ENGINEERING

Coal Flows to Furnace

Powder-fine coal will power locomotives and heat homes. Special furnace and engine must be used but operating costs for locomotives will be lowered.

By A. C. MONAHAN

➤ COAL HAS WON another point in the battle of fuels. Coal as fine as powder, pulverized by bursting at a nozzle end, will power two new coal-burning gas-turbine locomotives and will be used in home heating. It flows to the firebox through hose or tube, requiring no more handling than oil. It burns almost completely.

The principal competitors of coal are fuel oil and gas. In favor of coal, in the battle of fuels, are its abundance, relative cheapness and wide distribution. In favor of fuel oil is its easy handling. American coal reserves are great enough to last for many centuries. Natural oil reserves face relatively early depletion. Manufactured products from coal and oil shale will supplement petroleum production, but their cost will be an important factor.

To keep coal in the top place as a fuel, two requirements must be met. One is to develop methods of combustion that will convert the full energy in the coal to useful work; the other is to develop coal-handling methods as easy as those employed in handling fuel oil and gas. This finely pulverized coal may furnish the answer to both.

Tests Passed

Face-powder-fine coal has successfully passed laboratory and pilot-plant tests, and is to be tried out in both building heating and in power plants. The heating experiments will be tested by a commercial company in Baltimore in heating homes and office buildings. The power tryout will be in two giant railway locomotives now under construction. The locomotives will be powered by gas-turbine engines, but these gas-turbines burn coal instead of the customary liquid fuel.

Construction of a coal-burning gas-turbine engine does not present especially difficult problems in itself; the problem is putting an automatic system on the locomotive to crush, dry and pulverize the fuel and deliver it into the combustion chamber. Another problem is the removal of the non-combustible particles in the combustion products, the so-called fly-ash.

Coal, of course, can be converted in large part into combustible gases by long-used methods, and the gases used to power the gas turbines. This, however, is an expensive process and one that can not easily be adapted to use on a locomotive. The important new development includes a method of pulverizing lump coal in the locomotive, delivering it into the firebox, and insuring complete combustion.

The two coal-burning gas-turbine locomotives being built, which will be on the rails in 1948, carry all necessary equipment for converting ordinary lump coal into power. They will load with coal at ordinary railroad coal chutes. Wayside stations to deliver pulverized coal are not thought advisable because their use would confine the new locomotives to trackage where the stations were erected. These locomotives will also have storage capacity to hold the fly-ash until proper disposal sites are reached.

The process of pulverizing the coal on these locomotives is of particular interest. Coal can be pulverized mechanically, of course, but the process is not satisfactory for use on locomotives, largely because of space limitation. The method that will be used is the so-called air-operated "coal atomizer" system.

It is a relatively simple process, resembling one used in the preparation of certain puffed breakfast cereals. The coal atomizer was first used, it is claimed, at the Institute of Gas Technology, Chicago, to produce finely pulverized coal for gasification. It is a device that requires about one pound of air for a pound of coal, the air being under pressure about 80 pounds per square inch higher than the combustor pressure.

Development of Locomotives

The development of the coal-burning gas-turbine locomotives is under the Locomotive Development Committee of Bituminous Coal Research, Inc., in Baltimore. The director of research is John I. Yellott, with Charles F. Kottcamp as as-

FLOWING COAL—"Coal atomizer" and attrition chamber are being examined by John I. Yellott, director of research, and W. N. McDaniel of the Locomotive Development Committee of Bituminous Coal Research Laboratory at Johns Hopkins University

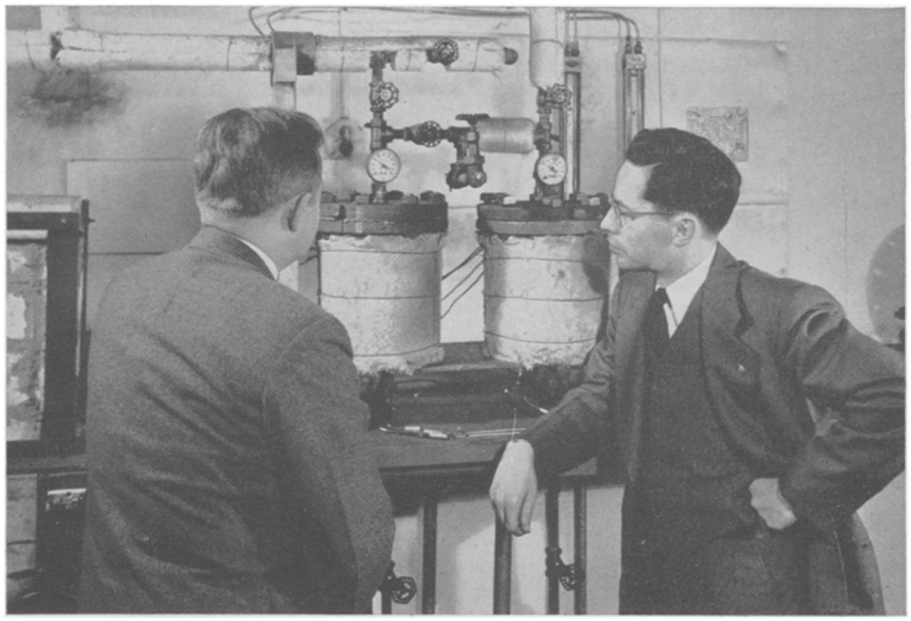
sistant. The committee itself is composed of the chief executives of six leading coal-burning railroads and three major coal producers. It is logical that these interests constitute the membership; the railroads and the coal industry are each other's best customers.

The coal atomizer consists of a nozzle through which is passed air under pressure and coal that has been crushed and dried. As the coal particles leave the nozzle, and the pressure is reduced, they burst with internal explosions which take place when the air entrapped within the pores of the coal is suddenly relieved of pressure. Because of its simplicity and lightness, the device is well suited for use on the locomotives, and it is the best coal-pulverizing method yet developed.

Problems of Burning

After pulverization, the fuel passes on to the combustion chamber. The actual burning of coal under pressure presented special problems of its own. In this, the Battelle Memorial Institute in Columbus, Ohio, made extensive contributions. This research and testing laboratory, serving industry, is among several institutions that played a part in the development of equipment for the new locomotives. Included also are the Johns Hopkins University, Purdue University, the Institute of Gas Technology in Chicago, and several makers of gas-turbine engines and locomotive builders.

The Battelle combustion chamber is the so-called vortex type. Air, laden with the finely pulverized coal, is driven into a cylindrical tube through a series of vanes which causes the air to spin vigorously as it passes toward a centrally located outlet. The action produces a rotating fuel bed suspended in rapidly rotating air. Ignition is started by a small pilot gas flame, which can be turned off once burning is under way.



IGNITION TEST—Test to determine the possibility of spontaneous ignition of coal when stored under pressure is witnessed by Mr. Yellott and his assistant director.

The removal and disposition of the fly-ash from the products of combustion are of the utmost importance. If the fly-ash passes through the turbine vanes, serious abrasion is caused. Under tests already made, small cyclone separators made by the Aerotec Company and the Thermix Engineering Company, both of Greenwich, Conn., produced satisfactory results.

Provisions for Ash

Special compartments to hold the removed fly-ash will be provided on the locomotives. If the ash were allowed to discharge into the air from the speeding locomotive, it would be gathered up by the air-conditioning systems of the following passenger cars and would clog up the equipment. If compacted and discharged as pellets, a hazard would be created.

This revolutionary type of locomotive, which will use a plentiful type of fuel, is expected to lower main-line operating costs to one-half that of diesel-electric power plants, and will cost about the same to build. It is a great saver on lubricating oil, and gas-turbines consume no water.

The commercial building-heating try-out in Baltimore, in which finely pulverized bituminous coal will be used as fuel, does not plan to sell coal but to sell heat, on an annual contract. The necessary furnaces and equipment will be operated by the company and not by the customer.

After installations are made, the company will do all maintenance and servicing. The pulverized coal will be delivered as needed in tank trucks, like oil, and run into the building through hose. The powdery ash resulting from the combustion will be taken away by the fuel delivery trucks.

For burning the pulverized coal, there is a special furnace, although some old furnaces can be converted, it is claimed. There is a storage tank for fuel, and one for ashes and equipment for air pressure. The house-size special furnace is a vertical sheet-metal cylinder lined with refractory material. Top-mounting of the powdered coal-burner provides for down-firing, after ignition by a gas pilot and sparkplug. The entire system is clean, and gives smokeless combustion.

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