocity air tangent to the circular burner housing. The coal thrown to the rim of the burner by centrifugal force and held by a coating of molten ash receives a vigorous scrubbing by the fast moving air until the energy of the incoming air is spent. Secondary air to complete combustion enters also at a high velocity and parallel to the path of the primary air-coal mix. With a temperature in the burner chamber high enough to promote and sustain combustion the stream of primary air combines with the distilled volatiles and the parallel secondary-air flow completes combustion to leave only ash.

If the fusion temperature of the coal

is below that reached during combustion the ash becomes molten and under centrifugal force clings to the surface of the burner. By inclining the burner the ash proceeds to the low point of the burner where it discharges continuously.

Combination Burners. The war years emphasized the need for fuel flexibility and since most pulverized-fuel furnaces lend themselves to oil or gas firing, combination burners have been developed. Most combination burners for oil, gas or coal admit all the air for combustion through the burner. Only the primary air carrying coal to the burner is premixed.

Furnace Types. The modern water-cooled furnace, such as is often used in firing pulverized coal, has two functions. It must (1) permit economical burning of fuel and (2) take away or absorb enough of the heat released to hold flue-gas temperatures below the slagging point.

Successful pulverized-fuel firing results from an intensive mixture of coal and air within the furnace proper to give complete combustion in the shortest time and within the least space. First requirement that the flame must meet is not to impinge on combustion-chamber walls. Beyond that blanket requirement for all firing systems, the pulverized-coal installation is characterized by a necessary balance between available coal transport time and combustion time.

Here is why that balance is so im-

portant. Temperatures realized in the combustion of most coals are well in excess of the ash-fusion temperatures. Coal burned in suspension, then, has its ash content at one time or another in a molten state. It is highly desirable for the ash to be dry if it is to enter the gas passages of the steam generator. Transfer of heat from the suspended coal particle by radiation to the boiler surface is the only way of attaining this dry state. And it takes time.

Can it be sped up? Yes, fully water-cooled furnaces absorb heat faster than other furnaces. But the time for absorbing the heat usually exceeds the combustion time. This time in a system of suspended-fuel firing is roughly equivalent to distance. So the distance between the burner point and the entrance to the gas surface is a function of the time required for heat absorption. The magnitude of this time or of furnace distance is largely determined by ash content of a given-sized fuel.

There is still one other factor growing out of the ash in suspended coal firing. In the course of combustion, ash particles, while still molten, bump into other ash particles to form still larger pieces. They are often too large to stay in suspension, so drop out. The accumulation of these pieces presents a problem of removing them from the furnace.

At this point a choice may be made whether to keep the ash, when once molten, in that state or to return it to the dry state before removal. That in

a nutshell is the reason for the two different designs—the slag tap for molten-ash removal, the dry bottom for dry-ash removal.

What steps can be taken to reduce atmospheric pollution from pulverized-coal firing? This pollution problem is almost entirely one of fine dust, or flyash as it is often called. Smoke con and does occur in arrested combustion—where flame impinged on tubes, or fuel feed went badly out of balance from, say, moisture hanging up the raw-coal supply. But the major problem is one of fine dust.

Flue dust is a byproduct of suspension firing of a solid fuel. Its quantity, by weight, can be reduced by striving for complete combustion. Here are some operating aids.

The pulverizing mill promotes good combustion by delivering uniformly fine coal to the coal transport system. This system, in turn, should distribute coal uniformly within the feeder aided by orifice or directional vanes.

Good burning depends on suitable coal, clean burners, proper mixing. Designs should permit a primary air as close as possible to the optimum ignition air ratio for all loads. For extremely low loads use separate burners.

Design improvements represent the principal hope for reduced flue dust to atmosphere from pulverized-coal burners. Removal of entrained flyash from flue gas by external collecting equipment will be discussed in a later article in the series.

COAL AND PRIMARY AIR discharge through the coal spreader of this horizontal flare-type burner, make turbulent mixture with incoming secondary air

