Coals of Chile

The results of an investigation of coals of Chile made at the request of the Chilean Government was published.17/ The investigation was made to determine whether the coal from beds mined in the Schwager and Lota mines will yield metallurgical coke suitable for use in the blast furnaces at the proposed steel plant at Concepcion; and whether the quality of the lower-rank coals from other areas in Chile, especially those in Magallanes, where the largest coal reserves of Chile appear to exist, can be improved by processing. Mining methods were studied, and decreased costs and increased production were recommended.

The principal coal-producing areas of Chile are adjacent to the Bay of Arauco, approximately 20 miles (32 kilometers) south of Concepcion (see fig. 6). The two principal mines are Lota and Schwager, which produce a high-volatile A bituminous coal equaling approximately 80 percent of the total Chilean output.

Mining practices at the Schwager and Lota mines are governed principally by the frequency and magnitude of the faults that displace the coal beds. The situation of the mine workings under the ocean and the ever-increasing distance of the advancing mining face from the mine openings create a problem of ventilation and transportation. The Schwager has begun to sink two new shafts 3,000 feet and will drive rock gangways to intercept the coal beds at approximately 4 miles from the shaft. These gangways will eventually be extended to 8 miles.

The coal-mining problem in Chile is not only physical but economic. There are coal regions in the United States where physical conditions are as adverse as those in some mines in Chile, but conditions in this country have been studied thoroughly, and efficient mining practices have been developed. Wages in the United States far exceed those paid for similar work in Chile, but on a dollar basis the labor cost per ton is materially less in the United States. This is due principally to the high ratio of non-producers to producers at most Chilean mines. The ratio is out of balance in most of these mines, and this results in a low over-all output per man. This condition probably developed from the theory that "many hands make light work", in years past when the wage scales were low; but today wage scales are high in comparison, and the resultant labor cost per ton is high. With fewer men for a required output, mechanization is not always possible, and it will be necessary to increase efficiency, either through mechanization or improved mining practices.

Extraction of Pillars with Mechanized Equipment

A progress report discussing the results of studies of pillar extraction with mechanized equipment at 10 mines in Pennsylvania, West Virginia, and Wyoming was issued.18/ The operational curves contained in the report and the conclusions reached are based upon detailed studies of mining operations at 55 coal mines in all of the important coal fields in the United States.

The relation of man-hours per ton (on mechanized units using mobile loading machines) to thickness of coal bed at mines practicing pillar extraction and at mines where pillars are not extracted is shown in figure 7. Man-hours per ton at the face

17/ Toenges, Albert L., Kelly, Leon W., Davis, J. D., Reynolds, D. A., Fraser, Thomas, Crentz, W. L., and Abernethy, R. F., Coals of Chile: Bureau of Mines Bull. 478, 1948, 106 pp.

18/ Turnbull, Louis A., and Toenges, Albert L., Mechanical Mining in Some Bituminous Coal Mines. Progress Report 5. Extraction of Pillars with Mechanized Equipment: Bureau of Mines Inf. Circ. 7527, 1949, 59 pp.

are higher at mines where pillars are extracted than where pillars are not extracted. The difference in man-hours per ton increases as the thickness of the coal bed increases and ranges from 0.09 man-hour per ton for a bed 42 inches thick to 0.21 man-hour per ton for a bed 120 inches thick. Roof control generally is a greater problem where pillars are extracted, and the difference in man-hours per ton shown on the curves is due to additional time spent in timbering to protect the roof in operating sections. More men are required to set timbers where beds are thick than where they are thin.

Figure 8 shows the relation of man-hours per ton for total underground labor (using mobile loading machines) to thickness of coal bed at mines practicing pillar extraction and at mines where pillars are not extracted. Total labor employed underground ranges from 0.22 to 0.25 man-hour per ton more at mines where pillars are extracted than where pillars are not extracted.

Figure 9 shows the relation of tons of raw coal loaded per mobile loading unit per hour to thickness of coal bed at mines practicing pillar extraction and at mines where pillars are not extracted. This shows the small difference in coal loaded per hour in pillar extraction and where pillars are not extracted. This difference is about 2 tons per hour for all bed thicknesses. For example, in a 72-inch bed, production per loading machine per hour where pillars are extracted will be about 7 percent less than in mines where pillars are not recovered.

The most difficult problem encountered in extracting pillars with mechanized equipment is the effective control of not only the immediate roof but the entire overlying strata. The speed and regularity with which pillars are extracted help to obtain regular breaks in overlying strata along established pillar lines, thus relieving the weight at the coal faces. Many mines take advantage of natural cleats in roof rock to obtain frequent and systematic roof falls.

The production per mobile loading machine is 6 to 10 percent less in pillar mining than where pillars are not recovered. Production per conveyor per hour seems to be about the same in pillar and nonpillar mining.

Extraction of pillars in coal mines brings considerations of costs and effects on other property, which should be examined prior to adopting a plan for extraction.19/ Consideration should be given to effect upon coal beds above and below that in which pillars are to be extracted and to effects upon the surface that will result from the inevitable subsidence.

Coal Mining Methods and Practices in Western Arkansas

A preliminary study of mining methods and practices was made at six Arkansas coal mines - two in each of the coal areas.20/

The western Arkansas coal fields lie in the Arkansas River Valley region, which is bounded on the north by the Boston Mountains and on the south by the Ouachita Mountains. Erosion of folded structures has divided the coal area into separate mining districts (see fig. 10).

19/ Greenwald, H. P., Surface Factors Affecting Pillar Recovery: Mining Cong. Jour., vol. 35, 1949, pp. 54-57.

20/ Toenges, Albert L., and Fish, Edward L., Coal Mining Methods and Practices in Western Arkansas. Preliminary Investigation: Bureau of Mines Rept. of Investigations 4448, 1949, 25 pp.

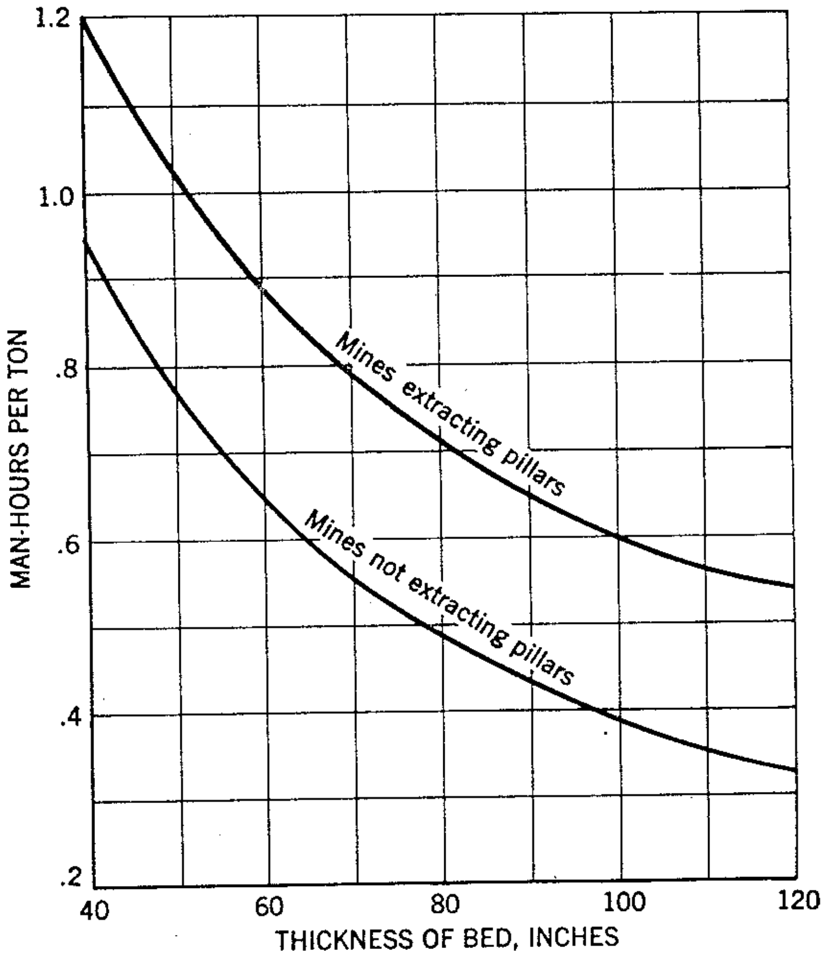

Figure 8. - Relation of man-hours per ton from total underground labor to thickness of bed. Pillars extracted and pillars not extracted. Mobile loading machines. (Man-hours computed from full 7-, 8-, or 9-hour shifts.)

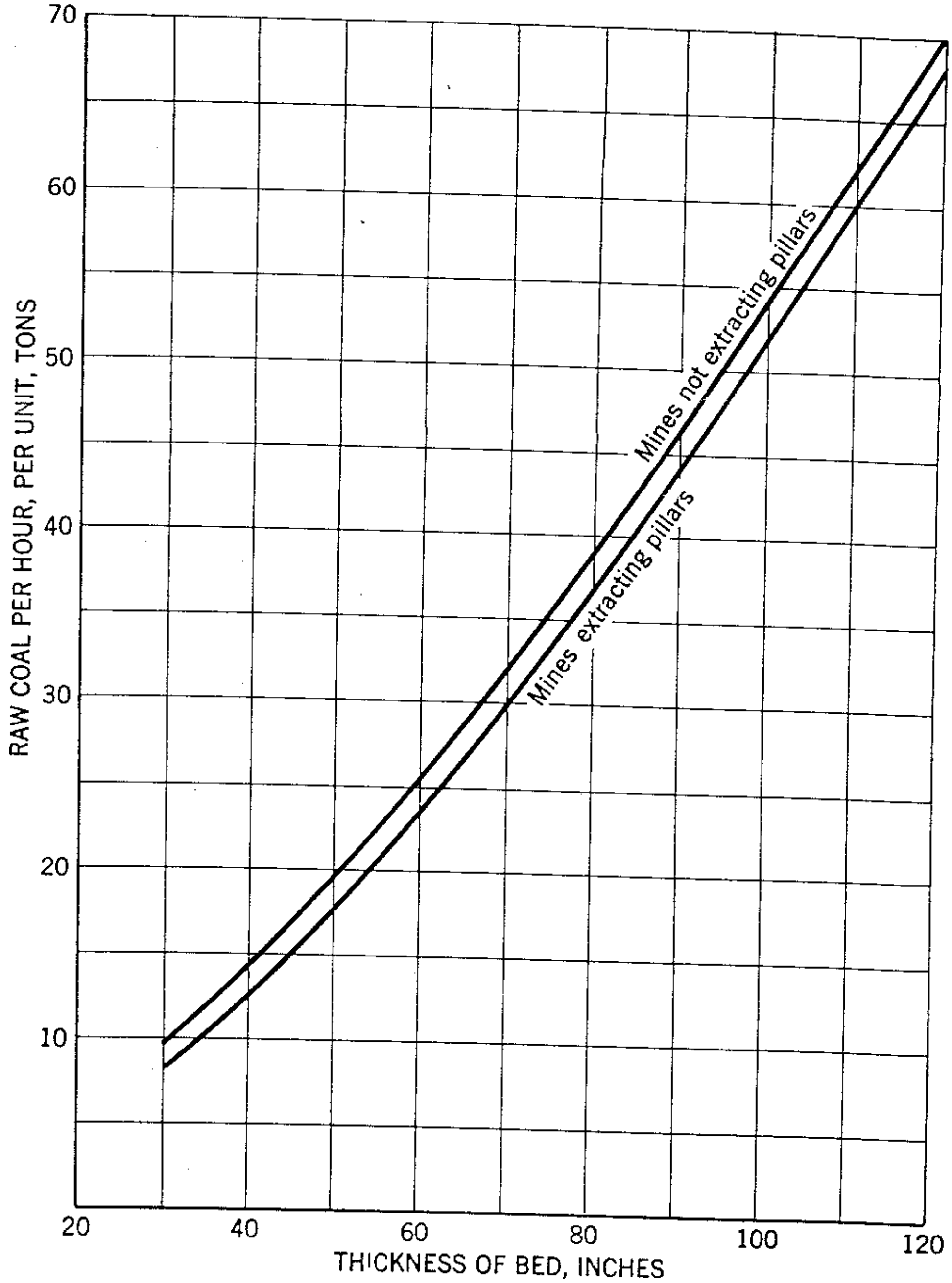

Figure 9. - Relation of tons of raw coal loaded per mobile loading unit per hour to thickness of coal bed. Pillars extracted and pillars not extracted. (Tons per hour computed from full 7-, 8-, or 9-hour shifts.)

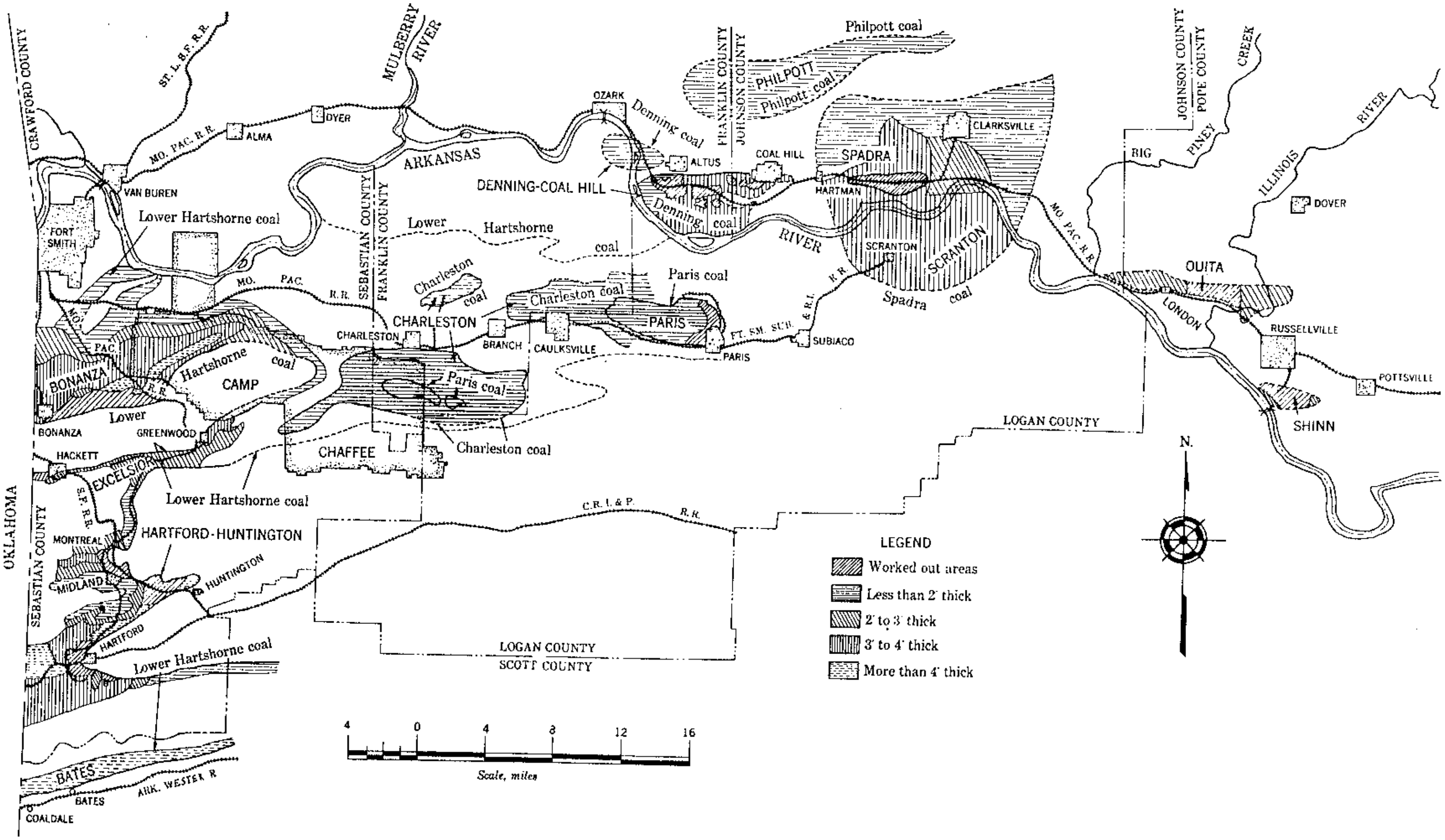

Figure 10. - Coal fields of western Arkansas. Compiled from unpublished map of western Arkansas coal fields. Arkansas Geological Survey, 1941.

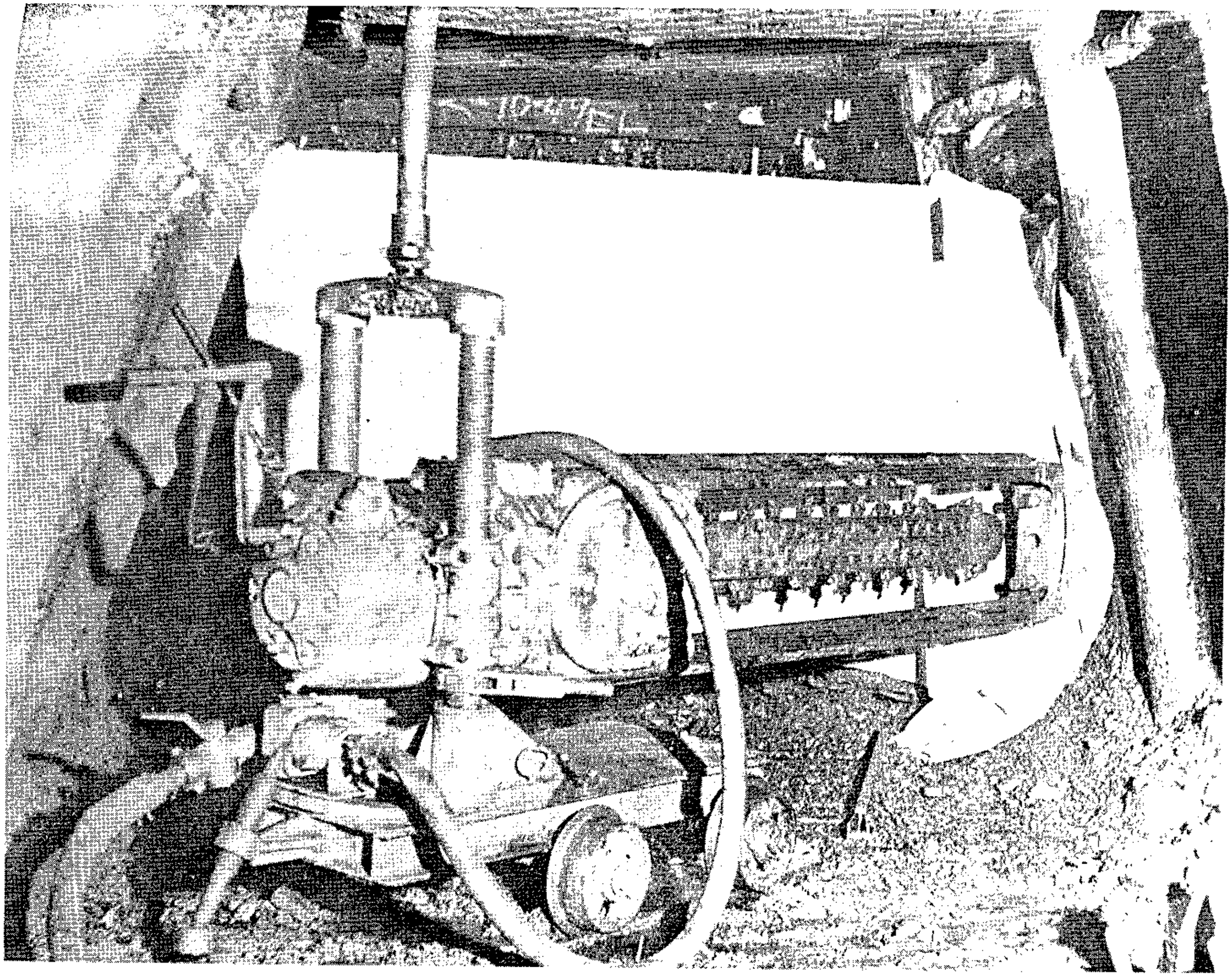

Figure 11. - Korfmann Universal shearing machine, Model SK 20, used in driving a 420-foot pillar road in a 28-foot coal bed without shattering the pillar.

New and broader markets are needed for Arkansas coals. Larger markets would necessitate a longer work year, which could attract the skilled type workman not now available to the mines of this State. A market for smaller sizes than are now demanded by consumers of Arkansas coal also is needed, as further mechanization of the mines would result in degradation of the friable coals of this area. Present market demands are for large lump coal.

Slope Sinking Through Water-Bearing Strata

The Bell & Zoller Coal & Mining Co. recently completed the construction of two slopes through water-bearing strata at mine 3, near Ziegler, Ill. These operations, which were studied by Bureau engineers,21/ were in the Big Muddy River Valley, and construction was particularly difficult because the strata from the surface to a depth of 70 feet comprised water-saturated, sandy clay, and sand.

Missouri River Basin Coal Studies

Studies of coal-mining methods and practices, electrical-power requirements at coal mines, and coal resources in the Missouri River Basin were continued. Detailed investigations in the Wind River Region, Fremont County, Wyo., were completed. A field study of coal-mining operations and coal resources in that part of the Kansas coal fields in the Missouri River drainage area was completed, and a report of this work is in preparation.

Greek Lignite

At the request of the Economic Cooperation Administration, an investigation of lignite deposits and mining methods and practices in Greece was made to determine whether sufficient reserves of lignite (the only fuel in Greece) were present for the development of mines to produce 1,000,000 tons annually, and to recommend improvements in mining methods and practices that would increase production and reduce costs.

Anthracite Mechanical Mining Research

The Bureau's participation in anthracite mechanical-mining studies has consisted in providing new and untried machinery22/ and engineering services. Cooperating companies have provided underground test sections, power, labor, supplies, and engineering services. Projects are active in the northern, western, middle, and southern fields of the anthracite region of Pennsylvania. Headquarters for activities are at Schuylkill Haven, Pa.

Air-powered German lightweight shearing machines have been introduced by the Bureau for both flat and pitching beds. In the flat beds of the northern field, a project was completed for driving a pillar road 420 feet long in a 28-foot-thick coal bed without shattering the pillar. This project was undertaken in connection with changing the mining system in an area containing 1,100,000 tons of marketable coal in pillars. The type of machine used for this work is shown in figure 11.

21/ Shields, Joseph J., and Turnbull, Louis A., Slope Sinking Through Water-Bearing Strata at Mine 3, Bell & Zoller Coal & Mining Co., Williamson County, Illinois: Bureau of Mines Inf. Circ. 7509, 1949, 5 pp.

22/ Buch, John W., Trends in Anthracite Underground Mine Mechanization: Trans. 7th Ann. Anthracite Conf., Lehigh University, Bethlehem, Pa., May 1949, pp. 195-206.

In the southern field, work has been completed that establishes the performance of lightweight air-powered shearers as a fourfold improvement over hand methods in developing thin coal beds on heavy pitch. One of these machines is illustrated in figure 12.

In connection with studies of mine development, conventional timbering methods were found to be wasteful of time and probably of material. In order to design a fully mechanized timbering method, tests were undertaken to establish data for loads borne by roadway supports. Preliminary laboratory test work is nearly completed. This work will be used as the basis for designing and building an experimental telescopic shield to improve efficiency and safety for the face worker and to eliminate the arduous labor of conventional timbering methods.

Hydraulic back filling and hand packing have been practiced for a long time in the anthracite area, and some small amount of work has been done pneumatically. However, all such work has proved so costly that full advantage has not been taken of back filling for roof control and pillar strengthening. Two years ago the Bureau imported, for experimental purposes, a packing machine of German origin that has had widespread use on the Continent and in England for many years. This machine was installed on the surface at a Northern field mining operation for preliminary test runs that proved very satisfactory. The machine has been installed underground for further testing. The machine is shown in figure 13.

A vibrating-blade coal planer patterned in principle after those experimented with in Germany during the years of World War II was designed by and is now being built for the Bureau.

Studies on the Use of Diesel Engines Underground

Work has been completed on the removal of aldehydes from Diesel exhaust gas by scrubbing with an aqueous solution containing sodium sulfite (10 percent by weight) and hydroquinone (0.5 percent by weight).[23]

A study of the variables that affect the average rate of reaction during inflammation in a Diesel engine was begun. Under the heterogeneous conditions existing during combustion in such an engine, it is difficult to separate the effects of different variables. However, preliminary results indicate that the following relationships exist: (1) Fuel concentration is of primary importance in determining the average rate of reaction. (2) The reaction rate increases with the increased density of the intake air; as previous work has established that reaction rate is independent of the partial pressure of oxygen, this effect is believed to be due to the better atomization and distribution of the fuel obtained with greater air density.

The lower limit of inflammability of natural gas (the concentration at which essentially all of the gas is burned) in a CFR Diesel engine was determined to be 4.8 percent in the intake at a liquid fuel:air ratio of 0.0066 pound per pound. Natural gas alone could not be ignited by compression in the CFR Diesel engine. The lower-limit flammability of hydrogen in a 4-cylinder Hercules DOOC Diesel engine was similarly determined to be 12 percent in the intake at a minimum liquid fuel:air ratio.

23/ Davis, R. F., and Elliott, M. A., The Removal of Aldehydes from Diesel Exhaust Gas: Trans. Am. Soc. Mech. Eng., vol. 70, 1948, pp. 745-750.

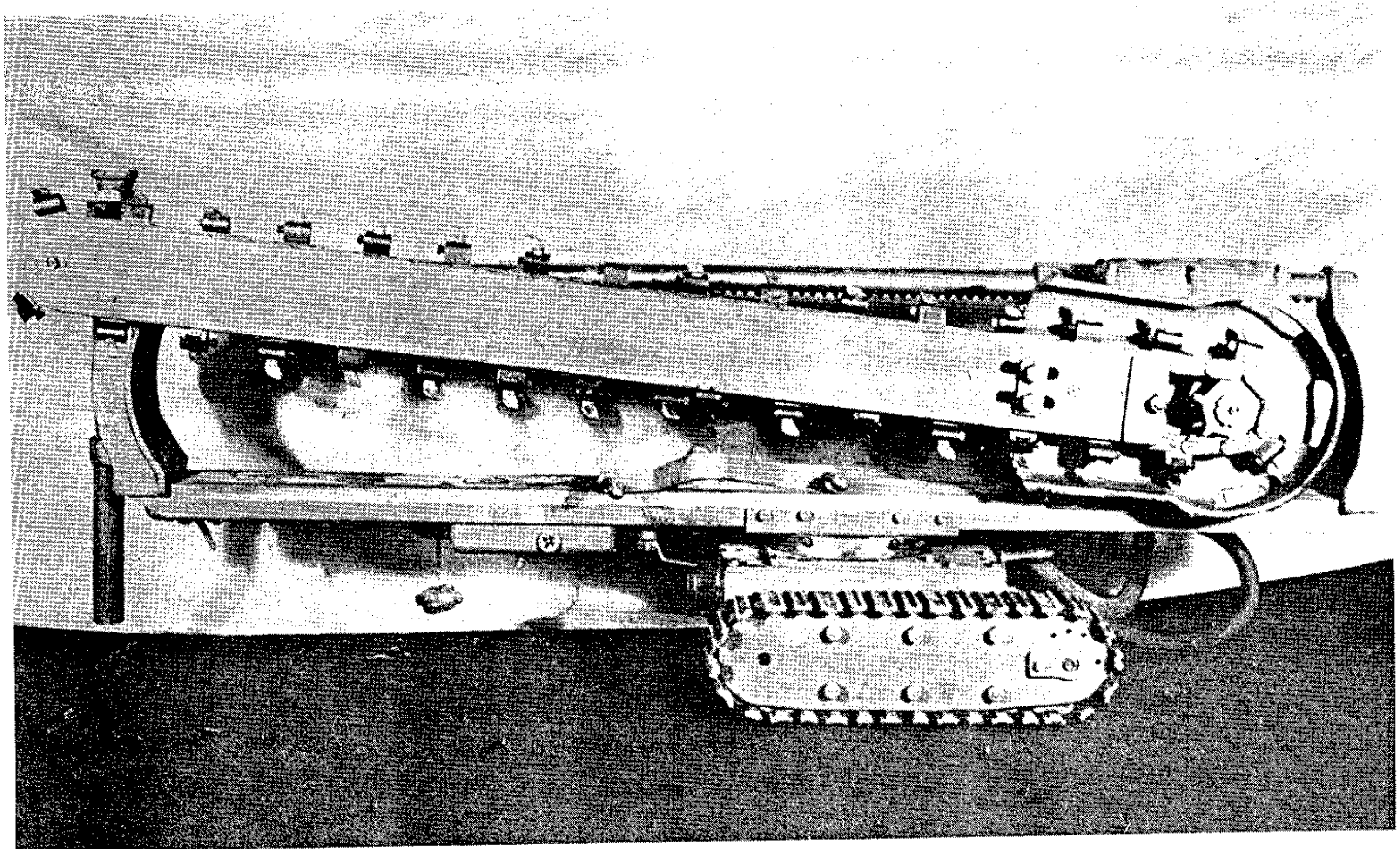

Figure 12. - Korfmann shearing machine, Model SK 15, used in establishing performance data for thin, steeply pitching beds of the Southern field.

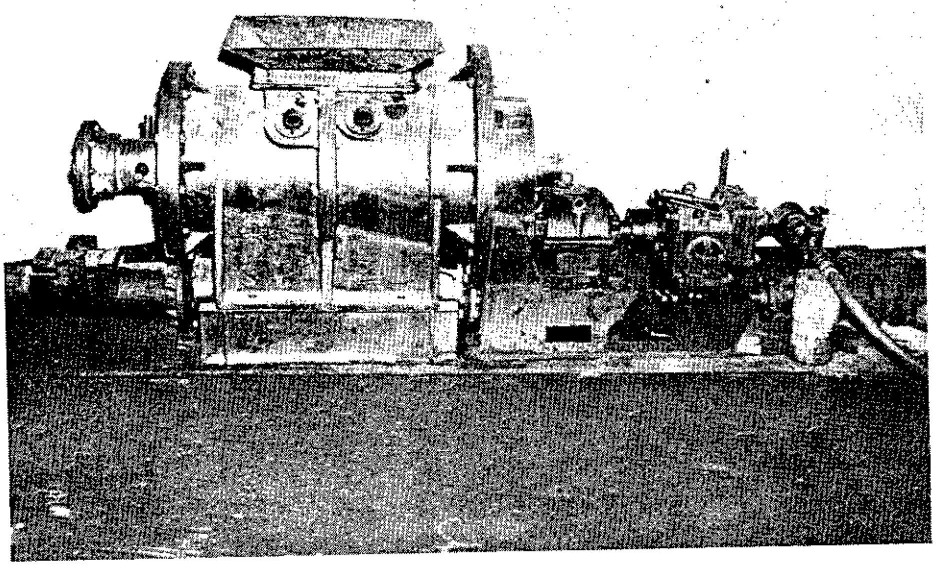

Figure 13. - Brieden pneumatic packing machine. Rock for building pack introduced at top of machine and fed to air stream at bottom by a segmented, rotary, internal drum powered by an air motor. Performance data not available.

The results of studies made by the Bureau of Mines on the use of Diesel engines underground were presented.24/ These studies, as well as those made by other agencies, have shown that Diesel engines can be operated safely underground if the following conditions are met:

1. Ventilation must be provided to dilute adequately and remove from the underground atmosphere all harmful and objectionable constituents (carbon monoxide, oxides of nitrogen, carbon dioxide, oxides of sulfur, aldehydes, and unburned carbon) of the exhaust from the engine.

2. Flame protective devices must be provided for the intake and exhaust systems of the engine to prevent ignition of a flammable atmosphere.

3. Fire hazards in handling Diesel fuel underground must be eliminated.

Under normal operating conditions with engines in proper mechanical condition, the concentration of flammable constituents in the exhaust is low enough to permit their dilution to a safe value in the underground atmosphere by supplying adequate ventilation. To avoid undesirable operating conditions, careful attention must be given to the maintenance and adjustment of Diesel engines in underground service.

Tests of three different Diesel engines have shown that a flammable atmosphere surrounding the engine could be ignited by flame issuing from either the intake or exhaust systems. Flame arrestors should therefore be provided for the intake and exhaust openings.

Flame arrestors on Diesel engines may operate at elevated temperatures, depending upon their position in the exhaust systems.

Upon the basis of information obtained in the testing station and in the field, the Bureau of Mines has issued schedules 25/, 26/ outlining the procedure for testing Diesel mine locomotives for permissibility and making recommendations for use of Diesel engines underground.

International Conference of Directors of Mine Safety Research

The Fifth International Conference of Directors of Mine Safety Research was sponsored by the Bureau of Mines and held in Pittsburgh on September 20 to 25, 1948. The Conference was attended by official delegates from five European countries and the United States and by many guests from these and other countries. The technical sessions were devoted to presentation and discussion of recently developed experimental data on explosives, firedamp, coal-dust explosions, mine fires, electricity and haulage, and health and safety in mining.

24/ Elliott, Martin A., Review of Bureau of Mines Work on the Use of Diesel Engines Underground: Bureau of Mines Rept. of Investigations 4381, 1948, 28 pp.
25/ Bureau of Mines Schedule 22 - Procedure for Testing Diesel Mine Locomotives for Permissibility and Recommendations on the use of Diesel Locomotives Underground: Federal Register, vol. 9, No. 230, Nov. 17, 1944, pp. 13742-13753, incl.
26/ Bureau of Mines Schedule 24 - Procedure for Testing Mobile Diesel Powered Equipment for Non-Coal Mines: Federal Register, vol. 14, No. 67, April 8, 1949, pp. 1671-1677, incl. Correction for Schedule 24: Federal Register, vol. 14, No. 113, June 14, 1949, p. 3201.