compounds in the $C_{10}$ and higher ranges. Similar calibration work is in progress in regard to the functional group analysis of olefins.

Information concerning the molecular-weight distribution in the wax and heavy oil product from the Fischer-Tropsch process can be obtained by distillation at reduced pressures if reliable data concerning the vapor pressure of organic compounds of high molecular weights are available. Such information has heretofore been lacking for compounds above about $C_{20}$ in the paraffin series. To supply this information, an alignment chart was prepared, which, if the vapor pressure of a paraffin at a particular temperature is known, permits an estimation of its molecular weight and vapor pressure at any other temperature. In connection with the evaluation of distillation columns operating at reduced pressures,96/ the use of a hydrocarbon whose hydrogen atoms are of mass one and the same hydrocarbon containing some deuterium atoms (hydrogen atoms of mass two) is highly desirable. Accordingly, a method of analysis for deuterated hydrocarbon was developed97/ that is superior to the analytical methods previously used.

## SYNTHETIC LIQUID FUELS DEMONSTRATION PLANTS

The coal-to-oil demonstration plants were formally dedicated May 8, 1949. During the first half of May, more than 3,600 persons, representing industry, Government, and local residents, visited the plants and were taken on conducted tours during which the salient features were pointed out. Prior to dedication, both plants were operated to a limited extent. Lignite tar was hydrogenated to produce Diesel fuel which powered a train from St. Louis to Louisiana, Mo., and return. Gasoline produced at the same time is being used in all plant automobiles. The gasifier in the gas-synthesis plant was operated to produce an acceptable synthesis gas. Nevertheless, the construction program has not yet been completed, and details of status are shown in figures 39 and 40.

### Coal Hydrogenation Plant

The process flow diagram of the 200- to 300-barrel-per-day capacity plant has been published.98/ More detailed discussion of the process flow, equipment, construction, and operation of the plant appeared in a recent publication.99/ Engineering design was completed in December 1948, and construction work by the Bechtel Corp. ended in January 1949. The testing of the units and finishing of odds and ends was undertaken by the station's maintenance and operating forces.

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96/ Feldman, J., Myles, M., Wender, I., and Orchin, M., Evaluation of Vacuum Rectification Columns. Use of Binary Mixtures: Ind. Eng. Chem., vol. 41, 1949, pp. 1032-1036.

97/ Wender, I., Friedel, R. A., and Orchin, M., Preparation of High-Purity Hydrogen Deuteride from Lithium-Aluminum Hydride: Jour. Am. Chem. Soc., vol. 71, 1949, p. 1140.

98/ Fieldner, A. C., and Gottlieb, Sidney, Annual Report of Research and Technologic Work on Coal, Fiscal Year 1948: Bureau of Mines Inf. Circ. 7518, 1949, 87 pp.

99/ Kastens, Merritt L., assoc. ed., (in collaboration with L. L. Hirst and C. C. Chaffee, Bureau of Mines, Louisiana, Mo.), Liquid Fuel from Coal: Ind. Eng. Chem., vol. 41, 1949, pp. 870-885.

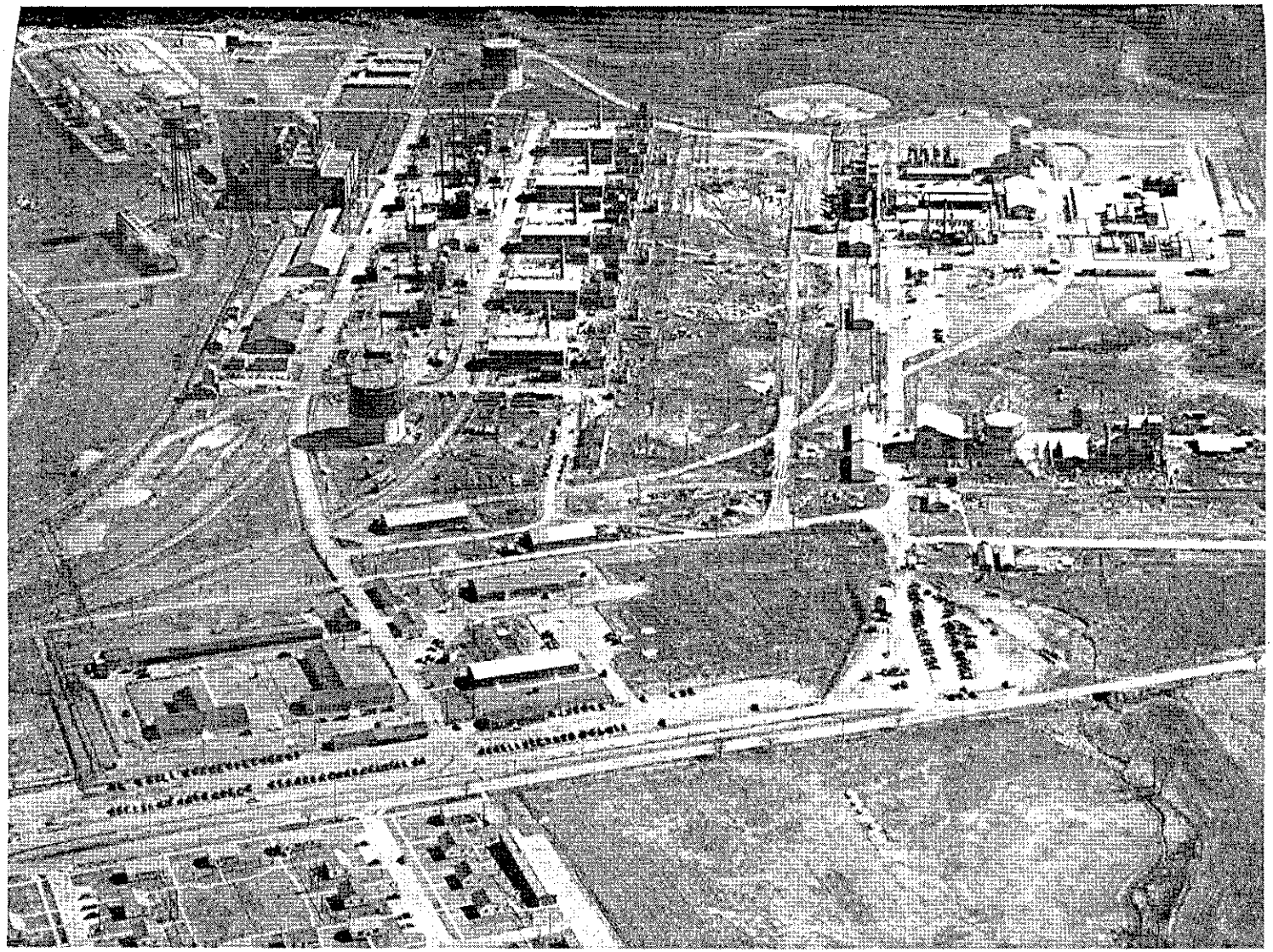

Figure 39. - Air view of coal-to-oil demonstration plants at Louisiana, Mo. Missouri Ordnance Works, upper left; hydrogenation plant, upper right; gas-synthesis plant, lower right; administration buildings and employee housing development, lower left.

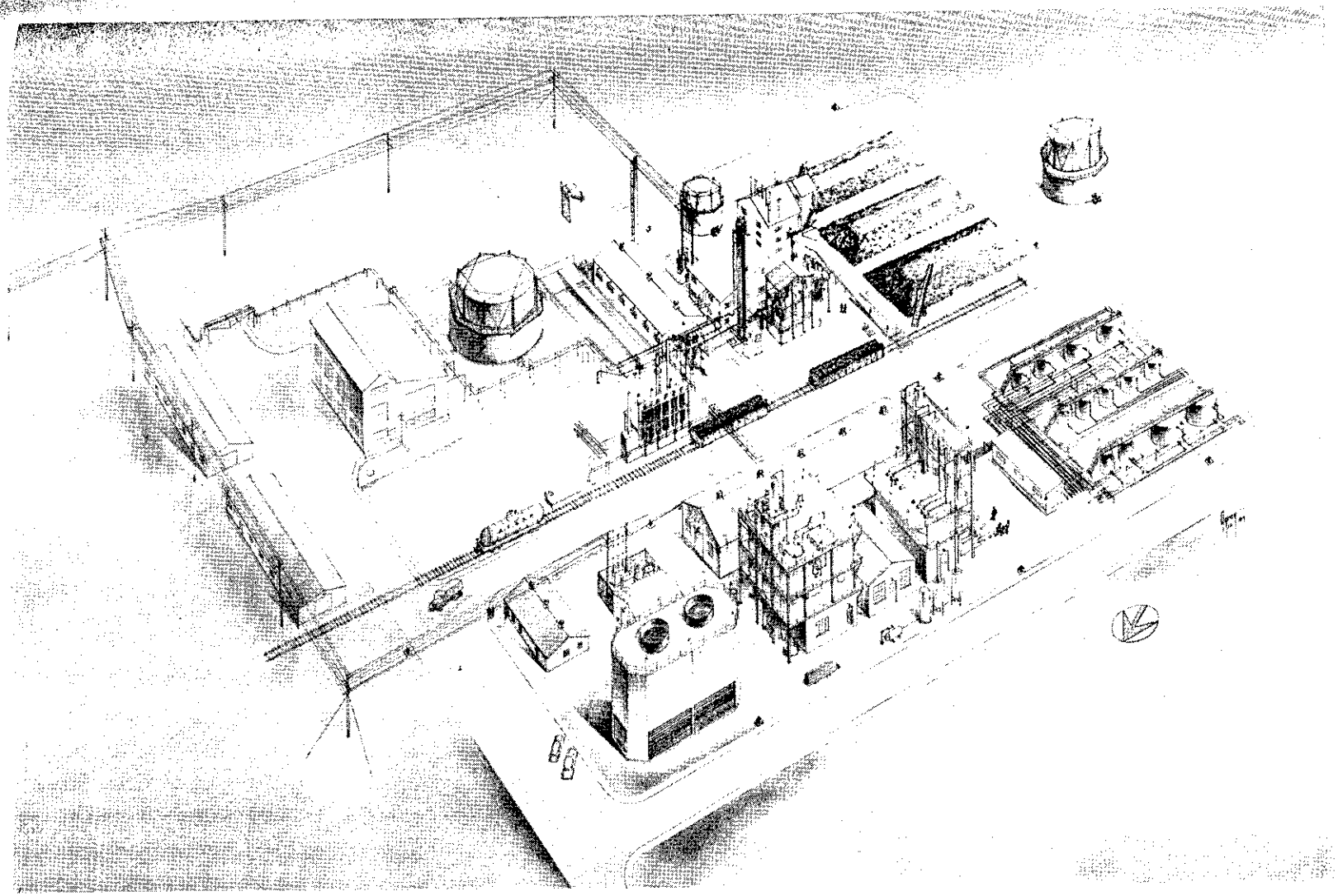

Figure 40. - Perspective sketch of the Bureau of Mines gas synthesis demonstration plant under construction at Louisiana, Mo. As this plant employs a modified Fischer-Tropsch process to convert coal to oil, this plant will have a capacity of 80 to 100 barrels daily. Left to right above the railroad tracks are the oxygen and coal gasification units; below the tracks are the synthesis units and the product storage area.

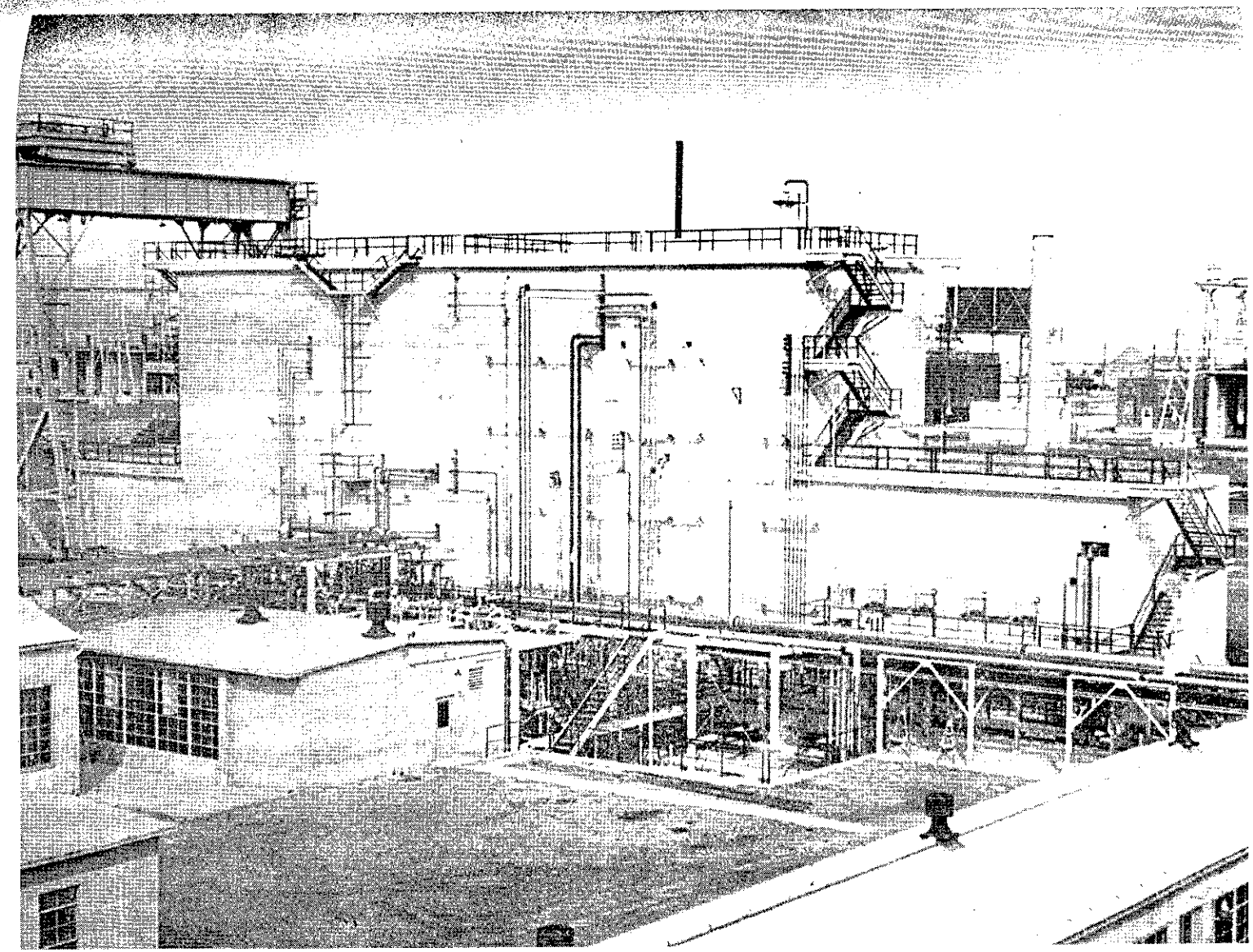

Figure 41. - This large reinforced-concrete structure is partitioned, for the protection of operators and equipment, into stalls enclosing on three sides the high-pressure and temperature vessels in which coal is converted to oil. The 130-ton traveling Gantry crane at left straddles the stalls and can carry the largest vessel. Squat building nearest the stalls is the control house.

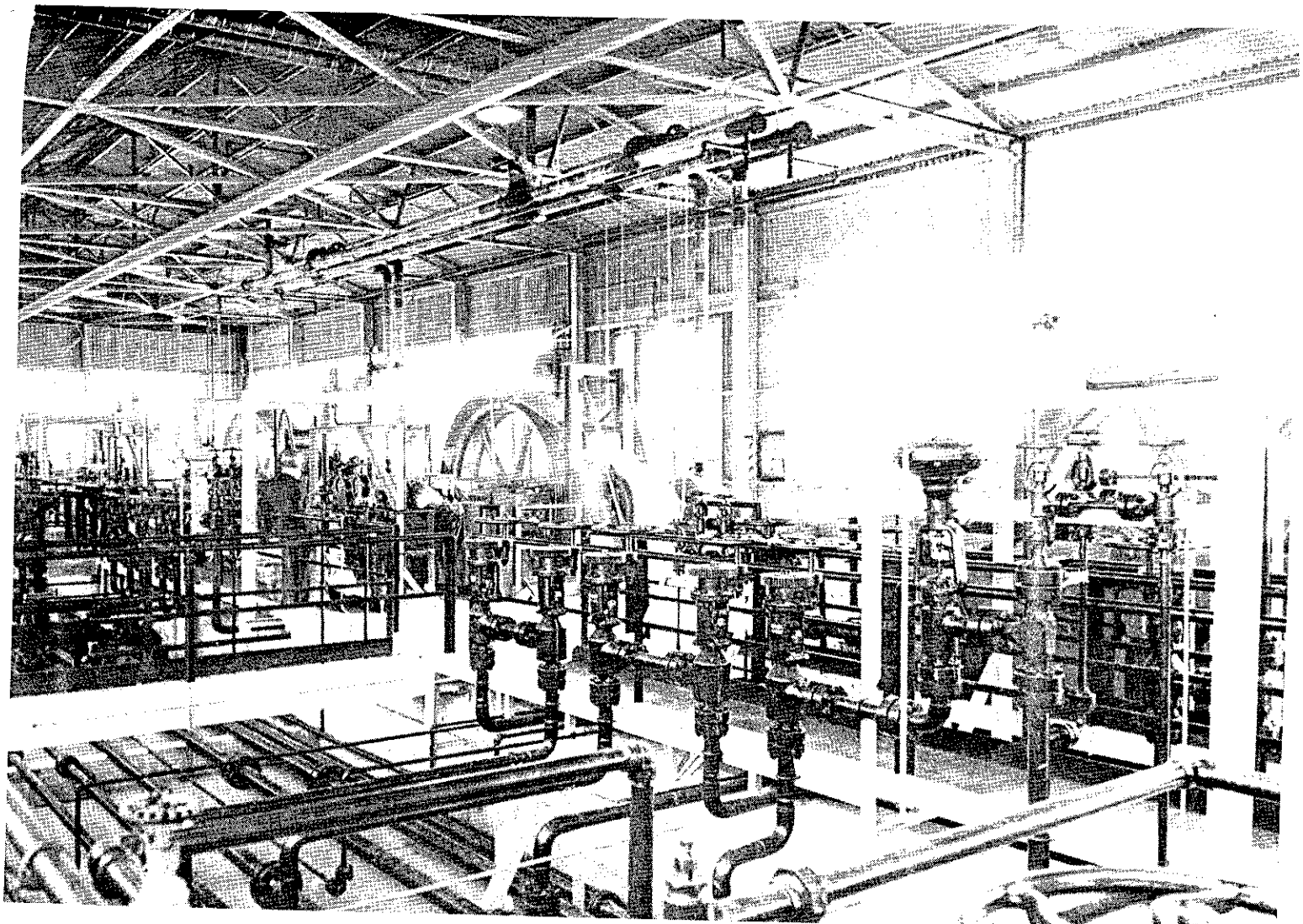

Figure 42. - In the compressor house, four high-pressure compressors return unused hydrogen to the conversion vessels, where it serves both as a cooling agent and as an additive to the coal. Two of the compressors are driven by electric motors and two by steam turbines.

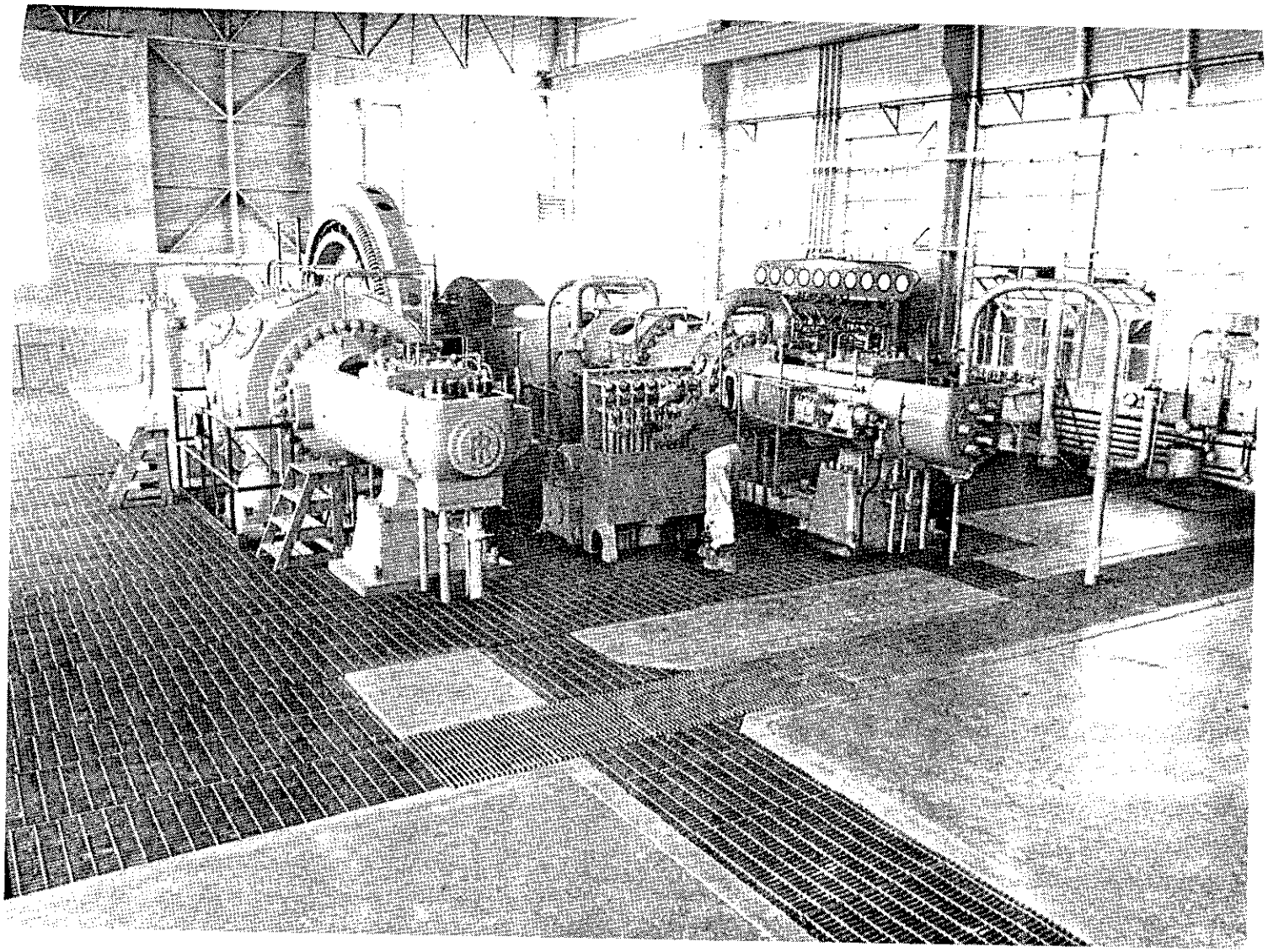

Figure 43. - One of the huge hyper compressors in the Missouri Ordnance Works now employed to replenish the hydrogen used in converting coal to oil. A seven-stage machine, it can compress 210,000 cubic feet of hydrogen per hour from atmospheric pressure to 15,000 pounds per square inch.

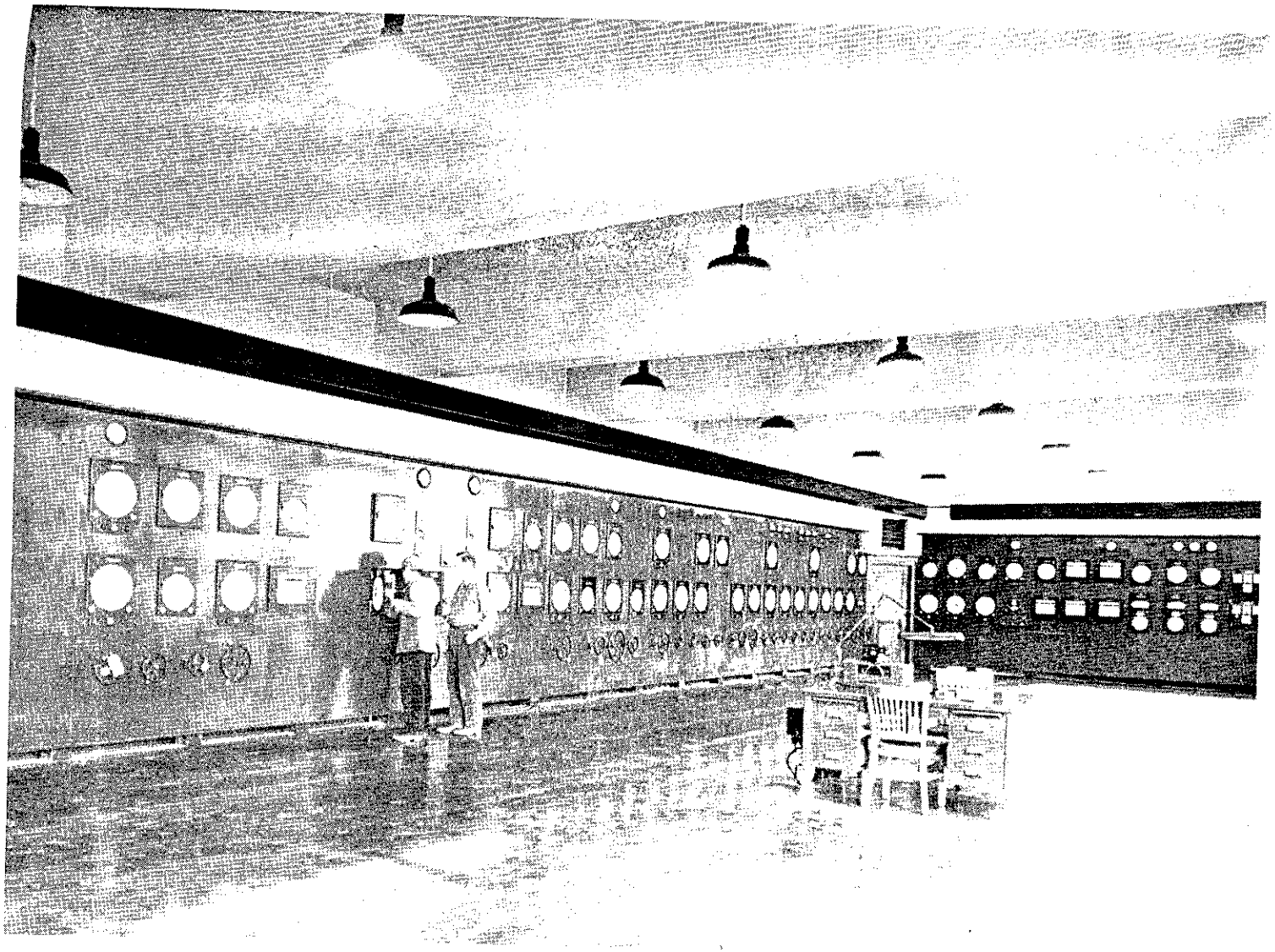

Figure 44. - The control house in the Coal Hydrogenation Demonstration Plant. Here, unerring instruments keep watch day and night over complex operations, observing and recording all pertinent changes in temperatures, pressures, and flows. No high-pressure lines enter this building, for the instruments transmit their messages by variable electric current or by air and liquid streams.

Although actual hydrogenation of coals has not yet been attempted, successful unit operations leading toward full plant operation have been carried out.

The gas-manufacturing area (part of the former Missouri Ordnance Works) was reactivated for the purpose of testing the equipment for hydrogen and nitrogen manufacture and for training the newly recruited, inexperienced operating personnel. This part of the plant also was operated intermittently, as required, during February and March for the purpose of supplying high-pressure nitrogen required in testing the high-pressure equipment in the hydrogenation plant. In April, hydrogen was manufactured, purified, and compressed as required for the first vapor-phase hydrogenation run.

The distillation area or refinery was taken over from the contractor late in 1948 for break-in operation on petroleum. Two months' operation required for testing the equipment, further training of operators, and preparation of petroleum-oil fractions for later hydrogenation break-in runs were completed successfully in February 1949.

The Bureau's operators and maintenance forces took over the high-pressure testing work of the hydrogenation plant in January 1949 (figs. 40, 41, 42, 43, and 44). High-pressure testing was carried out in February and March simultaneously with completion of wiring and zeroing instruments, process and steam piping, electrical installations, line bracing, insulation and painting. All testing was completed in the vapor phase unit and a run was made in April which successfully accomplished the following objectives:

1. It was determined that the unit as designed was operable.
2. The operating training program was found to be adequate.
3. Light petroleum oil was hydrogenated successfully at 700 atmospheres to produce motor gasoline.
4. Coal-tar distillate from North Dakota lignite was hydrogenated successfully at 700 atmospheres to produce high-octane gasoline and specification Diesel fuel.

This operation is of particular interest because it represents the successful run of the first 700 atmospheres hydrogenation plant in this country. It is also noteworthy that the run was made without delay or serious interruption, although the plant had not been run as a whole previously, and none of the operating crew had actual experience with similar operations.

The liquid-phase hydro plant has withstood high-pressure tests satisfactorily, and operation will be started when repairs and changes to injection pumps, nozzle welded piping, and instruments are completed.

Plant-scale coal preparation suitable for hydrogenation purposes is a new problem in this country. The coal must be dried to a low moisture content at low temperatures (300°-400° F.) in an inert-gas stream having low oxygen content to