COAL AGE

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DEVOTED TO THE OPERATING, TECHNICAL AND BUSINESS PROBLEMS OF THE COAL MINING INDUSTRY

SYDNEY A. HALE, *Editor*

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Salute to Indiana

No MAJOR coal district faces greater competition than Indiana. Rival producing States border it on east, south and west. Important home markets must be shared with Appalachian-region and Illinois mines. Yet, in good times and bad, Indiana has maintained its position in the national coal-production picture. Others may topple or climb in the scale; Indiana has stood sixth in the tonnage rank of bituminous States for a quarter of a century.

THIS STABILITY is a real tribute to progressive Indiana coal operators. More specifically, it is a tribute to their determination to keep down costs by adopting new equipment and methods for increasing man-hour and man-day productivity. That average output per man per day for Indiana in 1936 was topped only by Montana was no accident. On the contrary, it was the direct result of continuous and continuing modernization.

BACK IN 1922, when few operators were willing to give even lip service to the idea, an Indiana mine blazed the trail by completely mechanizing loading with mobile-type equipment. Three years later this same mine pioneered in double-shifting these machines. About the same time stripping, too, began to assume increasing importance. Ten years ago mechanized mining — underground and strip — accounted for about 45 per cent of the Indiana output; last year the percentage was approximately double the 1928 figure.

HOW THE MACHINE, properly employed, can bring new life to a field and re-create opportunities for employment is strikingly illustrated in the story of the Brazil Block field. Twenty years ago the impossibility of economic operation under older methods was tolling the knell of that area. Last year block-coal output was more than three times what it was in 1917. Dragline stripping at relatively small operations has been primarily responsible.

HITCH DRILLING has had its greatest development in the Hoosier mines. Its adoption has effected substantial savings in timbering costs under bad roof conditions. Indiana also has pioneered in conditioning intake air to check summertime roof disintegration. Hoosier strippers have been among the leaders in the use of automotive transportation and in dual-haulage systems between pits and preparation plants. Modern mechanical cleaning made its Midwestern debut in Indiana.

THIS MODEST CATALOG by no means exhausts the list of Indiana's contributions to mining progress. These contributions are set forth in the pages which follow. While, with two exceptions, the articles are the work of *Coal Age* editors, actually they represent the cooperation freely given by more than 250 Indiana executives and operating men. To them and to their readiness to share the fruits of their experience with their brother operators, the industry at large may well consider itself deeply indebted.

INDIANA COAL FIELDS

+ Lie Along Eastern Edge Of Large Three-State Basin

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THE Indiana coal field, covering about 7,000 square miles in the southwestern part of the State, is part of the Eastern Interior coal basin. The Indiana-Illinois-western Kentucky basin covers the southwest half of Indiana, practically all of Illinois except the most northerly portion of the State, and continues south into Kentucky, including most of the western part of the State down to the Tennessee border. The outcropping of the Pennsylvanian formations containing the coal of this district, however, is more limited than the extent of the basin structure as a whole. Coal formations probably underlie an area totaling 58,000 square miles, but only about 55 per cent of this district is productive (Fig. 1).

To the north of this large syncline, or basin, is found a somewhat similar structure occupying much of the southern peninsula of Michigan, where coal also is found, although its present commercial importance is far below that of the district we are describing. Oil production, on the other hand, has in recent years made Michigan one of the leading States east of the Mississippi in that industry. This discovery of important oil deposits in the Michigan basin no doubt contributed to the activity which has recently resulted in bringing into production new oil fields in Illinois, Indiana and western Kentucky. Seismic prospecting and new drill logs made in connection with this oil boom have contributed greatly to the detailed information of many sections of the basin where formerly little was known except the broad general structural outlines.

Separating the Michigan basin from the Illinois-Indiana-western Kentucky basin is an arch which is a northwest extension of the Cincinnati dome or anticline. To the south of the basin is another important dome structure called the Nashville arch, and to the southwest are observed some of the recent deposits of Tertiary age in the extensive Mississippi embayment. Farther to the southwest is located the extensive Ozark Mountain region.

In the center of the Eastern Interior coal basin, since outcrops are fairly rare, having been covered in many places by glacial deposits, what has been known of the structure was to a large extent due to opening up of coal properties and to occasional drilling operations that may have taken place. Recently, however, extensive geophysical prospecting has resulted in the clarification of much of the structure and in the discovery of details previously unsuspected. More minor anticlinal structures have been discovered on the major syncline, as well as a number of previously unknown fault zones. In Illinois we find a very strong northwest-southeast structure known as the LaSalle anticline which carries across the Wabash and into southern Indiana well below Terre Haute. In Illinois one of the most important structural breaks is the Shawneetown-Rough Creek fault, having an east-west direction. In In-

Table I—Geological Column*

Pennsylvanian	Post Alleghenian	Wabash, 250–300 ft. Meron, 75–90 ft. Shelburn, 150–235 ft.	Coal VIII
	Alleghenian	Petersburg, 180–300 ft.	Coal VII " VI " Va " V " IVa
		Staunton, 150–200 ft.	Coal IV " IIIa " III " II
	Pottsvillian	Brazil, 60–80 ft.	Minshall Upper Block Lower Block
		Mansfield, 80–300 ft.	Coal I
Mississippian	Chesterian Meramecian Osagian Kinderhookian		
Devonian	Senecan Erian		
Silurian	Cayugan Niagaran Medinan		
Ordovician	Cincinnatian Mohawkian		

*Summarized from the Geological Map of Indiana, Pub. No. 112, Department of Conservation, 1932.

diana just east of the outcropping of Pennsylvanian rocks is the Mt. Carmel fault, trending northwest-southeast and extending from Washington County down into Montgomery County.

The general dip of the formation in the Indiana part of the Eastern Interior basin is 30 to 50 ft. per mile, though locally greater dips may be observed.

The Pennsylvanian rocks with which we are most concerned—as they contain the coal seams—have a thickness of more than 2,400 ft. in southeastern Illinois, almost 3,000 ft. in parts of western Kentucky, and a little less than that in the thickest parts of the Indiana field. The geological column (in Table I) shows the thickness of the various units making up the Pennsylvanian System.

In the entire Eastern Interior basin, there are just under sixty different coals, but only about two-thirds of these have been worked for fuel. Operations generally have been in places where a thickness of 2 ft. or more has prevailed. In Indiana, 32 seams have been observed, of which nine may be considered to have been the seat of operations on a commercial scale and sixteen have been locally mined. Illinois has more coals present, but about the same number now are being worked. In western Kentucky the proportion is about the same as in Indiana.

Coal is said to have been discovered in the Eastern Interior basin toward the close of the seventeenth century by Father Marquette near LaSalle, Ill. In Indiana the date of 1763 is associated with mention of coal along the Wabash by Colonel Croghan, but the first mining is believed to have taken place in Perry County about 1812.

In discussing the various coal seams, we will start with the oldest and end with the youngest, following the nomenclature introduced by Ashley in his 1898 report for the Indiana State Geological Survey and corrected and added to in his 1908 report (see bibliography at the end of this article). Most of these coals are designated by the Roman numerals from I to VIII (Fig. 2). Many of these seams might be observed outcropping as one moved westward toward the interior of the basin from the region around Brazil, in Clay County, toward the Illinois portion of the basin.

There are several coals below the Brazil Block coals which are of local importance, such as the Cannelton coal in Perry County, the Kirksville coal in Monroe and Greene counties and the Shoals coal in Martin County, but they are of such limited extent that we will describe only one of them in this article.

Cannelton—In contrast with a thickness of 1,000 to 1,500 ft. for the Pottsville formation in Pennsylvania, here in Indiana we have only 150 to 400 ft. of this formation, and it is in this group of rocks that an interesting "block-like" Indiana coal is found. The Cannelton coal in Perry County probably is one of the first coals to have been mined in the Eastern Interior basin and also undoubtedly is the lowest coal to be mined commercially in the entire basin. It corresponds to the Hawesville coal of western Kentucky and coal No. Ia of southern Illinois. Its thickness ranges downward from 4 ft. to an average of about 3 ft., and the vein appears to be found in basins of comparatively limited areal extent. In various places it is underlaid by a variety of cannel coal, but more frequently by shale or clay. It is found a few feet above the top of the Mansfield formation.

Lower and Upper Block—The favorable qualities of this coal, which was first worked about 1851, led to a very rapid increase in coal production in Indiana, with the center of its production in Clay County.

Fig. 1—Geological map of the Central States showing relation of Indiana to other areas

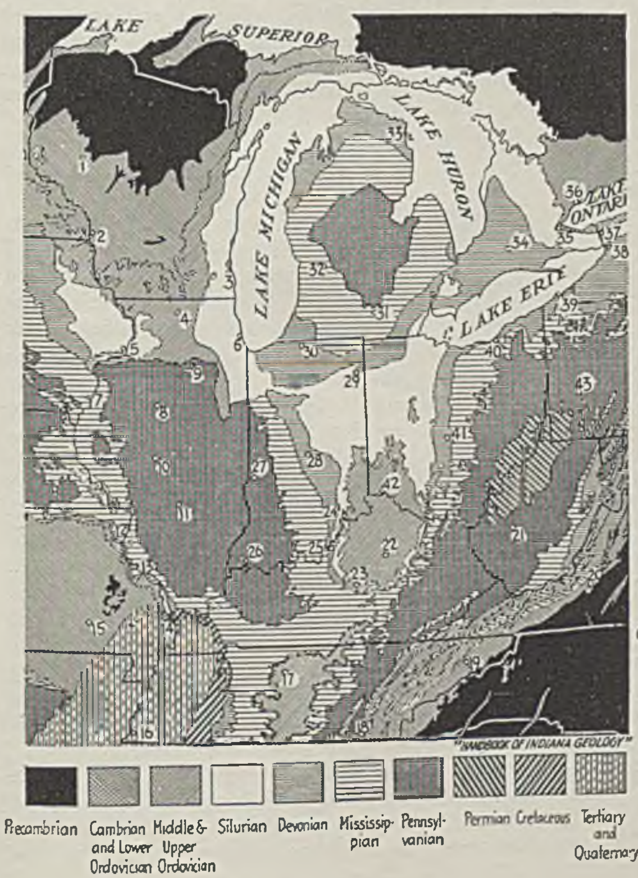

Fig. 2—Pennsylvanian outcrop map of Indiana and sequence of coal seams

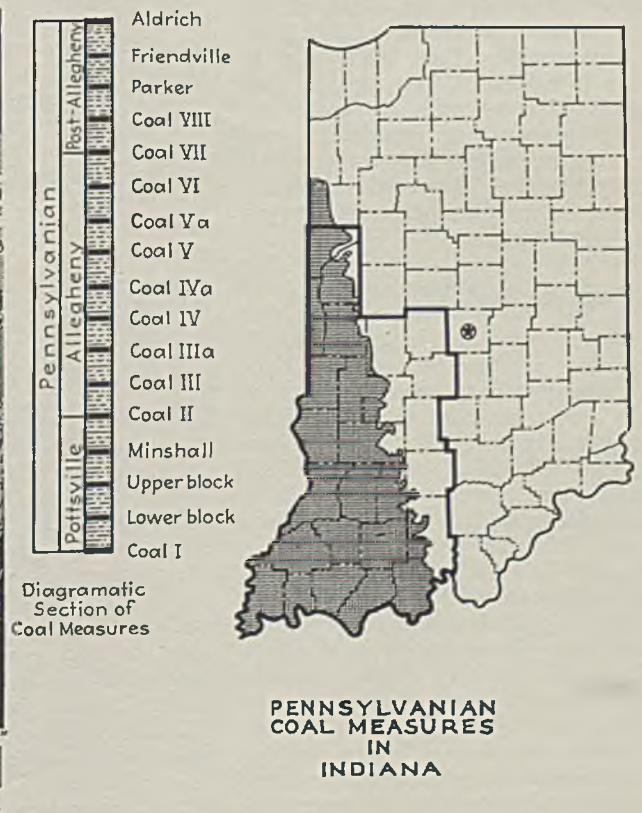

Table II—Correlation of Coals in the Indiana-Illinois-Western Kentucky Basin*

Northern and Western Illinois	Southern Illinois	Western Kentucky	Indiana
Trivoli (No. 8) coal	Present	?	Parker (VIIIa) coal
Absent	Present	No. 15 coal	Brouillott (VIII) coal
Present	Cutler Coal	Present	Present
Absent	Bankston coal	Baker No. 14 coal	Absent?
Danville No. 7 coal	Absent	No. 13 coal	Coal VII
Absent	Jamestown coal	No. 12 coal	Millersburg coal
Streator No. 6	Herrin No. 6 coal	No. 11 coal	Coal VI?
Absent	Briar Hill No. 5a coal	No. 10 coal	Grape Creek coal, E. Illinois
Springfield No. 5 coal	Harrisburg No. 5 coal	No. 9 coal	Petersburg (V) coal
Summum No. 4 coal	No. 4 coal	Goshen No. 8b coal	Houchin Creek IVa coal
Kertor Creek coal	Absent	Absent	Absent
Lowell coal	Local	No. 8 coal?	Linton (IV) coal
Colchestern No. 2 coal	Present	Schultztown coal	Veipen (IIIa) coal
Lower Liverpool coal	Present	Present	Staunton (III) coal
Greenbush coal	Dekoven coal	Dekoven coal	Present
Wiley coal	Davis coal	Davis coal	Present
Seahorne coal	Present	Present	Present
Present	Stonefort coal	Lewisport coal	Holland coal
Upper De Long coal	Bald Hill coal	Present	?
Lower De Long coal	Curlew coal	Mining City coal	Coal II
Rock Island No. 1 coal	Murphysboro coal	Mannington	Minshall coal
Pope Creek coal	Present	Elm Lick coal	Upper block
Tartar coal	Willis coal	Bell coal	Lower block
Absent	No. 1a coal	Hawesville coal	Cannelton coal
Babylon coal	Battery Rock coal	Main Nolin coal	Present
Absent	Absent	Absent	Coal Ia
Absent	Absent	Absent	Coal I

*Extract from an article by H. R. Wanless (see bibliography at end of article).

This county led others in the State in total production until the turn of the century. The mining of Brazil Block coal is now carried on most extensively in Clay, Owen, and Parke counties, with about fifteen rail shipping mines in Clay County, four in Owen and one in Parke County.

The Upper Block often lies about 30 feet below the Minshall seam and is followed at about a similar depth by the Lower Block coal. A small basin structure in these coals frequently is evident with the coal thinning out toward the edges of the basins from thicknesses of 4 or 5 ft. as maximums. These basins vary in size from several acres up to hundreds of acres, with the coal thinning between these depressions until mining operations are not economically possible. A layer of coal several inches in thickness generally connects adjacent basins.

Lower Block Widely Mined

The Lower Block is well represented in the northern part of Clay County and appears to extend from southern Parke down to Greene County. Apparently coal which may be correlated with this formation is mined locally in other southern Indiana sections as well as in western Kentucky (the Bell coal), southern Illinois (Willis seam) and western Illinois (Tartar coal).

The Upper Block is important in the same general region in northern Clay and southern Parke counties. To the south this coal thins out but it has been worked locally in Greene, Daviess, Dubois, and Perry counties on the south-southeasterly continuation of the formation. In southwestern and northwestern Illinois (Pope Creek) and in western Kentucky (Elm Lock), this coal has not been of great importance, local operations only being represented. In Clay County the roof generally is shale or sandstone with a floor of clay underlying the formation. One peculiarity of the seam is a band of brittle coal several inches thick which occurs just below the middle of the vein.

Block Veins Break Regularly

These seams may be termed splint coals characterized by a tendency to break in rather regular blocks, some of them 2 to 3 ft. on a side, and by their banded structure. They tend to be rather hard with a low ash content, as well as low percentages of sulphur and volatile matter, but are high in heat value. A typical sample of Brazil Lower Block coal would run:

Moisture	15.38
Volatile matter	32.66
Fixed carbon	46.08
Ash	5.88
Sulphur	1.95
B.t.u.	11,680

Minshall—In Parke, Warren, Vermillion and Fountain counties, about 30 ft. above the Upper Block and about 100 to 120 ft. below Coal No. III, is found the typical development of a compact shiny coal having some tendency to break in blocks, bearing the name Minshall. In comparison with the block coals it has a lower heat value and is higher in volatile material and sulphur. Underlaid by a fireclay, it has a roof of black shale followed by a rather thin-bedded layer of fossiliferous limestone which at times forms the roof for this coal. The presence of a marine limestone over this coal seems frequent not only in Indiana but a thick limestone is found in northwestern Illinois, in central Illinois, where the coal is Rock Island No. 1, and in Kentucky above the Load Creek coal. The thickness of the seam varies from about 4 ft. up to 6 ft. at Mecca, in Parke County. To the south this formation tends to thin down considerably, and in general throughout Indiana the small irregular deposits make conditions suitable for local operations only.

Coal II—Ten to 20 ft. above the Minshall is found the No. II coal. It is rarely commercially important because of its thinness, although in Warren County it ranges from 2 to 3½ ft. Much of it has been removed by erosion, rendering continuous mining operations largely a matter of chance. It is underlaid by fireclay which occasionally rests directly on top of the Minshall formation. This coal sometimes is called the Upper Minshall or Rider Minshall.

Between the Minshall and the No. III coals there are a number of veins which are important locally, particularly in Illinois and Kentucky; for example, the Davis coal.

Coal III—This coal is well represented from the Linton region, in Sullivan County, north to the Coxville area, in Parke County. At present only two rail shipping mines are working this vein, one an important mine in Vigo County and another in northern Clay County. In Parke and Vermillion counties it is about 4 ft. thick; in Clay County it reaches 6 ft. in thickness.

Partings Present in No. III

In the northern part of Vigo County, Vein III varies between 5 and 7 ft. in thickness, with about 5 ft. the average of the coal. In this same region the seam has two definite rock and pyrite partings about 12 to 18 in. apart in the lower half of the seam. Pyrite and sulphur balls also are found extensively throughout the seam. A fireclay floor comes immediately below the coal, but beneath this is found on occasion a very mobile layer which, because of its fluidity, may cause some mining problems. The roof is a gray slaty shale which at times becomes difficult because of the squeezing or subsidence in the floor rock. In other regions the clay and pyrite partings may total 6 to 12 in. and sulphur and pyrite balls frequently are encountered.

South of Greene County the seam narrows down to a foot or less and is not minable. Coal of similar age is found in western Kentucky and

Illinois but is not of enough importance for commercial operations. It is quite possible that in the future the No. III vein, which accounted last year for about 5.34 per cent of the State production, will become more important in the Indiana picture.

Coal IV—At the present time this seam accounts for more than three times the tonnage of the previous vein. Eighteen rail shipping mines are now operating in this vein from southern Vermillion through Vigo, Clay, Sullivan, and Greene to northern Knox counties, with most of the mining operations in western Greene County north of Linton. The coal is rather low in sulphur and ash.

Average thickness of this bed is about 5 ft., but it may go up to 7 ft. in some places. A parting near the center frequently is observed. In northern Vermillion County, this coal thins down considerably, as also to the south in Daviess and Pike counties. In Illinois and western Kentucky, it seems to be too thin to be worked at the places it has been examined. The roof is generally gray or blue shale, but sandstone is at times found and the floor often is a sandstone or fireclay.

Veins 75 ft. Apart

A 75-ft. interval generally separates Coal IV from Coal III, but in northern Vigo County this is reduced to between 50 and 55 ft. The pyrite content is in general much lower than in the No. III seam. A typical analysis of this coal is as follows:

Moisture	13.06
Volatile matter	34.32
Fixed carbon	46.25
Ash	6.37
Sulphur	0.95
B.t.u.	11,725

Coal V—Practically 65 per cent of the Indiana output in 1937 was from this bed and this figure is representative of production from this seam for the entire Eastern Interior basin. The quite constant thickness of this coal over large areas is a most important factor in its huge production. One large area of this coal extends from southern Illinois to include most of the western Kentucky coal basin and then north through Indiana to the middle of Vermillion County. At this writing 45 rail shipping mines in Indiana are extracting coal from this bed from Warrick County in the south to Vermillion in the north. As one would expect from the erosion of a basin structure dipping westward, the younger coals are found farther to the west than the older block coals.

In central Vigo County an average thickness of 5 ft. is observed for this coal, which is topped by a roof of 2 to 7 ft. of black shale followed by limestone and shale. Pyrite concretions are frequent in this black shale and may extend down into the coal. In the eastern part of Knox County, average thicknesses of 7 ft. are frequent. The roof is a strong slaty shale and a fireclay floor is observed. While there are no regular partings, in some mines narrow pyrite bands are seen and pyrites and sulphur balls are present. Coal V frequently is located 100 to 120 ft. above Coal IV.

The following analysis might be considered as typical of No. V coal before preparation:

Fig. 3—Rail-shipping mines in Indiana

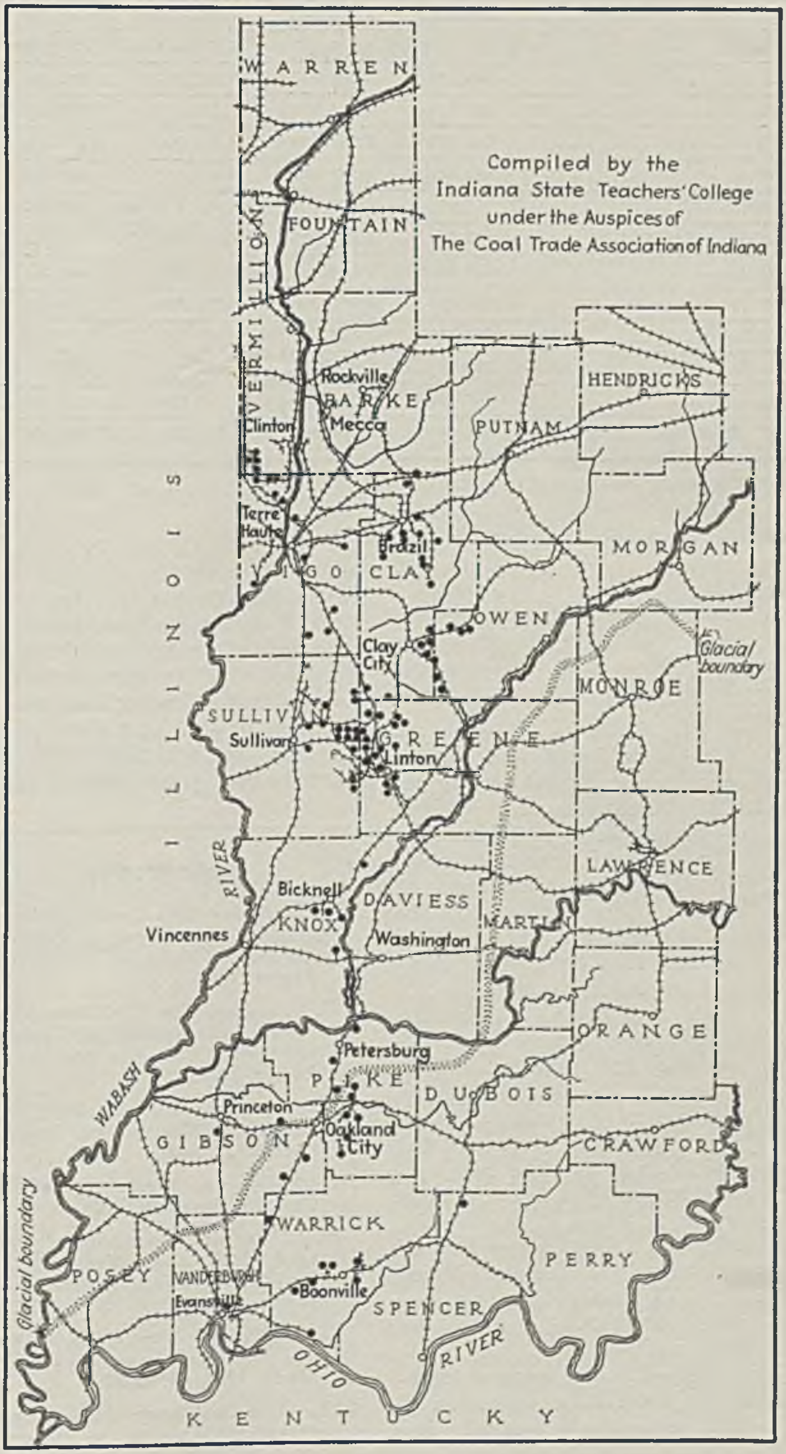

Table III—Output by Coal Seams in Indiana From the Year 1917*

Year	Vein of Coal							Total tons
	III	IV	V	VI	VII	Minshall	Block	
1917	1,410,930	8,352,440	13,201,910	2,009,402	111,864	335,414	634,307	26,056,267
1918	1,926,027	9,481,755	15.070,674	2,435,377	261,137	384,897	750,235	30,310,102
1919	892,774	6,392,928	10,353,364	1,709,828	165,027	242,229	421,146	20,177,296
1920	1,343,885	7,911,870	15,668,365	2,510.916	278,414	391,872	488,568	28,593,890
1921	735,444	6,814,513	10,889,337	1,460,737	63,985	186,084	183,186	20,333,286
1922	502,884	5,977,580	10.227,353	1,045,427	104,438	185,363	133,783	18.176,828
1923	636.676	8,335,110	14,369,531	1,556,939	176,498	191.423	179,239	25,445,416
1924	655,707	5,869,045	12,773,999	1,279,108	46,006	204,853	162,420	20,991,138
1925	667,497	4,612,665	14,118,654	1,397,460	31,103	143,556	272,909	21,243,844
1926	875,606	5,048,533	14,807,785	1,345,554	81,130	102,883	387,986	22,649,477
1927	350,271	2,951,751	11,552,374	1,949,365	225,920	67,046	502,311	17,599,038
1928	548,870	3.747,848	9,884,965	1.305,236	20,182	40.565	489,681	16,034,347
1929	972,427	4,224,628	10,907,132	1,009,830	485,759	12,321	402,292	18,014,389
1930	917,970	3,185,804	9,863,575	1.402,992	101.103	5,445	475,119	15,952,008
1931	803,229	2,364,572	8,856,356	1,206,023	4.165	1,540	469,663	13,705,548
1932	626,487	1,533,833	8,731,364	1,198,281	....	3,804	463,260	12,557,029
1933	654,005	2,167,340	8,757,309	1,009,508	2,000	3,212	488,137	13,081,511
1934	772,172	2,327,822	9,323,269	950,787	37,583	2,891	715,541	14,130,065
1935	562,692	2,288,459	10,301.743	952.341	21,069	1,403	821,072	14,948,779
1936	668,160	2,911,806	11,220,029	813,196	217,156	296	763,724	16,594,307
1937	874,429	2,756,349	10,614,237	1,043,174	180,889	....	916,673	16,385,751

* Coal Trade Association of Indiana.

Moisture	10.45
Volatile matter	38.62
Fixed carbon	41.35
Ash	9.58
Sulphur	4.04
B.t.u.	11,745

Coal VI—About 75 ft. above the No. V seam is found the No. VI coal, also in the Petersburg formation. At present this vein is being mined commercially in Vermillion, Vigo, Sullivan and Greene counties. In Sullivan County a thickness of 6 to 8 ft. is fairly common. In the center of the seam are two thin shaly partings less than an inch in thickness and separated about 5 in. To the south and north of Sullivan County this seam is much less regular, splitting and pinching out in many places. In Sullivan County the roof generally consists of shale varying in thickness from several inches to 10 or 20 ft. The floor usually is a fireclay just below a bony zone which is found at the base of the coal seam. Over 6 per cent of the coal mined in Indiana during 1937 was VI vein coal. This coal has been extensively operated by stripping methods.

Coal VII—The top seam of interest in the Petersburg formation is No. VII vein, which generally lies about 40 to 50 ft. above No. VI. In Sullivan County the seam varies from 3 to 6 ft. in thickness, lying on a floor of fireclay which frequently overlies a limestone formation. Just below the fireclay there may be sandstone or shale, but the limestone is found beneath that. The vein seems to be represented particularly well in Vermillion, Vigo, and Knox counties in addition to Sullivan. Sandstone lenses are found from time to time in the roof and may fall as the coal is mined.

In Illinois this coal is called the Danville or No. VII, and reaches a thickness near Danville of around 6 ft.; elsewhere in Illinois it is less consequential. Near Petersburg, in Pike County, only about 2½ ft. is present and to the south it becomes even less important.

Production—Coal from the seams just described has accounted for approximately 4 per cent of the total production of bituminous coal in the United States, or a total of more than 735,000,000 tons. In 1937 the State produced just under 16,500,000 tons of coal, of which about 50.85 per cent was by shaft mines and about 49.15 per cent by strip operations. This amounted to about 4 per cent of the total United States production for the year. Efficient extraction, mechanization and modern mechanical cleaning of the coal have resulted in lower costs and higher grade products for both strip and shaft operators, so that all probabilities are that many virgin coal territories will be opened up as present coal properties are exhausted.

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WITH MODERN PREPARATION

+ Coals From Indiana Fields Are Distributed Over Wide Area

By JONAS WAFFLE
Managing Director
Coal Trade Association of Indiana

THE INDIANA COAL FIELD extends throughout 26 counties in the southwestern part of the State. Coal is being produced in substantial quantities in nineteen counties, extending from Warren in the north to Vanderburgh, Warrick, Spencer and Perry counties on the Ohio River. Throughout the nineteen counties coal is being produced in the Third, Fourth, Fifth, Sixth, Seventh, Brazil-Block, semi-Brazil Block, Minshall and Cannel veins.

In so far as the rail-shipping mines are concerned, the Indiana coal field is divided into four major districts: (1) Brazil-Clinton, (2) Linton-Sullivan, (3) Princeton-Ayrshire, and (4) Boonville-Evansville. These districts had their origin in the grouping of the rail-shipping mines for rate-making purposes, the rates from each of the groups being differentially related to the long-haul territory.

During the calendar year 1937, as shown in Table I, the rail and truck mines, combined, produced a total of 16,849,975 tons. Rail mines produced 15,585,388 tons, or 92.50 per cent of the total, and the truck mines, 1,264,587 tons, or 7.50 per cent of the total. Table I also shows, in convenient form, the production of the rail mines by subdistricts and the truck mines by counties.

The Indiana coal-mining industry occupies rather a unique position in that the rail-mine production is divided about fifty-fifty between strip and deep mines. The ratio is somewhat different as to truck mines, the strip mines producing approximately 25 per cent and the deep mines 75 per cent of the total truck-mine production. However, the combined production of both rail and truck mines during 1937 indicates that the strip mines produced 48 and the deep mines 52 per cent. From the standpoint of increase in its percentage of the State output, strip mining in Indiana has had a more phenomenal growth than in any other coal-producing State.

Since 1917 there has been a very decided shift in the production from the various veins of coal. For example, during 1918 and 1919 Fourth Vein mines produced about 32 per cent of the total production. During 1936 and 1937 the Fourth Vein production dropped to about 17 per cent. During the two earlier years the production of Fifth Vein coal was about 50 per cent of the total, while during 1936 and 1937 it averaged about 65 per cent. There also has been a marked increase in the production of Brazil Block coal. For example, during the years 1921 through 1924, Brazil Block production was less than 1 per cent of the total. During the period 1935 to 1937, inclusive, the output increased to about 5 per cent of the total. This increase is due largely to the development of stripping operations in Clay County.

Table I — Rail-Mine Production by Subdistricts and Truck-Mine Production by Counties During 1937

Rail Mines

Subdistrict	Production	Per Cent
Brazil-Clinton	3,018,295	19.37
Linton-Sullivan	6,335,617	40.65
Princeton-Ayrshire	5,032,304	32.29
Boonville-Evansville	1,199,172	7.69
Total, rail mines	15,585,388	100.00

Truck Mines

County	Production	Per Cent
1. Clay	327,586	25.91
2. Daviess	56,095	4.44
3. Dubois	25,886	2.05
4. Fountain	40,582	3.21
5. Gibson	8,786	.69
6. Greene	70,475	5.57
7. Knox	155,544	12.30
8. Martin	19,874	1.57
9. Owen	2,081	.16
10. Parke	126,720	10.02
11. Perry	16,852	1.33
12. Pike	44,794	3.54
13. Spencer	13,304	1.05
14. Sullivan	32,183	2.55
15. Vanderburgh	....	.....
16. Vermillion	65,667	5.19
17. Vigo	135,777	10.74
18. Warren	2,548	.20
19. Warrick	119,833	9.48
Total, truck mines	1,264,587	100.00

Recapitulation

Total, rail mines	15,585,388	92.50
Total, truck mines	1,264,587	7.50
Grand total	16,849,975	100.00

Production by the rail-shipping mines in Indiana, 1918 to 1937, inclusive, is set forth in Table III, which shows, for each year, the per cent that the Indiana production is of the national production. From Table III it will be noted that the per cent the Indiana production, year by year, is of the national production varied from a minimum of 3.27 to a maximum of 5.30 per cent. For the years 1932 through 1936, the per cent of production ran slightly over 4, and the estimated figures for 1937 show a slight decline below 4 per cent.

As pointed out earlier in this article, during the calendar year 1937 there was shipped from the rail mines 15,585,388 tons. The actual production of the rail mines in 1937 was 15,988,842 tons. This tonnage was distributed as between the uses and in the amounts and per cents as shown in Table IV, from which it will be noted that the commercial rail and truck sales were approximately 64 per cent; railroad fuel, 34 per cent; and the remaining items, about 2 per cent of the total.

The commercial rail shipments of 9,790,143 tons shown in Table IV moved from the mines in over 80 different sizes and preparations to

Table II—Production by Veins of Coal in 1937

Vein	Rail Mines Tons	Rail Mines Per Cent	Truck Mines Tons	Truck Mines Per Cent	Combined Tons	Combined Per Cent
3d	981,696	6.30	51,423	4.07	1,033,119	6.13
4th	2,616,228	16.79	136,473	10.79	2,752,701	16.34
5th	9,971,817	63.98	306,024	24.20	10,277,841	61.00
6th	1,214,305	7.79	283,828	22.44	1,498,133	8.89
7th	7,640	.05	10,194	.81	17,834	.11
Block	793,702	5.09	312,154	24.68	1,105,856	6.56
Semi-Block	....	....	46,239	3.66	46,239	.27
Minshall	....	....	111,235	8.80	111,235	.66
Cannel	....	....	7,017	.55	7,017	.04
Total	15,585,388	100.00	1,264,587	100.00	16,849,975	100.00

Table III—Indiana Mine Production and Per Cent of United States Total*

Year	Indiana Production (1,000 Tons)	Per Cent of U. S. Production
1918	30,679	5.30
1919	20,912	4.49
1920	29,351	5.16
1921	20,319	4.89
1922	19,133	4.53
1923	26,229	4.65
1924	21,480	4.44
1925	21,225	4.08
1926	23,186	4.04
1927	17,936	3.46
1928	16,379	3.27
1929	18,344	3.43
1930	16,490	3.53
1931	14,295	3.74
1932	13,324	4.30
1933	13,761	4.13
1934	14,794	4.12
1935	15,754	4.23
1936	17,822	4.06
1937†	17,270	3.90

* U. S. Bureau of Mines reports. † Estimated.

several hundred destinations in thirteen States. Over 98 per cent of the total rail movement, however, was into the four States of Indiana, Illinois, Iowa, and Wisconsin (Table V).

Of the distribution of railroad fuel coal as between on-line and off-line carriers, eight on-line carriers purchased 4,041,883 tons and 31 off-line carriers purchased 933,644 tons. This railroad fuel was consumed in the States of Indiana, Ohio, Michigan, Kentucky, Illinois, Iowa, Minnesota, Wisconsin and South Dakota.

To market an otherwise unmerchantable coal, particularly in the industrial sizes—namely, 2 in. or less—the coal-mining industry in Indiana has installed a number of washing plants. During the NRA, there were two mines in the State equipped to wash coal. Today there is a total of eleven plants washing coals from fifteen mines. Table VI shows the number of tons of coal from each vein washed during the calendar year 1937. The figures for 1938 will show a marked increase, inasmuch as several washers have been installed during the current year.

Table IV — Distribution of Indiana Coal in 1937 by Uses

Use	Tons	Per Cent
Rail shipments, commercial	9,790,143	61.23
Truck sales	427,851	2.68
Railroad fuel, on-line	4,041,883	25.28
Railroad fuel, off-line	933,644	5.84
Power-house fuel	391,867	2.45
Sold to mine employees	26,464	.17
Used for mine fuel	155,580	.97
Increase in inventory	15,344	.09
Captive coal	206,066	1.29
Total production	15,988,842	100.00

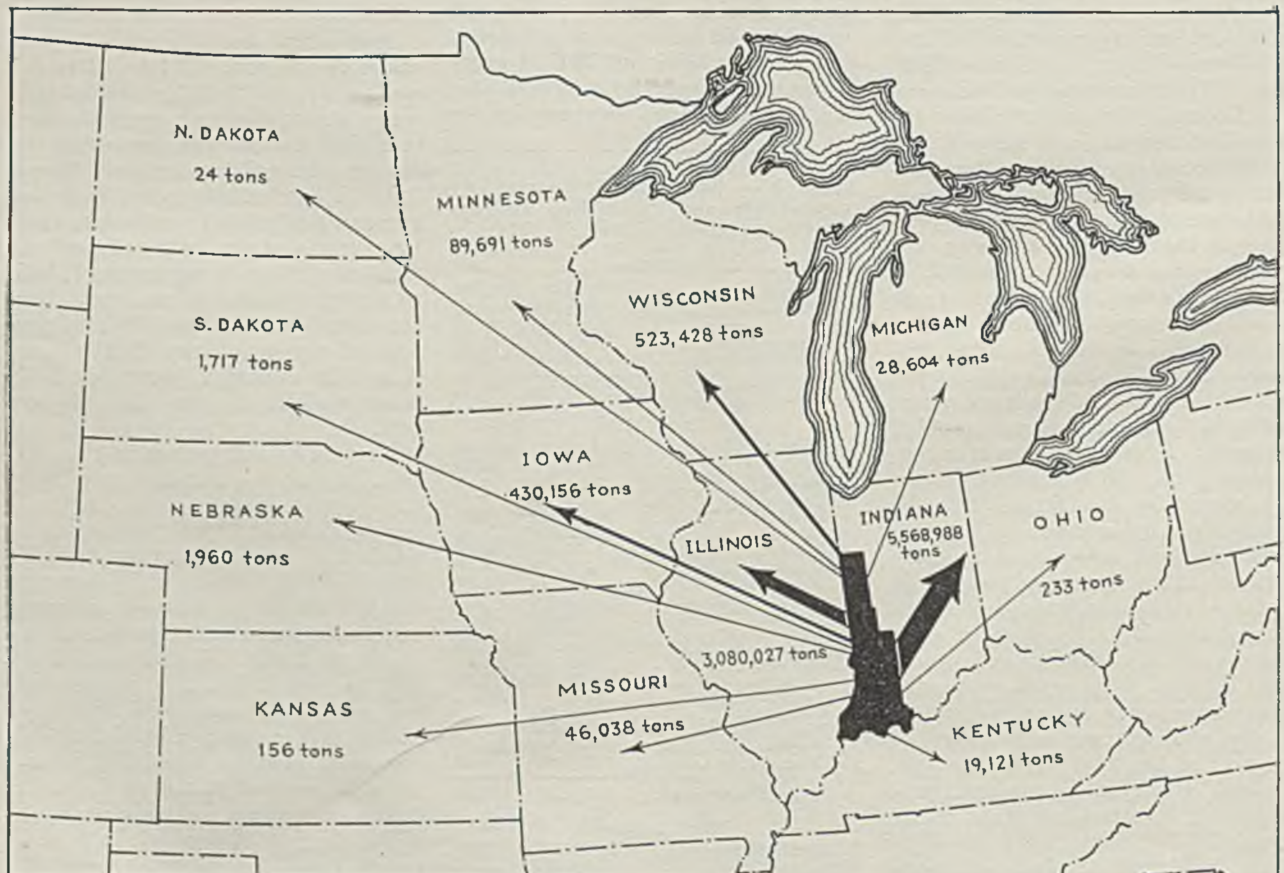
Table V—Distribution of Commercial Coals From Indiana Rail-Shipping Mines in 1937

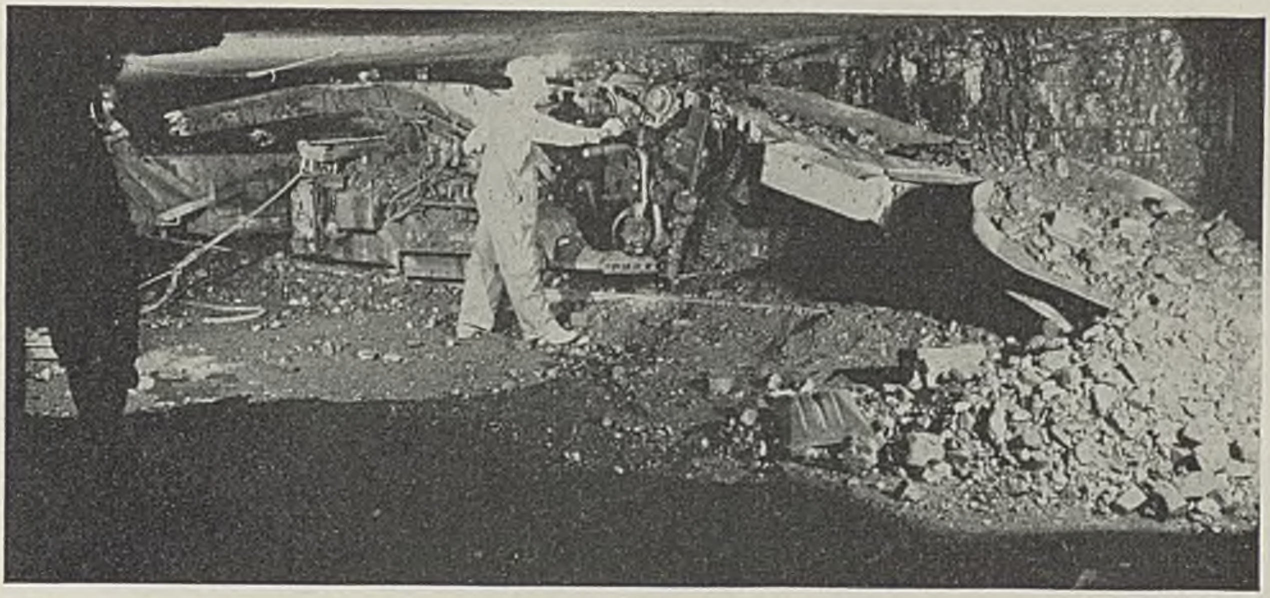
Destination	Tons	Per Cent
Indiana	5,568,988	56.88
Illinois	3,080,027	31.46
Wisconsin	523,428	5.35
Iowa	430,156	4.39
Minnesota	89,691	.92
Missouri	46,038	.47
Michigan	28,604	.29
Kentucky	19,121	.20
Nebraska	1,960	.02
South Dakota	1,717	.02
Ohio	233	......
Kansas	156	......
North Dakota	24	......
Total	9,790,143	100.00

Table VI—Washed Coal From Indiana Mines Sold in 1937

Vein	Tons
Third	355,870
Fourth	43,893
Fifth	602,498
Sixth	584,314
Total	1,586,575

Fig. 1—Showing graphically how Indiana commercial coal moved to market in 1937.





Track-mounted loading machine at work in the No. 6 seam, New Hope mine.

MINING METHODS AND MECHANICAL LOADING

+ Indiana Deep Mines

INDIANA, if small truck and local mines are excluded, presents a picture of almost complete mechanization of loading underground. Strictly hand-loading operations in what might be termed the "commercial" class now are the exception, and most of these, if developments in the past two or three years are any criterion, eventually will be found in the mechanized group.

High production per man employed underground is a natural corollary of the high degree of mechanization in the State. Data given in the 1936 report of the U. S. Bureau of Mines, the latest available, show that even with the mechanization then prevailing an average of 7,287 men were employed underground in producing 10,142,735 tons, making the average output per man per year 1,392 tons. Working time of deep mines alone must be estimated, but it appears that, even with a most liberal allowance for days worked in 1936, average output per man-shift underground was something over 7 tons.

The figures given above, of course, represent both hand and mechanical operations, whereas in 1938, according to information collected in the *Coal Age* study of mining in Indiana, production per man-shift worked underground in the strictly mechanized mines, on the basis of the actual tonnage shipped, ranged from 8.4 to 20.8 tons. The weighted average was 12.5 tons. In this connection it might be explained that these figures were derived from the answers to two questions: (1) "Average daily output of cleaned and prepared coal loaded for shipment?" and (2) "Average number of men employed underground on a typical day, including all employees engaged in supervision, inspection, distribution of supplies, maintenance and repairs, general work and, in fact, all men chargeable to underground operation?"

Indiana's record naturally is the result of years of experience with mechanical-loading equipment, marked by much pioneering by a number of operators to develop practices now accepted as standard not only in that State but also in other producing fields. The first mechanical-loading wage scale, adopted in 1920, covered equipment in use in Indiana. In 1922, David Ingle, Sr., opened the first 100-per-cent mobile-loader mine in the United States at Arthur, Ind., and in 1925 Mr. Ingle and his associates were the first to double-shift loading machines.

Aside from a few slopes, deep mines in Indiana are served almost universally by shafts. And within the past year, developments in the State have been characterized by the opening of two "mines within mines." At the Talleydale operation of the Snow Hill Coal Corporation, for example, the Indiana 4th Vein lies about 50 ft. above the No. 3 now being worked. Consequently, a 1,500-ton bin has been excavated in the in-

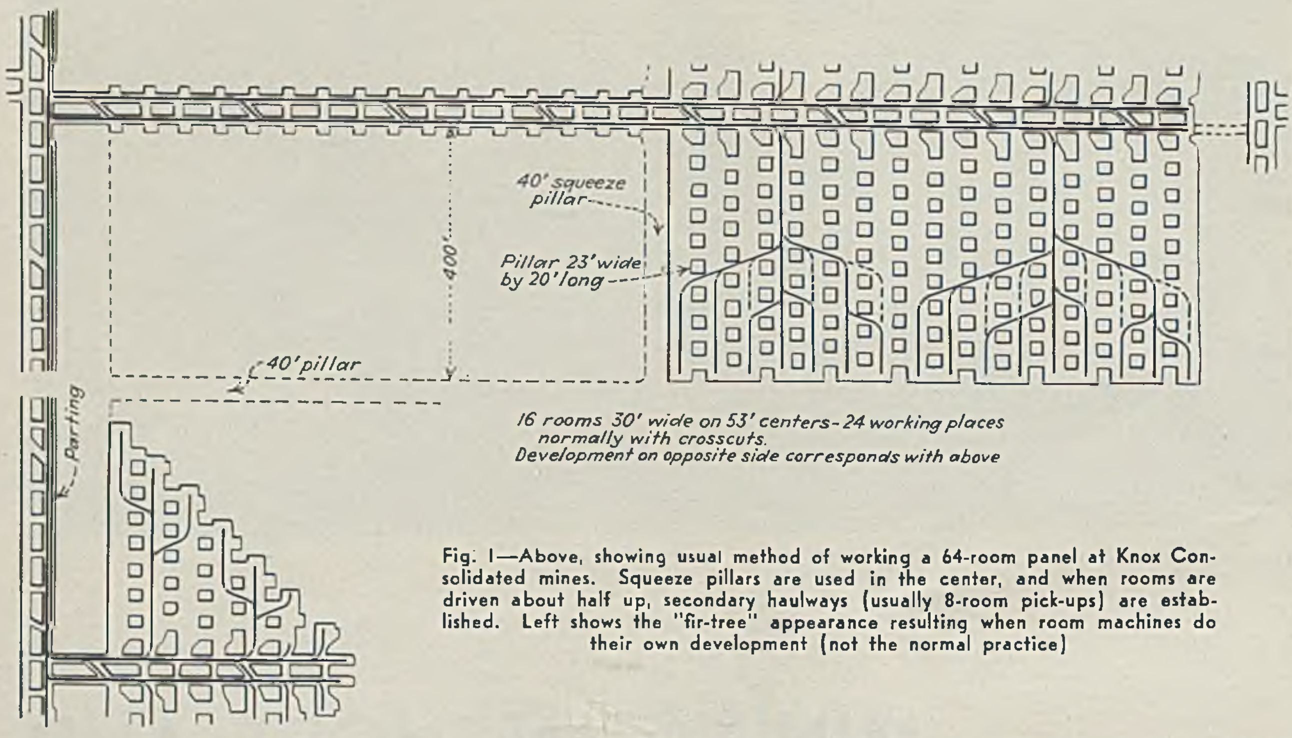


Fig. 1—Above, showing usual method of working a 64-room panel at Knox Consolidated mines. Squeeze pillars are used in the center, and when rooms are driven about half up, secondary haulways (usually 8-room pick-ups) are established. Left shows the "fir-tree" appearance resulting when room machines do their own development (not the normal practice)

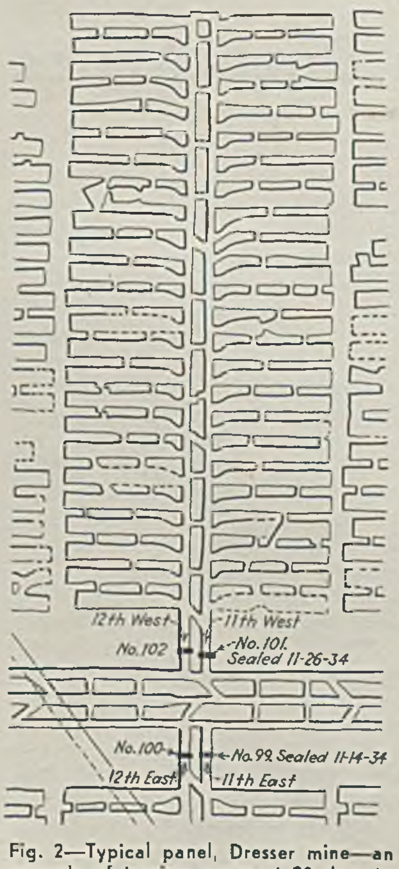


Fig. 2—Typical panel, Dresser mine—an example of turning rooms at 90 deg. to the panel entry

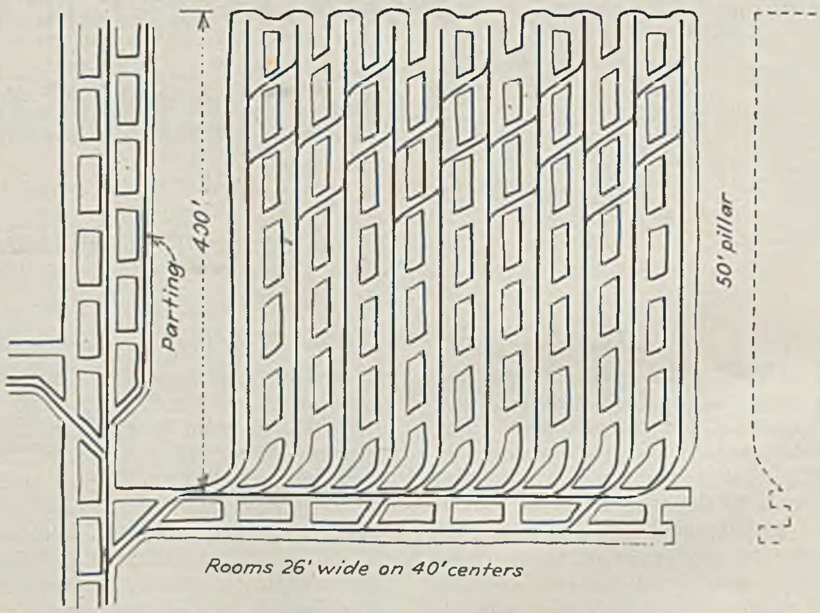


Fig. 3—Ten-room panel at Glendora, showing use of 45-deg. necks and also the practice of connecting track through all crosscuts to cut changing distance

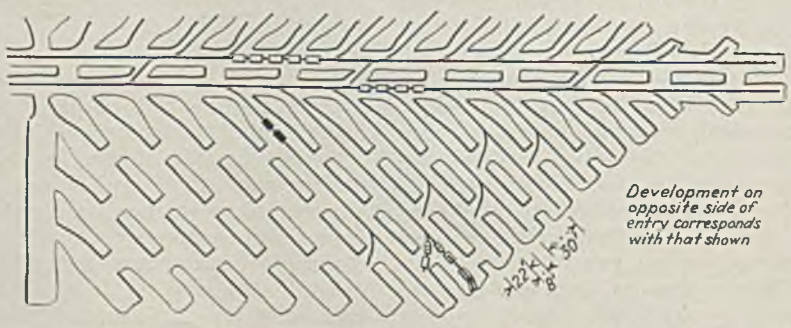


Fig. 4—Idealized panel development plan, New Hope mine, showing method of turning rooms on a 45-deg. angle, also use of stub tracks in crosscuts and method of working out triangular block of coal at panel mouth

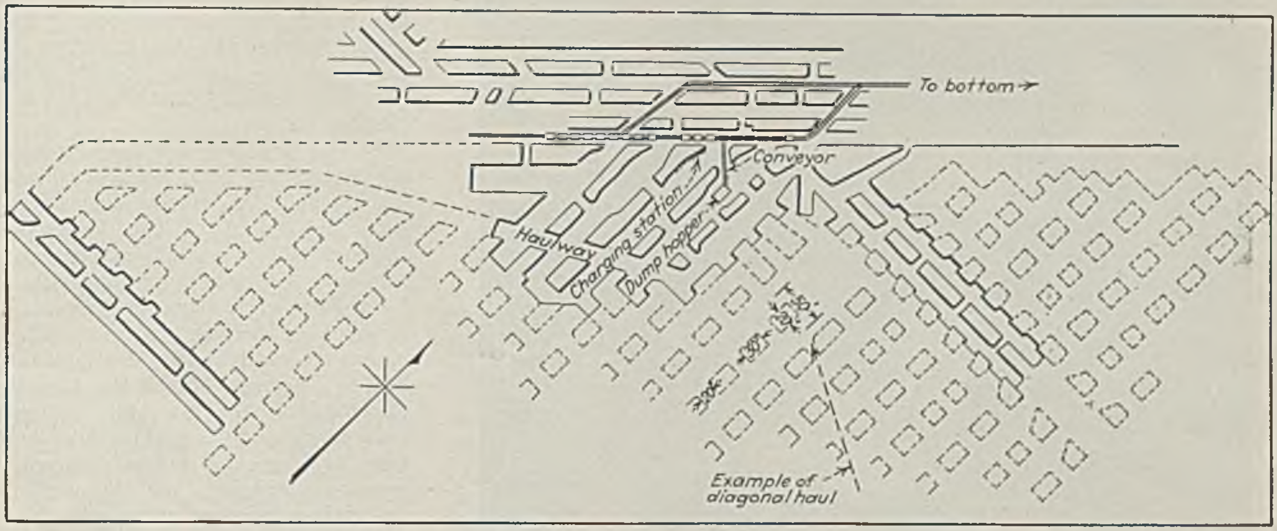


Fig. 5—Modified "checkerboard" working plan used with rubber-tired haulage at Wick mine, showing also location of dump hopper and car-loading conveyor, as well as method of bringing in trips of cars for loading

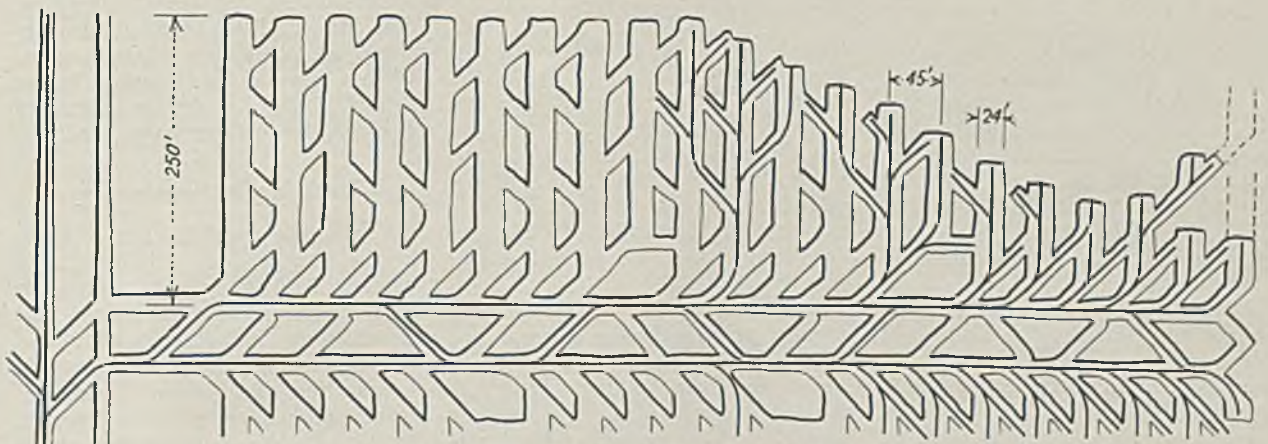


Fig. 6—Talleydale panel plan, showing "key-room" track layout

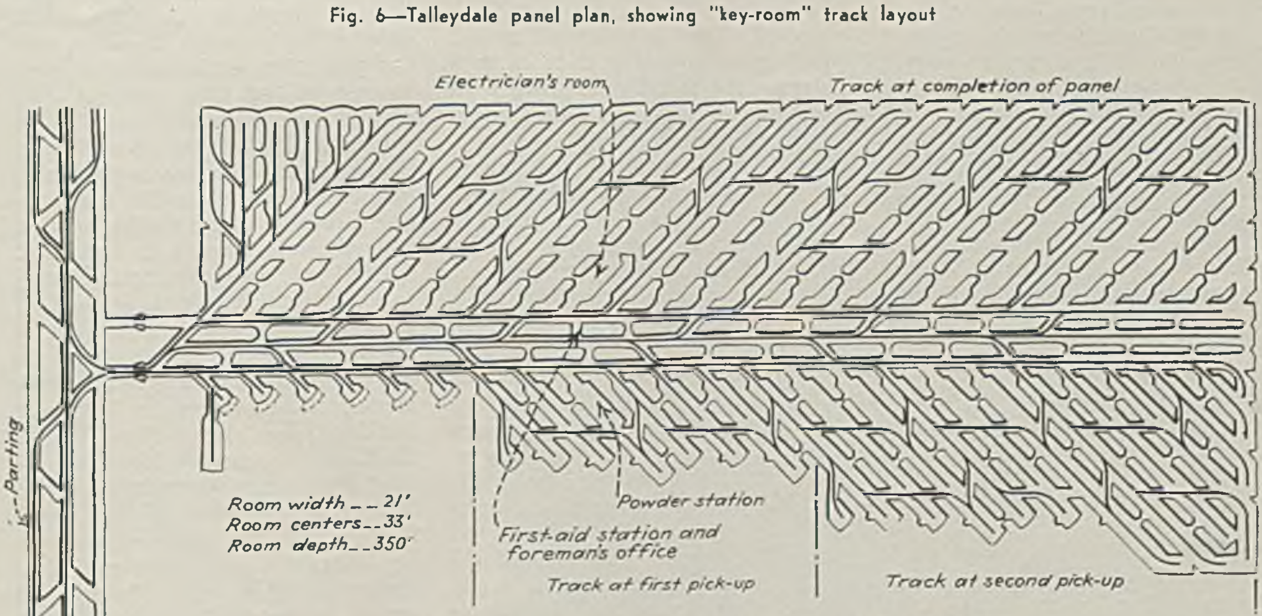


Fig. 7—Diagrammatic plan of 45-deg. room panel, Saxton mine, showing pick-up plan at various stages of room advance and (above) track layout at final stage of development

Bailing up coal in a 6-ft.-high place, Kings mine

terval between the two veins to receive coal mined in No. 4 during the day shift. Bottom-dumping cars will be used and on the night shift the coal will be fed out of the bin into cars in the No. 3 workings for hoisting and preparation on that shift. As in the case of No. 3, the 4th Vein operation will be completely mechanized.

At the New Hope mine of the Linton-Summit Coal Co. the No. 5 coal now being worked is overlaid at an interval of 50 to 55 ft. by the No. 6, averaging about 6 ft. in thickness. Consequently, a rock tunnel 1,950 ft. long on an upward grade of 5 per cent has been driven from the No. 5 to the No. 6, which will be operated on the night shift, using the dumping facilities originally put in for the No. 5 coal. No. 6 production, with two machine shifts, is expected to average 1,000 tons of coal cleaned and prepared for shipment, as compared with 1,700 tons (four machine shifts) from the No. 5 seam.

Thickness of the cover at Indiana mines varies from 75 to 100 ft. over the No. 5 at New Hope to 400 to 500 ft. at the Kings Station mine of the Princeton Mining Co., the deepest in the State. Usual depth, however, ranges from 200 to 250 ft. Seam thickness seldom exceeds 6 ft. and only in rare cases goes over 7½ ft. and then only locally. Minimum average thickness at any mobile-loader mine covered in this survey was 4 ft., with the majority of the seam heights falling in the range from 4 ft. 9 in. to 6 ft. Output per man employed reflects to some extent increase in thickness of coal, but extremely bad roof conditions in two mines operating in 6- to 7½-ft. coal place these in the exceptional class, while certain other operations have felt the effects of adverse roof conditions to a lesser extent. It is granted, of course, that roof condition is not the only factor influencing performance in the various seam-thickness classes.

Another characteristic of Indiana mining practice is the general use of the panel system: i.e., a system under which the working territory is divided into individual territories, or panels, each protected by solid pillars on all sides except where the headings are driven in to provide an entrance. Leaving pillars all around panels permits closing them off as a rule by the installation usually of two seals—another almost universal practice in Indiana. While seals represent an expense, particularly when they are of the high-strength or massive types usually installed in the State, and also are a possible hazard if not properly constructed, inspected, maintained and ventilated, Indiana operators find them advantageous for the following reasons: prevention of the escape of gas and elimination of ventilation which otherwise would be required to carry it off; elimination of inspection; protection against flooding of live workings in case of water breaks at some operations (see article beginning on p. 67); elimination of some of the pumping load under certain conditions, especially where high heads behind seals are not encountered; adaptability of sealed areas to use as sumps, again provided excessive heads are not generated; etc. In fact, sealing in Indiana is one of the major reasons why the majority of the mines are able to operate with relatively smaller quantities of ventilating air.

Except in a very few cases, rooms are turned off both sides of panel entries and the entries themselves generally consist of two headings, although more than that number are employed at certain operations, either for reasons of haulage or other convenience or because more working places are available for development loading machines. Black Hawk Coal Corporation, for example, drives four panel headings divided into two pairs by long chain pillars with only occasional openings for the use of supervisors, haulage units, etc. Panel headings, as at many other operations in the State, are connected to the mains by 45s, thus making it possible to benefit haulage by using larger-number frogs and longer-radius curves. Four headings also are employed at Kings Station mine, with a special modification to be detailed below, while the Standard Coal Co. drives three panel headings.

Track in Center Heading

The middle panel heading of three at the Saxton Coal Mining Co. is used for haulage during the development stage, and thus facilitates final switchlaying and other construction activities on the outside headings in preparation for room operation. Upon completion of development, track is removed from the center heading and it then is used as an airway. Headings are driven 11 ft. wide on 25-ft. centers, the short centers permitting crosscuts to be made by only one cut from opposite sides of the chain pillar. Certain other operations in the State, particularly those with track mounted cutters with long bars, also employ this cross-cutting method to eliminate the switches that otherwise would be required.

Number of rooms on a panel entry vary widely. But if any standard number could be said to prevail in the State it would be 20 or 24 on a side, or 40 or 48 total in a panel. Among those companies normally working panels larger than this is the Knox Consolidated Coal Corporation, which turns 32 rooms on a side at its Knox Consolidated Nos. 1 and 2 mines. At the other extreme are the Glendora and Templeton coal companies (Glendora 27 and 28 mines), where panels usually consist at the present time of only ten rooms on one side of an entry.

Both the latter companies recover

what is locally known as a "stray," or "lost," vein under about 250 ft. of cover. The vein in question lies approximately in the same position as the regular Indiana 5th Vein, but is entirely different in character. Over the coal is 12 to 15 ft. of gray chalky slate, overlaid by the black slate normally occurring on top of the No. 5. Gas in the chalk slate has a pressure sufficient to spring it down 3 or 4 in. unless it is relieved by drilling, while the nature of the slate itself is such as to require substantial support in addition.

The original Glendora mining plan was based on turning twenty rooms off each side of the panel entry, with solid pillars, or "squeeze blocks," between No. 10 and No. 11 rooms on each side. Usually, the inner group of ten rooms on each side was worked first, the squeeze block protecting the outer group and permitting sealing if deemed desirable. Squeezing on the entry before extraction could be completed and other difficulties, however, dictated a change to the 10-room panel noted above. At the same time, room depth was increased from about 250 to 400 ft. With the new panel, the center of squeezing, when it occurs, is about half way up Nos. 5 and 6 rooms instead of on the entry. However, the tendency to squeeze has been materially reduced by decreasing the number of rooms.

Squeeze Blocks Used

"Squeeze blocks," "breaker blocks," etc., also are employed by several other Indiana companies. At Miami No. 10 mine, Binkley Mining Co., where the cover averages 325 ft., this pillar is made by eliminating crosscuts in the regular pillar between Nos. 10 and 11 rooms. A room is omitted at Crown Hill No. 6 mine, Clinton Coal Co. Mining is done on the retreat where possible at this operation, and when this system can be used, squeeze blocks normally are not required. But if panels are developed and mined on the advance, they usually must be provided. At the Knox Consolidated mines (230 and 320 ft. of cover) the squeeze block, usually between Nos. 16 and 17 rooms (Fig. 1), is 40 ft. thick. Blocks are left between Nos. 10 and 11 rooms at Kings Station mine, and at the same time the number of panel headings is reduced from four to two. Cover thickness ranges from 400 to 500 ft. at this operation. A few other mines in the State provide for large pillars along panel entries, even though regular squeeze blocks are not employed. The mining plan at Talleydale (Fig. 6) provides one example of this practice. Cover at this operation ranges from 300 to 400 ft. and the immediate roof is very weak.

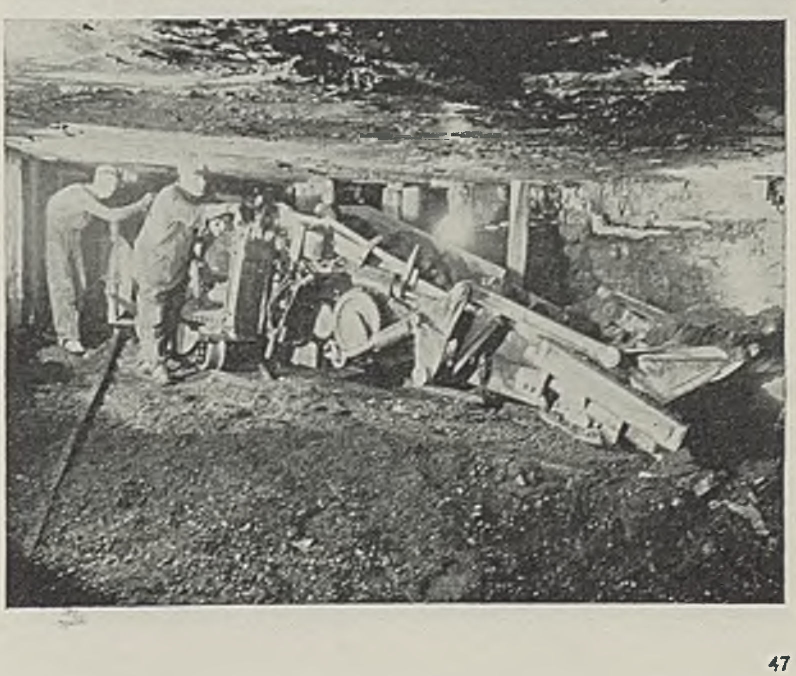
In the majority of mines in Indiana, rooms are driven at an angle of 90 deg. to the panel entries. To favor haulage, however, 45-deg.-angle layouts are used at several operations, including: Black Hawk; Jackson Hill No. 6, Jackson Hill Coal & Coke Co.; New Hope (Fig. 4), and Saxton (Fig. 7). It will be noted that in all these examples, all openings, including crosscuts, are made at a 45-deg. angle. To work out the triangular block of coal that otherwise would have to be left, stub rooms are driven off No. 1 as in Fig. 7, or an auxiliary 90-deg. place is turned where No. 1 room neck ordinarily would be cut (Fig. 4). Angle benefits are secured by other companies holding to the conventional 90-deg. room direction by necking the rooms on a 45 and then straightening them up, supplementing this by driving crosscuts at 45 deg. (Figs. 3 and 6).

Coal characteristics are such that rooms generally may be driven in almost any direction in Indiana with equally good production. There are, however, certain exceptions to this rule. Talleydale is one, due to the fact that planes of weakness in the roof, known locally as "cutters," generally run north and south and thus make it desirable to drive rooms east and west. Furthermore, grade conditions in the State usually are such that orderly turning of rooms is possible in most cases. But while general dips are relatively slight, some extremely rolling coal with short grades running as high as 25 per cent is encountered, as at New Hope and the Buckskin mine of the Buckskin Coal Corporation. Consequently, room direction at these operations, and others with substantially similar conditions, is subject to change without notice to increase efficiency.

Room width at the mines covered by the *Coal Age* survey ranges from 21 to 30 ft. and centers from 30 to 60, with the exception of one operation with a special mining system. In most cases, however, room width falls in the range from 22 to 26 ft. (30- to 44-ft. centers; one operation on 54 ft.). with another relatively large group with good roofs working 30-ft. places on 50-, 53- or 60-ft. centers. Room width and centers seem to have been set primarily to meet individual opinions as to the maximum extraction possible within the limitations set by convenience, condition of the immediate roof and the reach of certain types of equipment, such as track-mounted cutting and loading machines, with depth of cover as a secondary consideration. Thus Kings Station, with 400 to 500 ft. of overburden, drives its rooms 26 ft. wide on 44-ft. centers, almost the same as some other operations with less than half the cover. But light cover at New Hope (75 to 100 ft.) has enabled that mine to work 22-ft. rooms on 30-ft. centers. In a significant number of cases, however, pillar width is roughly half room width, as at Dresser mine, Walter Bledsoe & Co., 250 ft. of cover, 24-ft. rooms on 36-ft. centers, where experience has shown this to be the best relation.

Room depth in Indiana varies all

Development loader turning a place, Saxton mine



the way from 165 to 600 ft. or more, with most operations falling in the range of 250 to 400 ft. The 165-ft. depth at Crown Hill No. 6 grows out of the fact, among other things, that loading machines are served by a combination of pushing and mule haulage. At Black Hawk, on the other hand, where car changing is done by mules, room depth ranges from 350 to 600 ft. In some cases, room depth has been increased to reduce the length of entry that must be driven for a given tonnage, as at the Knox Consolidated mines, where rooms were lengthened from 256 to 400 ft. Natural conditions, however, put a limit on room depth in some mines. At Talleydale, as an instance, top character is such that driving farther than 250 ft. means greatly increasing the timbering cost if not the loss of most of the places.

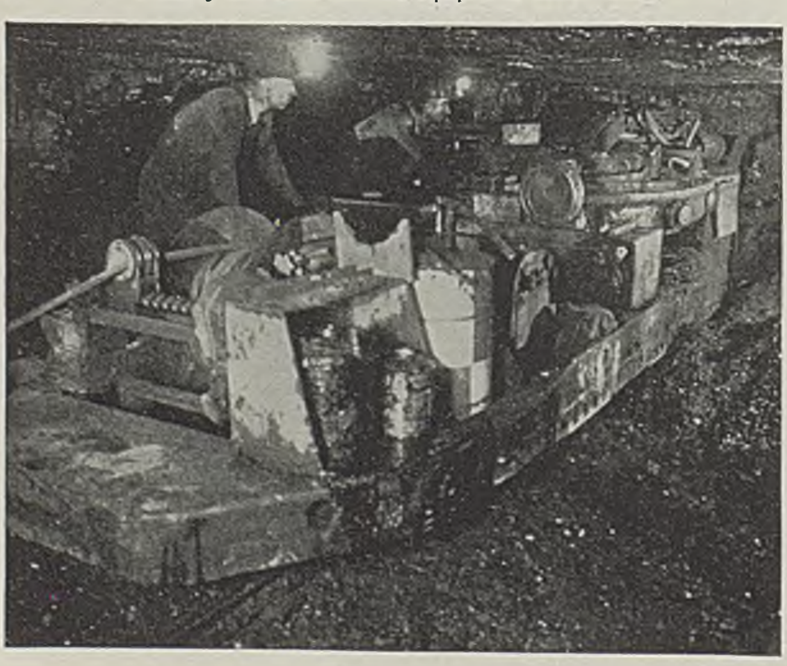
Room-pillar shape, as might be anticipated, is the conventional relatively narrow rectangle in most Indiana operations. At the Knox Consolidated mines, however, crosscuts are made 18 ft. wide and on centers which result in the room pillar being split into 23x20-ft. blocks (Fig. 1). These approximately square blocks are staggered so that any crosscut always has a pillar opposite it. Frequent crosscutting in this manner adds to the number of working places available without long moves, as well as the number in a section, thus increasing concentration.

Approximately square blocks also are provided in the mining plan adopted at the Wick mine of the Ingle Coal Co. with the installation of rubber-tired haulage in May, 1938 (October, 1938, *Coal Age*, p. 29). Rooms are driven 30 ft. wide on 50-ft. centers (Fig. 5) and crosscutting is conducted to leave 20x30-ft. pillars, which are staggered so that a solid pillar is opposite each crosscut, or at least so that the end of one pillar is in line with the end of the other across the place. Staggering the pillars also makes possible the establishment of diagonal tractor roads, thus shortening the distance from face to dump—an important consideration in rubber-tired haulage.

Indiana operators are almost solidly committed to a separate development cycle as compared with production from wide rooms. One exception is Talleydale, where the loading machines handle a combination of rooms and headings. Panel entries are turned both ways from the cross entries, and as a rule the two panel entries on opposite sides of the main are nearly opposite each other. Therefore, to assume a simplified example, a loading machine may be engaged in driving two main headings and two panel entries of two headings each, along with the necessary crosscuts, 45s, etc. Both main and panel entries (with rooms) are kept going, with all places being loaded out in sequence, none being favored over others. This means that the panels progress in characteristic "fir-tree" fashion.

As soon as about five rooms are available on a side in the panels, the machine moves into one and becomes primarily a room unit, although it still keeps extending its own panel headings to maintain the supply of rooms. Another machine takes the opposite panel and also keeps the main entry going until two more panel entries are turned and therefore sufficient places are available for another machine. As stated above, this is a simplified version of the Talleydale system, which, of course, is subject to a number of variations. Normal crews for machines in strictly room work number sixteen men, but in what might be termed development proper the number may go as high as 21, depending upon how much switchlaying, timbering, etc., is required. Under this system, with 5- to 6½-ft. coal, 5.8-ton cars and Goodman 260-A track-mounted loaders, each served by one locomotive, *mine-run* output per machine-shift in the first six months of 1938 was 484 tons.

Shearing with track-mounted equipment, Saxton mine



Rooms Ended Even

Making a panel come out even when all rooms are started abreast is a comparatively simple task. But where the fir-tree plan is used, keeping a full quota of places until the last day requires forethought. At Talleydale, consequently, when a panel gets in to about No. 16 or No. 17 room (20- or 21-room panels) room bosses concentrate on driving a pick-up from about the fourth from the last room, as in Fig. 6, so that the last and next to the last rooms can be driven from two points, as shown. The goal is to keep return trips by the loading machine to one or two days for about five places. Where "fir-treeing" is done at other mines in the State, the usual practice is to concentrate on the short rooms until the places are gotten as nearly as possible abreast.

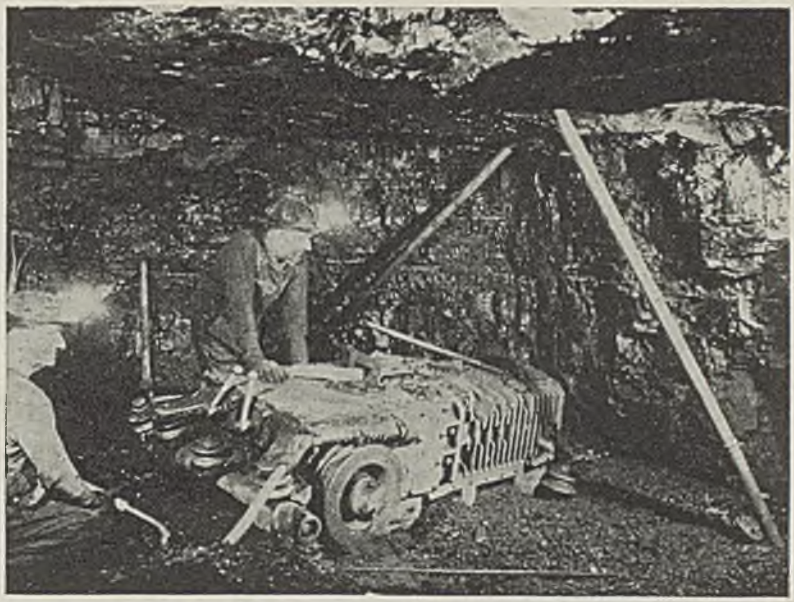
Black Hawk is another mine where production machines also do development, although a change to straight development machines is planned in the future. At the time this article was prepared, however, the general practice was to have a loader open up a panel, driving up the four headings and necking and working rooms as the opportunity presented until sufficient places were available on both sides to accommodate a machine. Thereafter, the development machine took one side and another loader the other, both working the rooms and keeping up the two headings on their respective sides. Black Hawk also is one of the several operations in the State to employ a "syndicate": i.e., a three-man crew with a loading machine, cutter and mule doing most of the work—all at some operations—in extending a main entry.

Production and development usually go hand in hand at New Hope also, with the resultant "fir-tree" effect shown in Fig. 4. Coal thickness (No. 5) ranges from 5 to 7½ ft. Two locomotives, handling 4½-ton cars, serve each loading machine, and on this basis output per machine-shift (18- to 19-man crews) averages 500 tons of mine-run. Equipment includes, in addition to the 260-A type, one Goodman 360 machine, which has loaded as high as 655 tons in seven hours.

While syndicates are common in Indiana, a number of operators employ development units with crews as large as or larger than room crews. Extension of entries and preparations for new working territories largely are confined to summer at Miami No. 10. Including air-shooting men, crews are nearly as large as room crews. The air equipment was installed to permit breaking down coal on the shift, as the use of explosives or other blasting mediums releasing any kind of a gas are prohibited in Indiana during the working shift. In opening a new territory off the Main South this summer, one development crew with a Joy 7BU loader and an Airdox unit averaged 100 linear feet per shift in two 12-ft.-wide headings, including crosscuts, 45s and other openings. Over the mine (Joy 7BUs, 4-ft. 9-in. to 5-ft. 4-in. coal, 1½-ton cars, usually 12- or 13-man crews) development machines have averaged 200 tons and room machines 250 tons per shift since the mine was reopened on the mechanical basis in 1933. To compensate for the small cars, Miami No. 10 employs a "circle-haulage" system, which will be detailed later in this article. One time-saving trick used in the Main South development was making pockets about two cuts deep at intervals in the barrier pillar to accommodate stub tracks and thus permit convenient storage of equipment or close car changing.

Develop With Big Crews

Dresser is another operation employing development crews almost as large as the normal 12-man room crews. Development machines drive the panel entries in far enough for ten or twelve necks to be turned on a side, whereupon room machines take over. Usually, one loader with one locomotive is assigned to a panel, but frequently, depending upon conditions, two may be used. These machines continue extension of the panel headings in addition to working out the rooms on approximately the "fir-tree" plan. Near the end of the panel, the machines concentrate on the inside places in order to make them all come out about even. With coal averaging 4 ft., Joy 8BU loaders and 2-ton cars, production per machine shift averages 210 to 215 tons. The maximum for one machine has been 350 tons in seven hours.



Bottom cutting in high coal, Buckskin mine

Another mine employing Airdox equipment, Kings Station, also uses crews equivalent to room crews, with air-shooting men in addition. Two Whaley "Automat" loading machines, manned by 12-man crews, do all the development work at Saxton. Under the Saxton plan, the development machine drives the 24-room panels to their full depth if time permits, or at least within three room-necks of the limit. Room necks are driven in the set distance with steel-tie switches, after which the heading track and switches are laid on wood ties. Finally, all faces are cut but not shot ready for the room machines—Jeffrey 44-D. Incidentally, development includes driving No. 9 room on each side part way up, one place serving as the electrician's quarters and the other for powder storage. Finally, concrete bulkheads are set in the headings at the mouth of the entry so that emergency water doors may be installed. Room crews at Saxton are slightly larger (one man or two) than development crews, and on this basis, with 4½- to 5½-ft. coal and 3-ton cars, development crews average 190 tons per shift. Room crews get 200 tons in low coal and 285 tons in high. Loaders are served by one locomotive each.

Air-shooting also is employed at Standard, where development machines drive the panel entries and neck the rooms in preparation for regular room machines. In common with certain other mines, Standard also concentrates on development work in the summer, leaving only the minimum necessary for operation for the winter season. One machine on each side of a panel is the usual schedule at Standard for room operation, although the goal is three (six rooms each) per panel.

Four-man syndicates drive up panel entries and neck the rooms at Buckskin, using Joy 5BU loaders served by one locomotive. Room work is done by 11BU machines manned by crews averaging fifteen men. Average thickness of the coal, which ranges from 4 to 9, is 7 ft. Car capacity is 3.8 tons. Syndicate crews turn out 150 to 180 tons of mine-run per shift, compared with 475 to 500 tons for room machines. At Wick mine, one four-man syndicate, using a Joy 7BU loader, drives the main headings. Coal thickness, varying from 5½ to 7, averages 6 ft., and car capacity is nominally 5 tons. The syndicate, doing, as is customary, all the necessary work, averages around 125 tons of mine-run per shift, compared with around 950 tons from two 7BUs operated by a 25-man crew, including supervision, in the rubber-tired-haulage section.

Syndicates also comprise four men at the Knox Consolidated mines, where they drive panel entries and neck the rooms, although on occasions room machines may do their own developing, working in general on the fir-tree plan as indicated in Fig. 1. Loading machines at Knox Consolidated primarily are of the

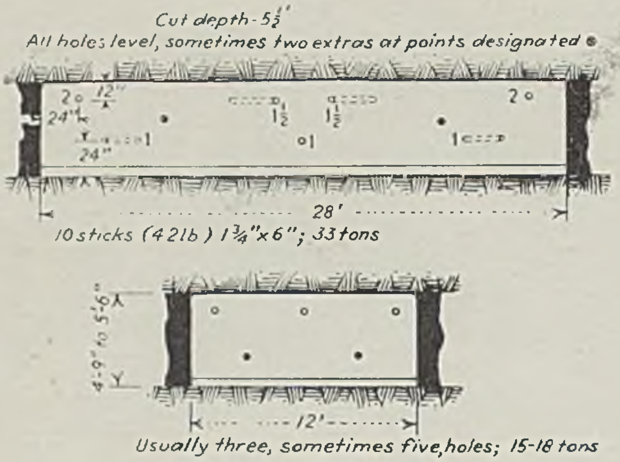


Fig. 8—Black Hawk drilling plans

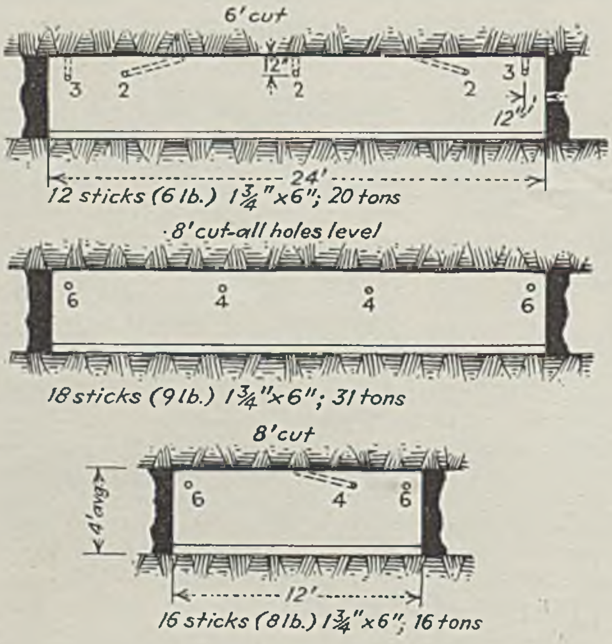


Fig. 9—Dresser drilling plans

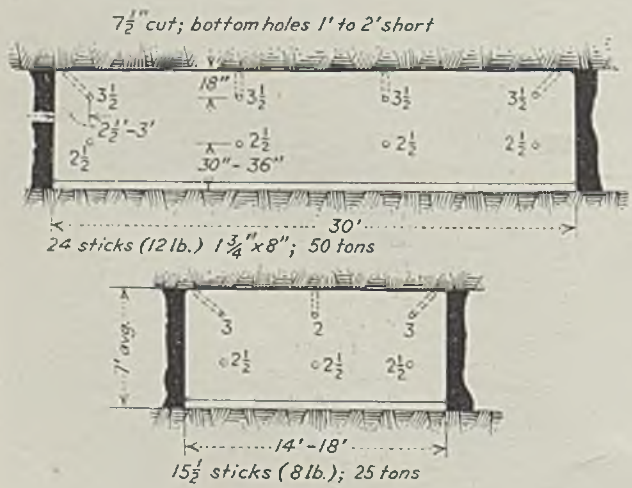


Fig. 10—Buckskin drilling plans

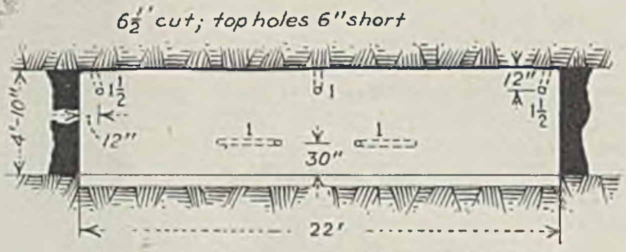


Fig. 11—Room drilling plan, Crown Hill No. 6

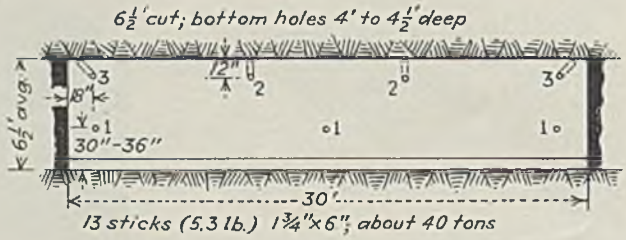


Fig. 12—Room drilling plan, Wick mine

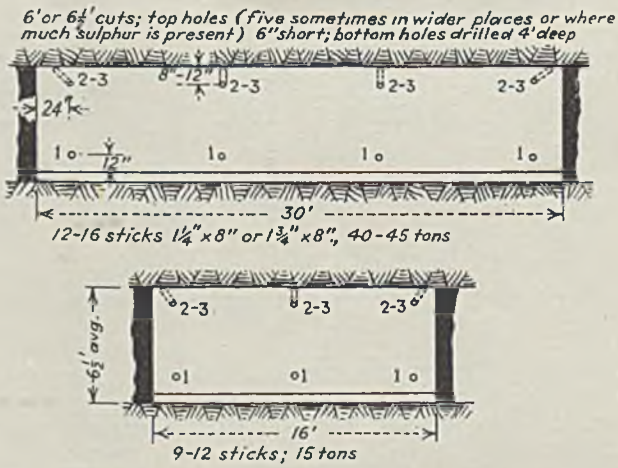


Fig. 13—Drilling plans, Knox Consolidated mines

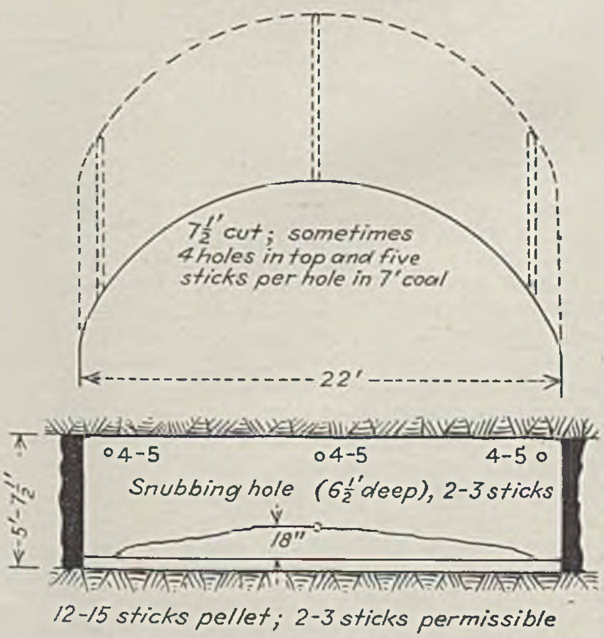


Fig. 14—New Hope room drilling plan

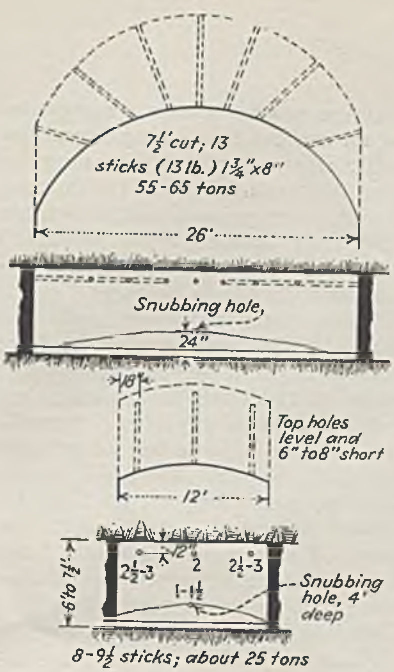


Fig. 15—Glendora drilling plans

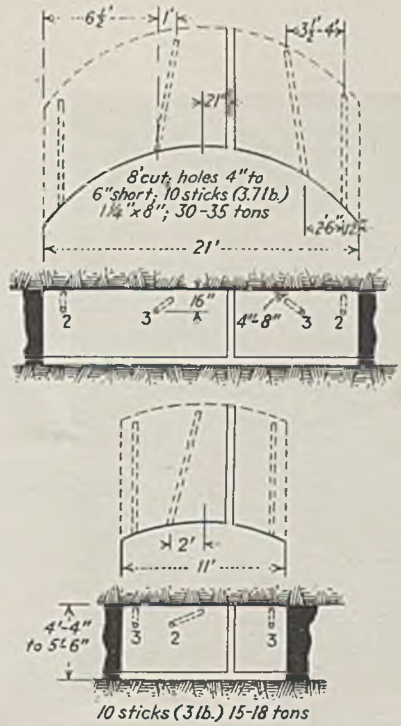


Fig. 18—Saxton drilling plans

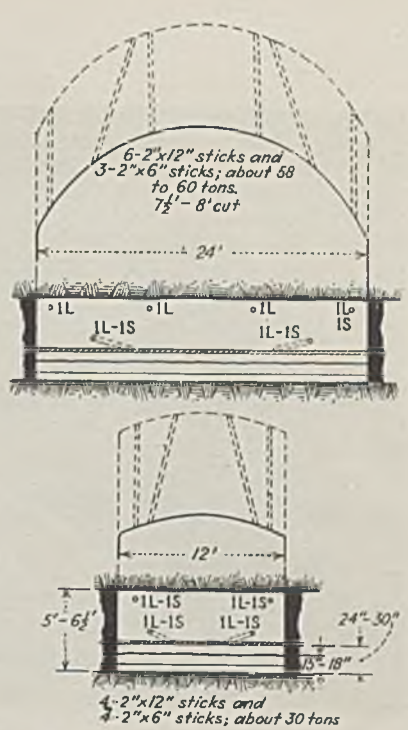


Fig. 19—Talleydale drilling plans

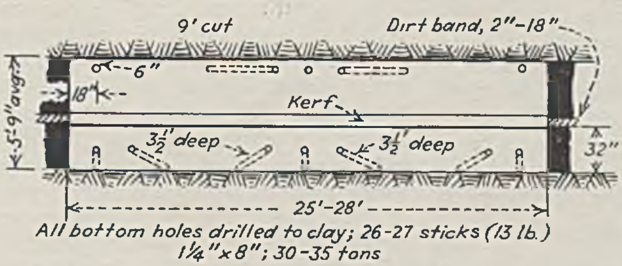


Fig. 16—Peabody 48 room drilling plan

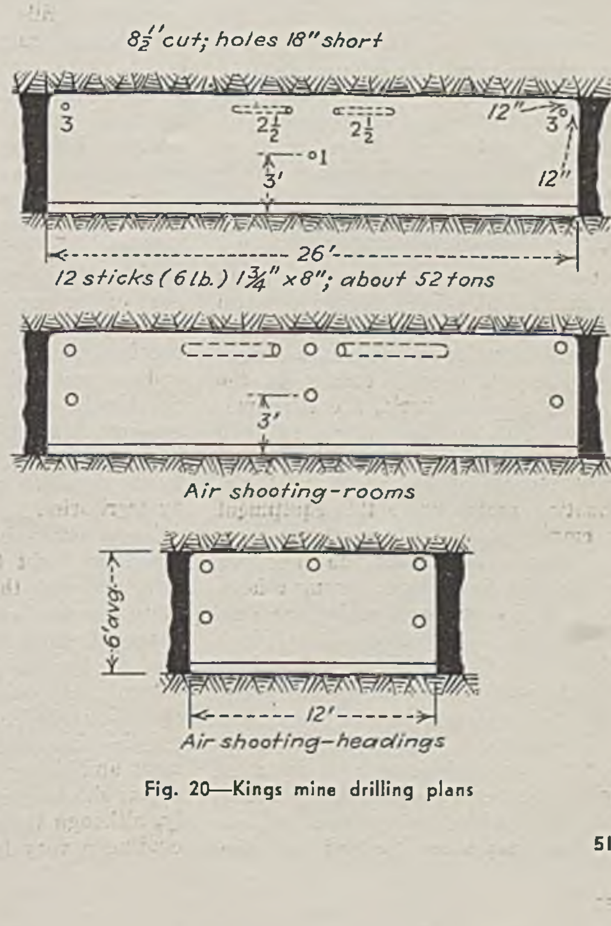


Fig. 20—Kings mine drilling plans

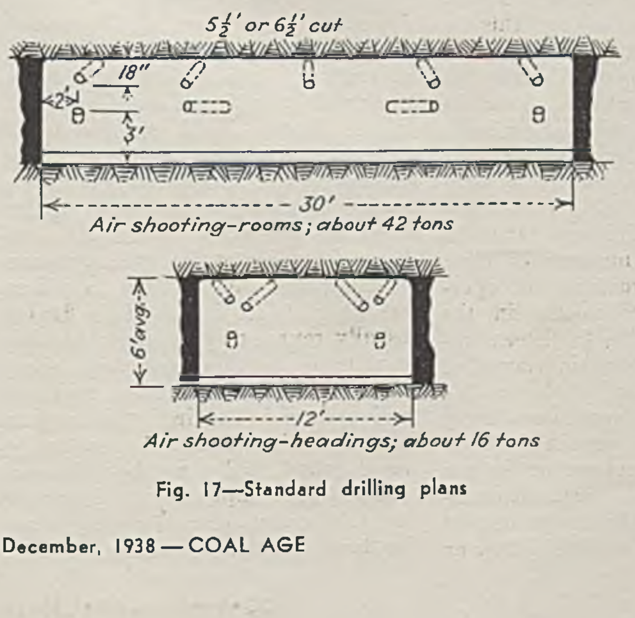
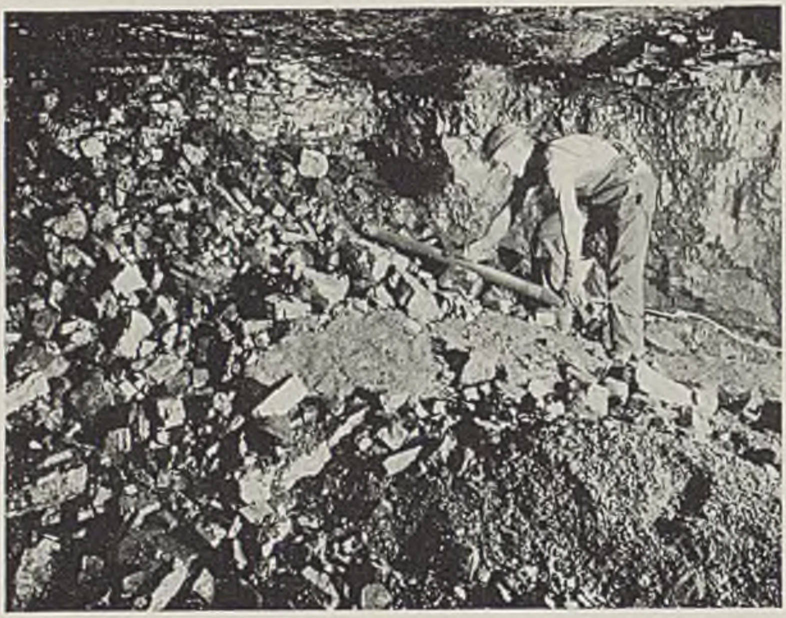


Fig. 17—Standard drilling plans



Air-shot place, Standard mine

5BU type with certain modifications to increase capacity. Coal thickness averages 6 ft., and cars average 3.3 and 3.6 tons mechanically loaded. Syndicates, under these conditions, produce 120 to 160 tons per shift, compared with around 400 for room machines, each served by a single locomotive. A few six-man syndicates with Jeffrey 44 loaders develop at the Glendora mines.

Some pit-car loaders are used for development in Indiana, certain operations, such as Miami No. 10 and Crown Hill No. 6, employing them to supplement development by regular loading machines and, at Crown Hill, to work rooms where the top is bad or much water is encountered. At No. 48 mine, Peabody Coal Co., all development is done by pit-car loaders, leaving the room work to 5BUs each served by two locomotives.

Loading units in Indiana, as might be expected, usually consist of the loading machine itself, a cutting machine, drill and locomotive in both development and room work. Departures consist of the addition of air-shooting units, where this equipment is employed, or the use of two service locomotives, as at the Glendora mines and New Hope, among others. And in a few cases, mules are substituted for locomotives, as at Black Hawk and Crown Hill No. 6 and on pit-car loader units at Peabody No. 48.

Peabody No. 48 also furnishes another major departure from what might be termed the usual practice, in that loading units consist of two loading machines instead of one, one track-mounted cutter, three post-mounted drills (one part time) and two 5-, 6- or 7-ton service locomotives. In fact a great many of the departures occur in the mines using track-mounted cutting equipment as a result of its higher capacity. And at Wick mine also, where rubber-tired equipment is used for haulage, two loading machines comprise a unit and are served by two shortwall cutters, two drills and either four or five battery tractors with semi-trailers.

Under the usual conditions where shortwall cutters are employed, an adequate balance is secured with only one cutting machine and drill. But where the cutting or drilling is hard or other conditions result in an unbalance, the general practice is to work extra machines or double-shift part of the regular machines to provide the necessary coal. This is regular practice at several mines, and is resorted to occasionally at practically all operations. And in syndicate operation, cutting or drilling—usually the latter—may be done by the regular room crews from nearby territories.

Room crews in Indiana range in size from eight to nineteen or more men, although the majority of operators employ crews falling in the range of from twelve to fifteen, including bosses. Crews in excess of fifteen usually signify two-locomotive operations, bad roof conditions, heavy switchlaying under certain development and changing plans, or the use of air-shooting equipment. Normally, although there are exceptions, including a very few striking ones, an increase in crew size is accompanied by an increase in machine output per shift, other conditions remaining the same. Of course, where two loading machines comprise a unit, crews are practically doubled, as at Wick (25 men, including supervisors) and Peabody No. 48 (27 to 28 men).

Aside from loading and car changing, face operations in the State normally comprise the following: clean-up, track and timber extension, cutting, drilling, bugdusting or mucking, loading holes and shooting after the working shift. The order is subject to considerable variation, although in mines employing track-mounted equipment immediate track extension is mandatory. At the same time, timbers also are extended. Not all mines include a clean-up man in their crews, as there is a growing tendency to leave this task to the loading machine or transfer it to some other crew members, such as cutters, drillers, bugdusters, tracklayers or timbermen. And notably at Standard, bugdusting is omitted when places are shot with air. Saxton mine includes taking up bottoms for height in its operating cycle, while at Crown Hill No. 6 a man is employed to take down boulders which otherwise frequently hang low enough to prevent passage of the loading equipment. Depending upon conditions, timbermen sometimes are eliminated from loading crews, this task being relegated to night men or to other crew members, usually the loading-machine operator and helper, etc. Snubbing is practiced at the Knox Consolidated, New Hope, Glendora and Standard mines (experimental in the latter case) and consequently is included in the cycle.

Use Air and Powder

Although air is used for breaking down the larger part of the output at two mines and for heading coal at another, fixed explosives are the most widely employed shooting agent in the State. Yield per pound of explosive, disregarding the varying characteristics of the different types, ranges from 2½ to 10 tons on the basis of available data. The low figure is reported by one operation shooting two thin benches in places cut about 9 ft. deep. High figures usually represent very good shooting conditions in thin coal with short cuts or thicker-than-average coal and wide places. Drilling and loading methods also influence results to some extent, and a number of operators have improved performance materially by changing explosives or hole layouts. Shearing of both headings and rooms is done at the Saxton mine, using 9-ft. cutter bars, and here the yield per pound of explosive is around 9 tons in rooms and 5½ tons in headings.

Long cutter bars have been used by some Indiana mines for years and new converts constantly are being made. A major reason is the fact that more coal is available per fall and thus the loading machine need not move so often for the same tonnage. As a corollary, headings can be advanced faster for the same reason. Finally, fewer working places are required for the same tonnage, thereby promoting concentration. At Miami No. 10, Goodman shortwalls used in entry work have been equipped with 8-ft. thin-kerf bars instead of the 6-ft. standard-kerf bars used in rooms. The thin (4-in.) kerf reduces screening in the same proportion as the thickness of the kerf—an important item in the summer, when all the development is being carried on. Headings are drilled with five holes for the Airdox shell, using Chicago Pneumatic post-mounted drills, Hardsocg augers and molefoot heads, and Hyslop bits. The Airdox unit can shoot as many as 100 holes in a shift, and air has been found a definite advantage in pulling the deep cuts in headings. Coal in rooms is broken down with Atlas "Coalite M."

Patent Bits Cut Cost

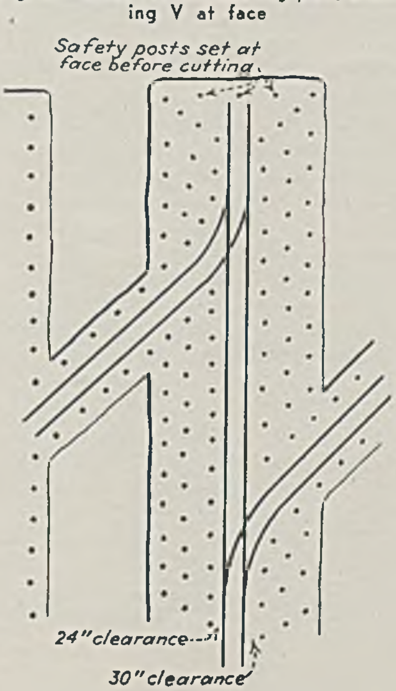
Management at the Black Hawk mine has equipped part of its Jeffrey and Goodman shortwalls (6-ft. bars) with Goodman chains accommodating double-ended bits and Jeffrey chains taking three-pointed, or "star," bits. Standard chains are used on the remaining machines. In addition to savings in the cost of resharpening and handling, patent bits cut 20 per cent more tonnage with less power and wear and tear on the machine. U. S. No. 15 permissible and pellet powder are employed at Black Hawk, with Ensign-Bickford single- or double-tape fuse and caps. Rooms are shot with seven holes, placed usually as shown in Fig. 8. Three holes normally are drilled in headings.

Ryerson alloy-steel bits, heat-treated at the mine, are used on the Goodman 50-hp. universals employed at Dresser. This heat-treating process, installed by James Hyslop, now manager of operations, consists essentially of heating, rolling, air cooling, reheating to insure a uniform temperature, quenching in oil and finally drawing in a bath of fusible salt. All mines in Indiana which heat-treat their bits employ substantially the same system. At Dresser, heat treatment has increased production per point from 1 to 2 tons.

Dresser is another in the group lengthening cutter bars, replacing old 6½- with new 8½-ft. units making a 6-in. kerf. The 20-in. feed speed of the machines has been retained, bringing the motor demand up to 50 hp., as it was determined by experiment that a reduction to 16 in. per minute resulted in poorer cutting. With coal averaging 4 ft. in thickness, it was found that wide places could be shot with four holes instead of five, as in Fig. 9, using Monobel C. Headings, however, require three holes and must be shot much harder.

Cutting equipment at Buckskin has been equipped with Cincinnati "Duplex" chains and bits. Difficult cutting, with much sulphur and other hard material in the bottom, prompted the change in bit types, which raised output per point from ½ to 1½ tons. Rooms at Buckskin (7-ft. coal) are shot with eight holes (Fig. 10) put in with CP drills, Hardsocg or "Coalmaster" conveyor-type augers and molefoot heads, and Hyslop bits. Holes are loaded with Red Diamond No. 11 LF, and are shot with Ensign-Bickford fuse and caps. Buckskin recently changed from ten holes in rooms from three set-ups to the present eight holes from four set-ups and found that drilling time per place actually was reduced. Cutting equipment comprises Sullivan CR3 and Goodman 112-AA shortwalls and one Jeffrey 29LE track-mounted machine for syndicate use, all with 8-ft. bars.

Fig. 21—Black Hawk timbering plan, showing V at face



The cut is made in the clay under the coal (averaging 4 ft. 10 in.) at Crown Hill No. 6, using shortwalls with 6½-ft. bars. Consequently, the output of fines is reduced, the coal is kept cleaner, and extra height is provided for the loading machines. Cutters are equipped with Prox "ToolSteel" and Bowdil chains and bits which, in addition to reducing power and wear and tear, have increased output per point from about 1½ to 3 tons. Five holes are drilled in rooms at Crown Hill as shown in Fig. 11.

Cutters Moved on Truck

Extremely difficult cutting conditions also prevail at Wick mine (sulphur, boulders, etc.) and consequently this operation also has gone to Cincinnati "Duplex" chains and bits and has installed a machine for cutting the bits from bar stock. Jeffrey 35BB shortwalls with 7-ft. bars are employed and, inasmuch as rubber-tired equipment is used for haulage, cutters are moved from place to place on Joy caterpillar-mounted transfer trucks. Adoption of the new bits has, among other things, reduced bit cost, increased production per point, improved the quality of the bugdust, reduced power consumption (from 0.59 to 0.395 kw.-hr. per ton in one test), and raised the feed speed (15 to 17.2 in. per minute). Coal thickness at Wick averages 6 ft. and the most-used drilling plan is shown in Fig. 12. At this mine, the bottom holes are drilled only 4 to 4½ ft. deep. Shooting is done with Red H F and fuse and caps.

At the Knox Consolidated mines, where 6½- and 7-ft. bars are used and the coal averages 6½ ft., places are shot with Austin and Atlas permissible in 1¼x6- and 1¾x6-in. sticks. Holes, however, are drilled 3 in. in size. Four dummies are used in the top holes (Fig. 13) and the one next to the charge is not tamped, the combination giving some cushioning effect. In the bottom holes, drilled only 4 ft. deep and used only for snubbing, and therefore requiring only a minimum of breaking force, only one dummy is used, usually wedged in place by a chunk of coal.

Snubbing at Knox Consolidated is done on the second shift, employing pans 2½ ft. wide and 5 ft. long. Pan design, in the opinion of company officials, has much to do with the good results attained. Usually, pans are made of screen plate with two 2½x2-in. angles welded on, one at the inner end and the other in the center. When screens are scarce, however,

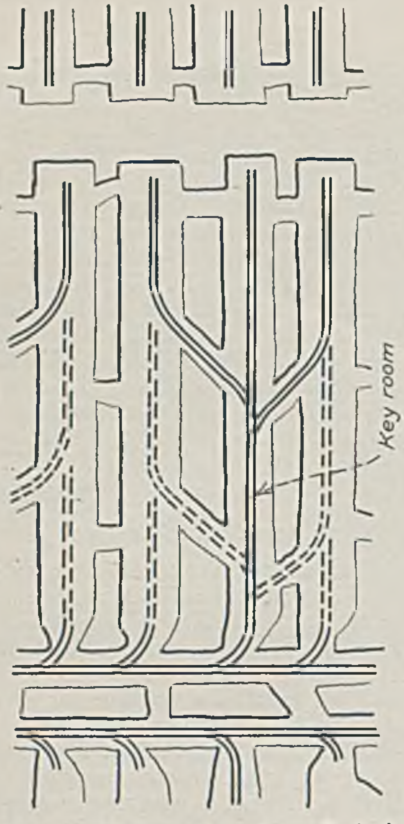


Fig. 22—"Key-room" system, Peabody No. 48

pans are made, lattice fashion, of ½x1½-in. bar stock. Two pans are placed under each snubbing hole, after which the holes are fired. Pans then are pulled out by a locomotive and are dumped by hand. Top holes are fired to complete breaking down the cut. The free space resulting from snubbing permits rolling the rest of the cut out in better shape for the loading machines with less powder.

Snubbing also is the regular order of business at the New Hope and Glendora mines, where Goodman track-mounted cutters with 8-ft. bars are used. One snubbing hole 6 ft. deep is drilled at New Hope (Fig. 14), with three or four holes in the top, depending upon the thickness of the coal, which varies from 5 to 7½ ft. Snubbing holes are loaded with Red H 4, and after they are shot on the second shift the coal is pulled out by hand. Finally, the top holes, loaded with pellet powder, are fired. Heat-treated bits are used at New Hope, whereas mostly Cincinnati "Duplex" and Goodman (double-pointed-bit) chains are employed at Glendora. Production per point is approximately the same as with standard bits, but less power is consumed and screenings are better.

Rooms at Glendora are shot with eight holes, seven in the top and one snubber, the latter handled as at New Hope. All holes, including the top group, are drilled from one setup (Fig. 15), as this has been found, under conditions at these mines, to provide a better grade and higher percentage of lump, in addition to improved loading conditions. Coal thickness ranges from 6 to 7½ ft., and a special U.S. permissible powder in 1¾x8-in. sticks is used.

Band Cut by Machine

Average coal thickness at Peabody No. 48 mine is 5 ft. 9 in., with variations from 4 to 6½ ft. A dirty band 2 to 18 in. thick occurs about 34 in. above the floor and this is cut out, or cut and raked out, by Jeffrey 29C track-mounted machines fitted with 9½-ft. bars. Heat-treated bits are used giving, among other advantages, four more places per shift and a 50-per-cent reduction in per-ton cost of bit-sharpening and machine repairs. Rooms usually are shot with twelve holes placed approximately as indicated in Fig. 16. The holes are put in from three set-ups, with five in the top bench drilled level and seven in the bottom angled down to hit the clay. Two of the bottom holes (see figure) are drilled only 3½ ft. deep to knock the front of the bench loose. The larger-than-usual number of holes is necessary because of the thinness of the benches and the depth of the cut.

Five Airdox units, three in rooms and two in headings, shoot a substantial proportion of the output at Kings Station mine, where average coal thickness is 6 ft. The remainder is broken down by Red Diamond No. 11. With Airdox, rooms are drilled with eight 4¼-in. holes put in with CP equipment. Five holes (Fig. 20) are required in headings. Using powder, however, rooms are shot with only five holes. Cutter bars at Kings Station are 9 ft. long, and where powder is used the management is experimenting with drilling Airdox-size holes and then bundling all the explosive together and placing it in the back, which so far seems to roll the cut out considerably better. A Tamping Bag Co. vibrating dummy maker is used at the mine. Cutting bits are tipped with "Sulite," which gives a production, according to one test, of 10 tons per point, against 3 tons with untreated points. The feed speed of eight shortwalls (112-AA) has been increased from 16 to 24 in., partly as a result of use of the tipped bits.

All places, as noted above, are both cut and sheared at Saxton, using Jeffrey 29LE track-mounted machines with 9-ft. bars equipped with Bowdil and "star-bit" chains. Bits are not discarded when worn, but instead are repointed with "Stoodite." Tipping increases production per point to about 1½ tons, as compared with about half that figure for the untipped bits and, furthermore, purchases of bits have been materially reduced by using the old ones over several times.

The shear at Saxton usually is made over one rail, as indicated in Fig. 18. Rooms are drilled with four holes, while headings are shot with three, positioned as shown in the figure. Coal thickness varies from 4 ft. 4 in. to 5 ft. 6 in. Holes are loaded with Monobel A in 1¼x8-in. sticks. This represents a change from Monobel E in 1¾x6-in. sticks, primarily to stretch out the charge and thus distribute the breaking force over more of the cut.

Goodman track-mounted cutting machines with 8- and 9-ft. bars, set with heat-treated bits, are employed at Talleydale mine. This operation has used, since the summer of 1937, "Lump Coal C" in 2x12- and 2x6-in. sticks, developed at the instigation of the management for two purposes: convenience in adjusting size of charge, and concentration of the breaking force toward the backs of

Fig. 23—Diagrammatic sketch of two-car changing system, Knox Consolidated mines

the holes in the deep cuts employed. Coal thickness at Talleydale is 5 to 6½ ft., and the shooting problem is complicated by the presence of two persistent bands about one-third the way up the face.

Rooms at Talleydale are shot with six holes, four in a row in the top and two over the top parting, as indicated in Fig. 19. Four holes are drilled in headings, which must be shot, as indicated in the figure, much harder than rooms. A major result of the adoption of the new powder size and supplementary changes in shooting practice has been a substantial increase in loading-machine output, due to better falls of coal.

All but 13 per cent of the coal at Standard mine is broken down by Airdox units. The major objective in their installation was a reduction in screenings output (March, 1935, *Coal Age*, p. 118). Seam thickness at Standard averages 6 ft., and the coal is cut by Jeffrey 35B machines with 6- and 7-ft. bars with heat-treated bits. Rooms are broken down with nine holes, positioned as a rule as shown in Fig. 17, while six holes are drilled in headings. The number of holes, of course, is reduced when powder is employed. Holes are drilled with CP equipment, using "Coalmaster" conveyor-type augers and molefoot heads and bits. Good results have followed the use of one special head constructed of alloy steel and hard-surfaced. Experiments with snubbing now are being conducted in one section of the mine.

Timbering Done Regularly

Regular timbering is an almost invariable rule in mechanical-loading mines in Indiana, with practically all operations using a V at the face to provide working space for the loader. The number of rows set on each side of the track—track almost invariably in the center of the place—varies from two to four. The V at the face is formed by setting the rib post on each side 2 to 3 ft. to one cut back from the face after it is cleaned up, the distance varying at the individual mines. The posts along the rails on each side of the track then are placed as far as three cuts back, and intermediate posts are set to form the V, as indicated in Fig. 21.

Before cutting, the usual practice is either to fill the V with safety posts or set a line of them across the face. These safety posts then are removed one by one as the place is cut and, if necessary, are reset afterward, the same applying in later loading operations. And in several mines, depending upon roof conditions, timbermen accompany the loading machines at all times and extend the timber lines as the coal is loaded. The Glendora mines are examples of operations where this practice is followed.

Loading out a cut in Submarine No. 2 conveyor mine

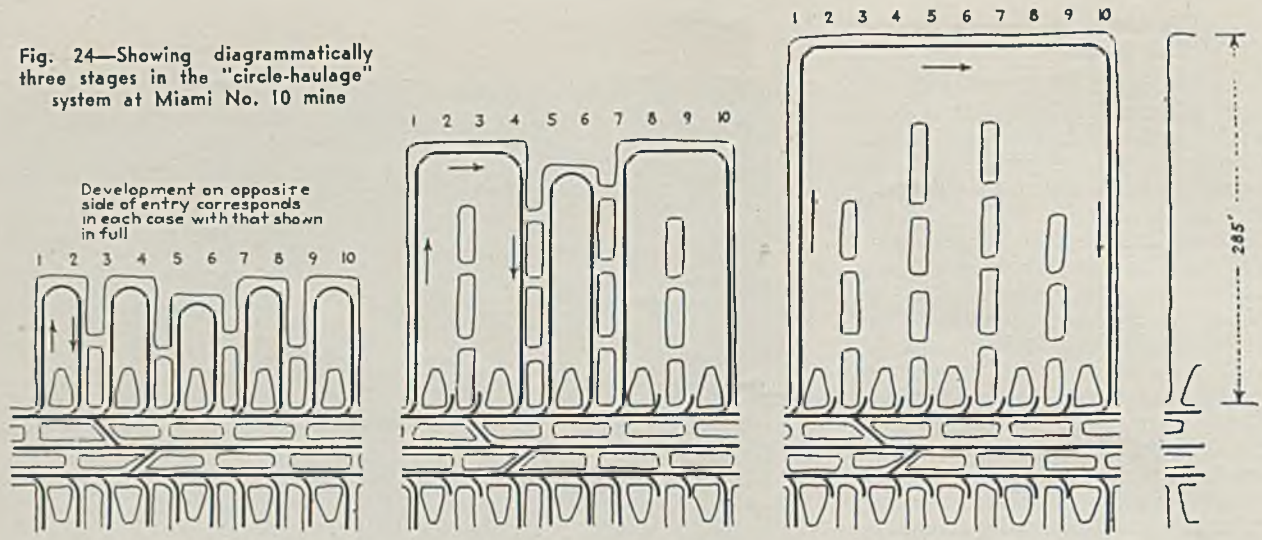
Normally, single posts are sufficient to maintain the top until the place is finished, with crossbars under bad spots, over long spans, etc. At Talleydale, however, the character of the top is such that before the rooms can be driven to their standard depth of 250 ft., crossbars usually must be installed over the track from the mouth to a point about half way up or farther. Crossbars are used all the way over the track in the "key" rooms at Peabody No. 48, with three rows of props on each side of the track in the rooms on each side picked up from the key room. Peabody practice involves carrying a 20-ft. H-beam at the face in every room. This beam is advanced every cut. Then for 20 ft. back of the H-beam, 12-ft. bars are installed over the track. Back of the 12-ft. bars in key rooms, 10-ft. bars are installed, with the necessary amount of single posts for protection in addition.

One-locomotive car-changing is the rule in most Indiana mines, with some operations using two locomotives behind each loader and two employing, respectively, mules or mules and pushers. Car capacity runs all the way from 1½ to 5.8 tons, the lower limits reflecting, as a rule, small shafts inherited from hand-loading days. To shorten the car-changing distance, a majority of Indiana operations make use of what generally is known as the "key-room" system, in which rooms on either side of the key place are picked up at intervals through the crosscuts. Relay locomotives are used in all but a few mines to handle cars between the working sections and main-line partings.

Some operations in the State, however, make a practice of connecting all room tracks together through the crosscuts, usually to facilitate changing with two gathering units, although this is not always the case. At Black Hawk, two mules are assigned to each loader and rooms are connected through every crosscut. While one car is being loaded, the second mule takes the other out to the storage track, gets an empty and comes back, usually through the last crosscut from the adjacent place, to the last switch in the place being loaded. Here he waits until the first mule comes out with the load. Under this system, changing distance (one way) seldom is over 100 ft., although, of course, the distance traveled to store a load and pick up an empty may be much greater. However, it is the distance from the last switch to the face that counts. The time required for loading the car (1½ tons) permits storing the load and returning with an empty. Loads and empties naturally are parked as close as possible, either on the heading or in the rooms closest to the working place. Eventually, relay hauls to partings will be eliminated and main-line locomotives will operate directly from the working sections to the bottom.

Black Hawk also furnishes an example of a practice at several mines which permits making two-car changes at least part of the time. Under this system, the loading machine works off the end of the track to the back of the cut. The track then is extended so that two cars can be placed, one against the face. This

Fig. 24—Showing diagrammatically three stages in the "circle-haulage" system at Miami No. 10 mine



brings the rear car within reach of the rear conveyor of the loader, which naturally works from a position alongside the trip, first on one side of the room and then on the other. When the rear car is filled, the trip is pulled away from the face to bring the front one in position.

Connecting track through every crosscut and the use of two 6-ton General Electric locomotives per loading machine were adopted at Glendora Nos. 27 and 28 mines to compensate as far as possible for the small car capacities, 4,000 and 5,200 lb., respectively. Track layout is indicated in Fig. 3, and changing practice is substantially similar to that outlined above for Black Hawk. Under this system, one machine has loaded as high as 363 4,000-lb. cars at No. 27 mine in seven hours. Although only one machine is served by two locomotives at Standard (4-ton cars), this operation has recently adopted the practice of connecting all rooms through crosscuts at intervals of about 150 ft., primarily as a means of always insuring a short change, as well as to facilitate the movement of air-shooting units and other equipment operating on tracks. Six rooms are assigned to a loading unit at Standard, and one room is equipped with a parting accommodating 18 to 24 loads and empties. Before the rooms reach their depth of 500 ft., this parting is moved ahead once.

Two 6-ton G. E. locomotives handling 4½-ton cars also serve the New Hope loading machines. At this mine, as indicated in Fig. 4, stub tracks are laid in the crosscuts next to the faces as waiting points for one locomotive and an empty car. Main-line locomotives at New Hope bring empty cars in to the working sections, spotting them as close to the working room as possible and picking up the loaded trips, usually made up in a room.

An example of the commonest key-room changing system is given in Fig. 22. In this example, used at Peabody 48, one room on each side of a center room is picked up twice in a total depth of 250 ft. by track through 45-deg. crosscuts. Thus, a changing switch always is kept within at least 125 ft. of the face. One 5-, 6- or 7-ton locomotive serves each loading machine at No. 48. Car capacity is 3,750 lb. As soon as a room is picked up, whether the first or second time, all material is removed, including timber, which is pulled out with a locomotive and cable. Then the top is allowed to cave or, if necessary, is shot to bring it down. This practice grows out of the presence of water and gas under pressure in the roof. Bringing down the roof in worked-out territory relieves the pressure in adjacent openings, such as in the key rooms. As a corollary, holes are drilled in the roof every cut in the haulage side of all entries, and the top is timbered to hold it in place. In the aircourses, the top is allowed to fall to relieve the heading side.

With a room depth of 175 ft. and 2-ton cars, Dresser mine employs one 6-ton G. E. locomotive per loading machine. In the three-room key system used, side rooms are picked up once through a 45 about half way up. Thus the changing distance is about 125 ft. and seldom is over 150 ft. One 7-ton locomotive, as a rule, serves a loading machine at the Knox Consolidated mines, where car capacity is 3 tons. Room depth is 400 ft., and the key system with three rooms is employed until the places are about half way in. Then eight rooms, as a rule, are picked up from one main room, the pick-up tracks forming secondary haulage roads paralleling the panel entry. After the secondaries are in service, the usual three-room system is resumed. A study of the possibilities of changing with two locomotives was made some time ago at these mines, but showed, with the capacity of loaders used, that it would not pay out.

To provide for two-car changes, the Knox Consolidated management is experimenting with the room-track position shown in Fig. 23. Under this system, the track is laid with its center 7 ft. from one rib. With loading machines 26 ft. long and pillars 23 ft. thick, it naturally is possible to complete crosscuts without laying switches or turning the track into them, unless required for pick-up purposes. At the same time, of course, a number of cars may be run past the crosscut toward the face to permit multiple loading. Knox Consolidated also expects when operating in the face to clean out in front of the track and lay down ball rails to permit running cars up into the lane through the broken-down coal, thus bringing the last car in a two-car trip within reach of the rear conveyor on the loader working alongside the trip. With the machine length noted above and the track 23 ft. from one rib, the machine still can reach coal in the farthest corner and load two cars at a time.

One battery locomotive—a 6-ton Whitcomb or Ironton with Exide-Ironclad battery—accompanies each loading machine at Jackson Hill No. 6, where the side rooms in the key-room system are picked up through every crosscut. Car capacity is 3,200 lb. At Saxton, the 350-ft. rooms employed are picked up twice, the system used providing for picking up one room on one side of the key place and two on the other (Fig. 7). Also, track connections provide for inside routes in groups of eight rooms. One 6-ton locomotive handling 3-ton cars serves Saxton loading machines.

Formerly employing a system whereby rooms were connected through all crosscuts, Talleydale has changed to the key-room system shown in Fig. 6, picking up the side rooms through every crosscut, with the result that changing time—6-ton locomotive and 5.8-ton cars—has been cut to a maximum of 45 and minimum of 25 seconds. Talleydale also conducted experiments with two-locomotive changing and found not only no gain but an actual loss in performance.

Rooms, as indicated above, usually are worked in groups of ten at the Kings Station mine, where one locomotive usually serves the 5BU and 260-A equipment and two the 10BU and 11BU equipment, handling 3½-ton cars. At this mine, the remaining nine rooms in a group of ten usually are picked up from No. 5 or 6, the pick-up road starting from a point about 50 ft. in and extending out both ways on an angle of about 45 deg. to the outside rooms. In addition, a supplementary pick-up is made about 100 ft. farther in in a normal 300-ft. room.

Loading machines in rooms at Wick are served by Baker-Raulang rubber-tired tractors each pulling a 4-ton Sanford-Day bottom-dumping trail car. Using the mining system detailed in Fig. 5, two tractor-trailer units serve one loading machine and two more the other—that is, until the round-trip haul reaches a maximum of about 1,600 ft., whereupon a fifth tractor unit will go into service, alternating between the two loaders. Under the rubber-tired haulage plan, developed by James H. Fletcher, the trailers dump into a hopper from which the coal is fed out onto an inclined loading conveyor used to fill mine cars in trips (October, 1938, *Coal Age*, p. 29).

Car changing at Crown Hill No. 6 is done entirely on the entry, no pick-ups, stub tracks, etc., being employed because the extra crosscutting required results in squeezing. Room depth is limited to 165 to 200 ft. and 1½-ton cars are used. Cars are pushed in to the loader and when loaded are pulled out by a mule. As many as 215 changes have been made in seven hours under this system when the rooms were just starting and the changing distance consequently was short.

"Circle haulage" was adopted at Miami No. 10 mine (*Coal Age*, July, 1935, p. 286) to compensate for the small capacity of the cars which had to be used (1½ tons mechanically loaded) by providing for loading them in trips. The system is detailed in Fig. 24. Briefly, it consists of necking ten rooms on 27-ft. centers and then, after the rooms are in 30 ft., omitting the middle pillar to form 40-ft.-wide places. Track then is laid in a "circle" in the place, going in one room neck, across the face and out the other room neck. Naturally, this permits pulling a complete trip past the face for loading. When the rooms have advanced about 150 ft. more, pillars are omitted as indicated in the figure to provide even longer faces. And when the places, usually driven about 285 ft. deep, reach about 210 to 235 ft., all room pillars, if conditions permit, are omitted, resulting in a single face approximately 258 ft. long, with the cars coming in No. 1 room neck and leaving by No. 10. As the cars are of the end-gate type, running them across the face in this fashion naturally results in a reversal in gate position. Therefore, provision has

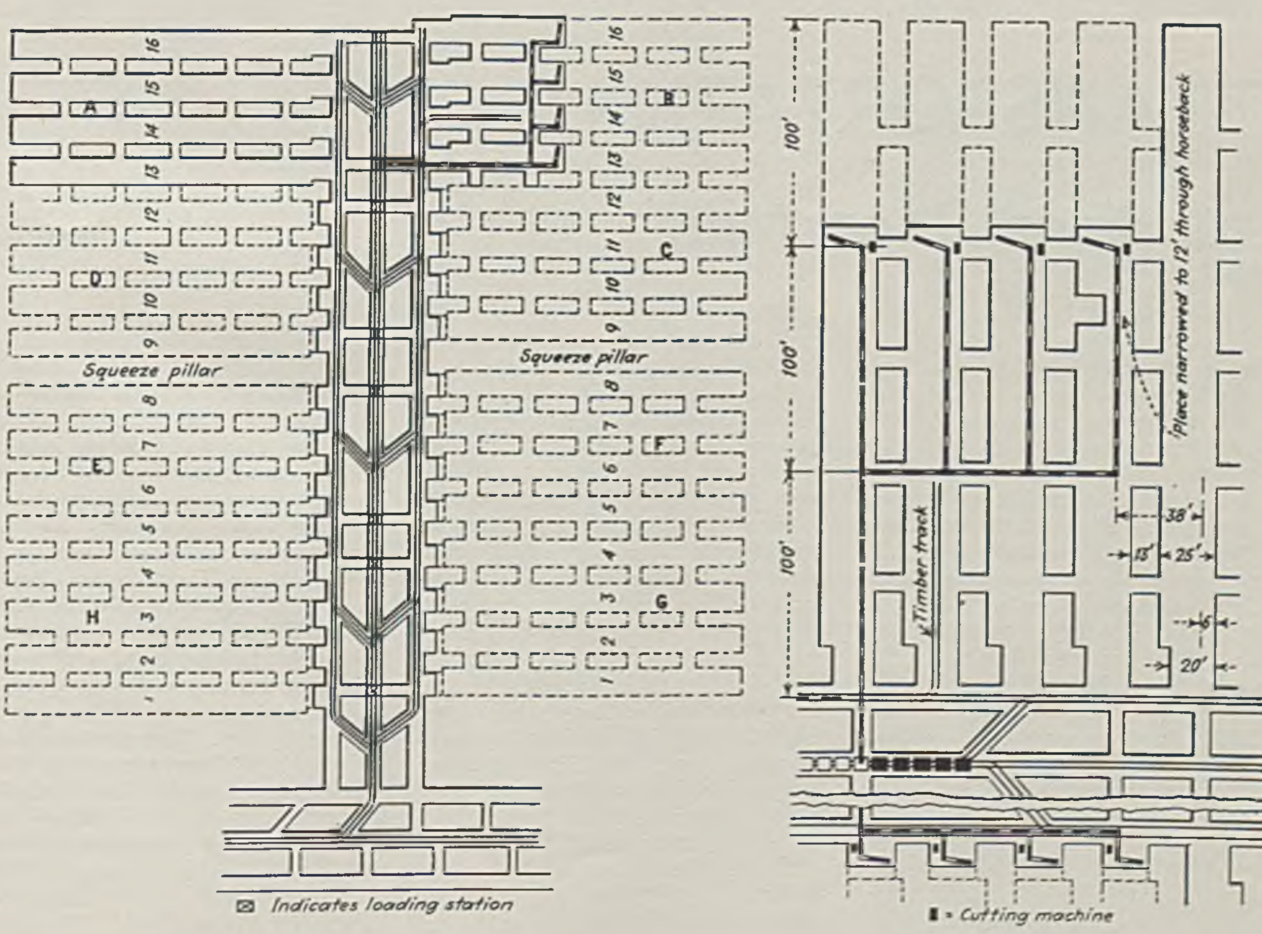


Fig. 25—Left, general plan of mining with conveyor units, Submarine No. 2; right, above, details of conveyor set-up in four-room group; right, below, equipment placement when starting a four-room group.

been made for completing the "circle" in the main-haulage system and thus turning the cars to the right position. When sections are completed they are allowed to cave and then are permanently sealed.

One completely conveyor mine was in operation in Indiana at the time the *Coal Age* survey was made: namely, Submarine No. 2 of the Clinton Coal Co., mining the Indiana 4th Vein 90 ft. below the No. 5 originally operated through the same shaft. Fourth Vein thickness averages 3 ft. 9 in., and it is overlaid by an average of 17 ft. of gray slate which, while normally strong, cuts badly in fresh air. Average depth of cover is 285 ft.

Equipment at Submarine No. 2 (Jeffrey, Tracy and Fairfield) is sufficient for the operation of three four-room conveyor units when desired. Each conveyor unit is assigned to a 32-room panel (16 rooms on a side, with a squeeze pillar between No. 8 and No. 9 on each side, as shown in Fig. 25). Panel entries are driven, two cuts are loaded out of each room neck and a third cut is made by entry crews, using pit-car loaders. Average pit-car-loader performance is five cuts 10 ft. wide and approximately 5½ ft. deep per shift.

As the panel entries (three headings each) are extended, eight loading stations are made at points indicated in Fig. 25 by shooting out the top, etc., although only four normally are used in completing an entry. However, the others are available in case conditions prevent the use of the regular stations. Two crosscuts are made at each loading station to allow it to be used in loading from two groups of four rooms, one on each side of the entry.

Equipment in a conveyor unit consists of one 300-ft. main, or mother, conveyor; one 114-ft. cross conveyor; three 100-ft. parallel room conveyors; four 14-ft. face conveyors; four Sullivan CE7 shortwalls with 6-ft. bars; one Hardsocg or Chicago Pneumatic post-mounted portable electric drill; and one 5½-ton Goodman locomotive handling trips of cars under the elevating conveyor receiving coal from the mother conveyor. The conveyors are installed as shown at the right in Fig. 25, one view showing the start of work in a group of rooms and the other the position of the cross conveyor after the first move-up. The operating schedule calls for working out a group of four rooms on one side of the entry and then moving to the opposite side, using the same loading station, to work out the second group, as indicated by the letters in the plan in Fig. 25. Cross-conveyor move-ups are accomplished in less than half a shift, and an entire unit has been moved from one room group to another in one shift, employing eight to ten men and using the cutting machines to skid the conveyor sections out of the places preparatory to loading them on a light steel truck for transportation to new rooms.

Room width is 25 ft. and conveyors are placed 6 ft. from one rib. Places are shot with four holes in the top loaded with a total of four sticks of 1¾x6-in. Red H F. Normally, four cuts are loaded out and prepared by the noon hour, whereupon all the men are taken out of the mine to permit shooting. After lunch, the crews (thirteen men) return and finish up four more cuts as a general rule. Each cut yields about 20 tons of coal, although as high as 233 tons has been obtained off one unit in a shift of seven hours.

TRANSPORTATION

+ Indiana Deep Mines

WITH shaft operations predominating, mechanical mines in Indiana, with some exceptions, divide their underground haulage into three stages—gathering, relay and main-line—although some eliminate the relay step. Many mines necessarily use small cars, either because of low coal or the limitations of shafts inherited from hand-loading days. However, a skip has been installed in one case to permit a change from a small to a large car. As most of the mines have a fairly long producing history, main hauls seldom are less than a mile and in many cases run up to two miles, while the total distance to the face in several instances is three miles or more. Overturning cages, permitting the use of solid-end equipment, are used at several mines—the latest installation handling a 5.8-ton car.

Track construction in Indiana is marked by an extension of the use of heavier steel on main, secondary and gathering routes. Now, 60-lb. or heavier rail is used on main lines in most of the mines in the State, and in some cases this weight of steel is laid clear to the mouths of the room panels. Even in rooms, the tendency toward heavier rail has been marked in late years, with 40-lb. not uncommon in many cases. Welding of main-line tracks is under way at a few operations, while research to reduce the time of installing turnouts in rooms has resulted, among other things, in the recent development of a sectionalized steel-tie switch laid by bolting it together.

Steam is the most-used hoisting medium in the State. At the Kings Station mine of the Princeton Mining Co., the deepest in the State, hoisting distance is 530 ft. Self-dumping cages weighing 5.8 tons accommodate cars weighing 2 tons and holding an average of 3½ tons of coal. Nolan cagers are used and cars are hoisted by a 7- to 12-ft. four-step steam-driven hoist with a capacity of 175 cars per hour. The usual hoisting rate, however, is 140 cars per hour. At the Black Hawk mine, Black Hawk Coal Corporation, on the other hand, where the hoisting distance is 200 ft., a straight drum with a diameter of 7 ft. is used to get out a maximum of 245 cars per hour, each holding 1½ tons. The usual hoist is 1,250 to 1,350 cars per shift. The steam hoist at No. 48 mine, Peabody Coal Co., to cite still another example, has a capacity of 240 cars per hour over a hoisting distance of 265 ft. Cages weigh from 5 to 6 tons and cars hold 1.9 tons of coal. The average hoist is 1,350 cars per shift.

Electric hoists in the State are

used mostly in connection with overturning cages at plants designed by the Allen & Garcia Co. One exception is Knox Consolidated No. 2 mine, Knox Consolidated Coal Corporation, also put in by the Allen & Garcia Co., where a Nordberg hoist driven by an 800-hp. General Electric motor has a capacity of 200 cars per hour. The average hoist at present, however, is around 650 cars per shift. Hoisting distance is 287 ft., cars weigh 2.05 and 2.50 tons and hold 3.3 and 3.6 tons. Nolan cagers are employed and the hoist is equipped with a 200-hp. standby motor.

Car weight and coal weight are both 2 tons at the Dresser mine, Walter Bledsoe & Co., where the hoisting distance is 240 ft. Allen & Garcia Co. overturning cages weighing 10 tons are employed, and hoisting is done by a 4- to 8-ft. two-step Ottumwa hoist powered by a 400-hp. General Electric motor. The minimum hoisting cycle is 24 seconds. At the Standard mine, Standard Coal Co., cars weigh 2 tons and hold 4 tons of coal. Weight of the overturning cages is 11 tons. Hoisting distance is 290 ft., and hoisting is done by an Ottumwa straight-cylindrical drum powered by a 250-hp. motor. Hoist capacity is 110 cars per hour and the usual average per shift is 650 cars.

Overturning Cage Installed

Talleydale mine, Snow Hill Coal Corporation, also is served by overturning cages weighing 11 tons, although the aluminum bonnets and decking being specified for future units are expected to reduce this total somewhat. Talleydale cars weigh approximately 2½ tons and hold an average of 5.8 tons. Hoisting distance is 397 ft. and hoisting is done by an 8- to 10-ft. two-step Hardie-Tynes hoist driven by a 700-hp. Allis-Chalmers motor. The normal hoisting cycle, with manual caging, is 30 seconds. To minimize the shock to guides and cages arising from checking the heavy loads in caging, stopping dogs on the cages are mounted on movable shafts, which are thrust forward against spring buffers mounted in the wall of the sump. Auxiliary springs on the cages return the shafts to normal position after the cars rebound against the holding dogs.

Hoisting at the Saxton mine of the Saxton Coal Mining Co. is done in a single 6-ton counterweighted skip. Cars hold three tons of coal and are discharged by a rotary dump into an 18-ton bin. Skip loading is done by automatic gates actuated by the skip itself. A steam hoist is used and the hoisting distance is 240 ft. Capacity is about 55 skip loads, or 110 cars, per hour.

One cage at the Buckskin mine of the Buckskin Coal Corporation has been replaced with a skip to permit the use of a substantially larger car than the mine originally was equipped with. Weight of the skip, fabricated by arc welding, is approximately 5½ tons, and it and its load of coal are balanced by the original cage, plus a counterweight, in the opposite shaft compartment. The counterweight is a weighted truck, which is rolled off when men are being handled. Capacity of the skip is 5 tons, but in actual practice it is loaded with but one car, or 3.8 tons. A steam hoist (5-ft. drum, 36 in. across the face) is employed and hoisting distance is 257 ft. Record performance with this installation has been 507 hoists in seven hours. Present cars are Sanford-Day bottom-dumping units with a capacity of 3.8 tons mechanically loaded. Cars are dumped one at a time directly into the skip. Trips are pulled past the dumping point by a special tandem locomotive.

Circular Shafts at Saxton

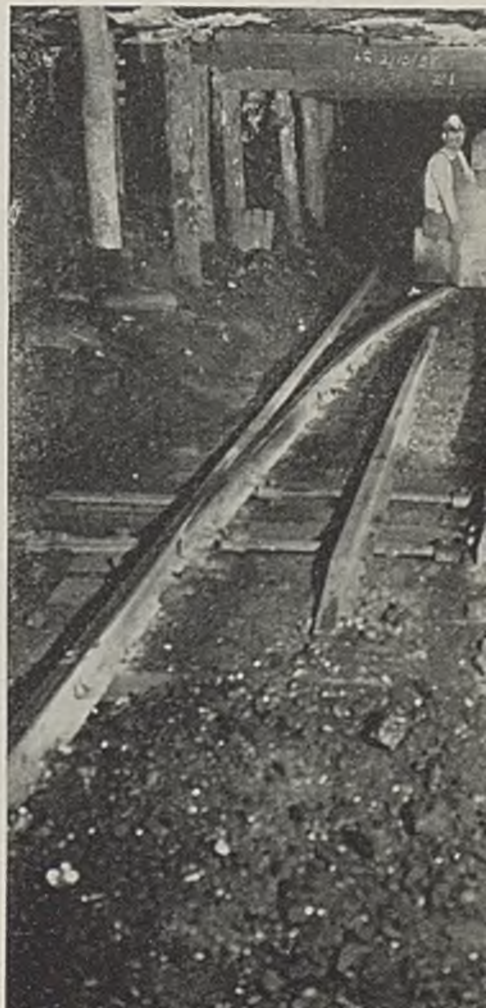
While most of the shafts in Indiana are of the timbered type, or timber with concrete at the top or bottom, or both, circular concrete-lined shafts were installed at the Saxton mine when it was opened in 1922 under Allen & Garcia Co. direction. The circular shape was adopted because of its greater resistance to the hydrostatic pressure encountered in sinking through the water-filled Wabash Valley gravel overlying the solid top at the mine. Cover thickness at the mine ranges from 200 to 240 ft., while the solid material over the coal varies from a minimum of 20 to a maximum of 110 ft. No coal, as a rule, is mined where the solid material is less than 30 ft. thick, however, and a Sullivan portable diamond core drill is used to check thickness of the solid, drilling diagonally upward from the mine workings. The drill is operated by compressed air.

The main opening at the Wick mine of the Ingle Coal Co., sunk in 1928, is a 6½x16-ft. slope 261 ft. long. Inclination of the slope is 18 deg., and it is fitted with a track and hoist for handling materials and equipment, as well as 36-in. belt conveyor 508 ft. long between pulley centers for bringing out the coal. An 80-ton bin at the foot of the slope receives coal from A.C.F. and Sanford-Day 5-ton bottom-dumping cars with Timken and "Whitney Wonder" wheels. From this bin the coal is fed out onto the belt by an adjustable-stroke feeder driven by a 5-hp. motor. The belt is driven by a 100-hp. motor, although the running demand, fully loaded, is only 35 to 40 hp. This low power requirement and a substantial reduction in labor cost were the major factors in the choice of a slope rather than a shaft. On the average, the belt handles 175 to 200 tons of coal an hour.

A slope also was chosen at the New Hope mine of the Linton-Summit Coal Co., opened in 1932. Length of the slope, on a 35-deg. pitch, is 107 ft., and it is fitted with a chain-and-flight conveyor 150 ft. long with a maximum capacity of 375 tons per hour. Bottom-dumping A.C.F. and Sanford-Day cars (4½ tons mechanically loaded) are used, and dump into a 125-ton bin at the foot of the slope. A reciprocating feeder driven by a 10-hp. motor feeds the coal out onto the conveyor, which is powered by a 125-hp. motor. Three feeder speeds are available.

Haulage locomotive used at mines

70-lb. main-line turnout on creosoted ties, with the 13-ton haulage motor in the background, Buckskin mine. A brass- and bronze-welded joint shows in rail at left.



covered in the *Coal Age* survey range in size from 5½ to 13 tons. The number required at the different operations naturally varies with the size of locomotive, size of car, mine production and length of haul. At Black Hawk, producing 2,000 tons per shift with 1½-ton cars, three 10-ton Goodman locomotives and one 8-ton unit which does its own relaying deliver 1,250 to 1,350 cars to the shaft in one shift. These four locomotives serve three partings, each over a mile from the bottom. Grades on each route run up to 7 to 8 per cent for fairly short distances and the average trip size is 25 cars. The main line is double-tracked for 3,000 ft. to a main junction. Wood cars with solid-roller bearings are employed.

One 10-ton General Electric locomotive with 13-ton equipment, including contactor controls, is employed at the Dresser mine for the long hauls. Actual weight of this unit is 12 tons and it usually handles 50-car trips over single-track routes with maximum grades (after leveling) of 1¾ per cent. As noted above, 2-ton A.C.F. steel cars weighing 4,000 lb. each with Timken-bearing wheels are employed. Quite frequently at this operation, depending upon distance from the shaft, the 6-ton relay locomotives pull their trips of 12 to 30 cars directly to the bottom.

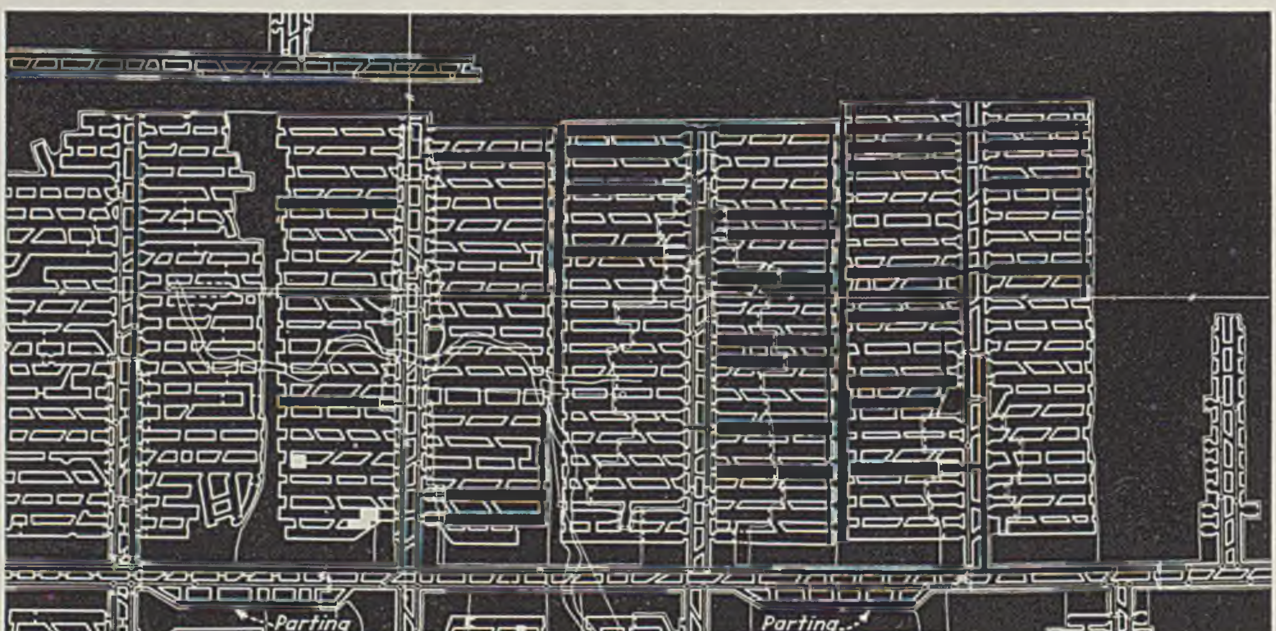
At the Buckskin mine, shipping an average of 1,400 tons per day, trip size (3.8-ton Sanford-Day cars with anti-friction bearings) is limited to 24 cars in view of the 6-per-cent maximum grades and uphill haul to the bottom. One 13-ton G.E. locomotive delivers 450 to 480 cars of mine-run to the bottom in a shift. The haul to the main parting is 1¼ miles. At Submarine No. 2, four 5½-ton Goodman locomotives—not all in service at one time—shuttle back and forth between conveyor-loading stations with 12- to 20-car trips (1½-ton wood cars). Consequently, this is one of several operations where no relay or gathering equipment is employed. The same condition obtains at the Wick mine, where coal from the rubber-tired-haulage section is loaded into bottom-dumping cars (see above) by an elevating conveyor. One 8-ton Goodman and one 10-ton General Electric locomotives handle 8-car trips over the 2,000-ft. route between the loading conveyor and the dump hopper at the bottom, delivering 900 to 1,000 tons of mine-run per shift.

Two 13-ton G.E. locomotives serve two partings approximately two miles from the shaft bottom at Knox Consolidated No. 1 mine, Knox Consolidated Coal Corporation (2,300 tons per day), and deliver around 750 cars to the bottom in a shift in trips of not over 25 each. With a booster locomotive, occasionally called into service, trip size is increased. Both wood and steel cars (3.3 and 3.6 tons average, respectively) are used, with both tapered-roller and ball-bearing wheels. Grades are cut to a maximum of 3 per cent. Two thousand feet of double track is in service, and preparations now are under way for extending it to 7,000 ft. Two Jeffrey 13-ton locomotives at Knox Consolidated No. 2 (2,100 tons per day) deliver around 650 to 700 cars to the shaft bottom per shift under substantially similar conditions.

New Hope, shipping 1,700 tons per day, is another operation in which main-line locomotives (one 10- and one 13-ton G.E.) pull directly from the working sections to the dump hopper at the slope bottom. Consequently, relay locomotives are not used. Trip size (4½-ton cars; see above) ranges from thirteen to twenty cars. At Glendora No. 27 mine, Templeton Coal Co., shipping 1,800 tons, two 10-ton G.E. units haul 900 cars from four sections one to two miles away from the bottom in one shift. Trip size is 25 to 50 cars; car capacity is 2 tons. Maximum grades on main lines are around 5 per cent. One 13-ton G. E. and one 13-ton Goodman locomotives at Glendora No. 28 (2,100 tons per shift) deliver 600 to 700 2.6-ton cars to the bottom under approximately the same conditions. The Glendora mines, as compared with most other single-track operations in the State, where passing usually is done at junctions, install passing tracks at intervals.

Five partings are in operation ¾ to 1 mile from the shaft in Peabody No. 48 mine, where maximum grades of 12 per cent on main-haulage routes limit trips to 22 to 25 1.9-ton cars. Three 10- and 13-ton locomotives under these conditions deliver around 1,350 cars to the bottom for an output of 2,400 tons per shift. Five partings also are installed in Kings Station mine, although distance from

Fig. 1—Section of the Peabody No. 48 mine map, showing method of installing partings for every other panel entry.



the shaft in each case is around two miles. The average grade is 3 per cent in favor of the loads. Sanford-Day cars with Timken-bearing wheels and a capacity mechanically loaded of 3½ tons are used. Two 10- and one 13-ton locomotives are used, hauling 6- to 30-car trips and delivering around 800 cars to the bottom per shift.

At the Saxton mine, one 13-ton G.E., one 10-ton Jeffrey and one 8-ton G.E. locomotives deliver 760 cars to the bottom in producing 2,300 tons on a normal day. Distance to the two main partings is 8,000 and 9,000 ft., and grades against the loads are kept at 1½ per cent or less, with 3 per cent as one exception. Trips from the North are limited to 25 and 15 cars (two locomotive sizes) and from the South to 20 cars. A.C.F. and Bethlehem wood and steel cars with A.C.F.-Timken double-plate wheels and a capacity of 3 tons are employed. The main line is double-tracked for 1,500 ft. west of the shaft. Elsewhere, single tracks are used, with passing at junctions.

Cars Hold 5.8 Tons

Two 10-ton locomotives deliver from 675 to 700 cars to the bottom at Talleydale per shift for an output of around 2,800 tons. Average main-line haul is one mile. Cars used in the No. 3 works at Talleydale have a capacity of 5.8 tons. Except for a few units since built at the mine, car equipment was designed by the Allen & Garcia Co. and built by the Marion Steam Shovel Co. Equipment includes A. & G. semi-automatic couplings providing both spring draft and buff and Bonney-Floyd individual wheel units (Timken bearings) pivoted at one end and working against springs at the other.

Four-ton steel cars with solid ends for use in the overturning cages noted above are employed at the Standard mine. Main-line motive power is provided by one 10-ton General Electric locomotive hauling from a junction point 3,000 ft. from the bottom. Trip size varies from 16 to 24 cars, or whatever is delivered by the pickup, or relay, units in use, and the one locomotive delivers an average of 650 cars to the bottom per shift for a mine production of 2,350 tons (shipped basis).

Relay, or pick-up, locomotives are used in all but a very few mines in Indiana for the stage between gathering and main-line haulage. And with a few exceptions relay units are the same size as the gathering units, which in practically all cases are

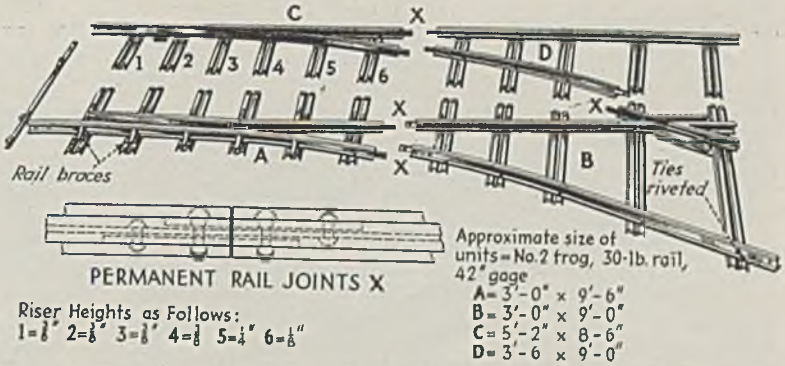


Fig. 2—Sketch of commercial version of the sectionalized steel-tie turnout developed at the Kings Station mine.

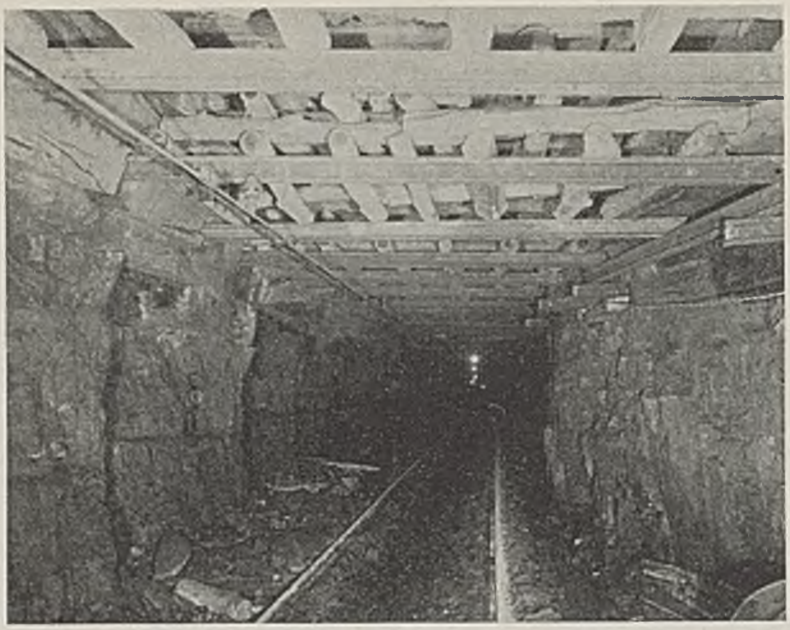
6-ton cable-reel equipment, although, as indicated in the discussion of car-changing methods in the article beginning on p. 43, mules are used in at least two mines, with 6-ton Ironton and Whitcomb battery locomotives in Jackson Hill No. 6, Jackson Hill Coal & Coke Co. Relay hauls usually are short, with most operations trying to hold them to an average of 1,000 ft., although this distance is subject to considerable fluctuation, depending upon the operating system in force. In many cases, relay locomotives haul to side-tracks or partings turned for every panel entry (see pp. 44 and 45 for examples) or for every other panel entry, as in Fig. 1. Thus, the relay haul usually is influenced by the length of the room panels, among other things. As a rule, main-line locomotives operate between these partings, whether between room panels or at other strategic points, and the bottom. But at Miami No. 10 and New Hope—and Black Hawk eventually—among others, main-line locomotives come directly to storage tracks in the working sections. With few exceptions, one relay locomotive usually serves two gathering locomotives or the equivalent in mules.

More than half the mines covered in the *Coal Age* survey use 60-lb. rail on their main lines, including some recent additions to the ranks of the heavy-rail advocates. Black Hawk mine, for example, eventually will have all the earlier 35-lb. rail relaid with 60-lb. steel on 4x6-in. oak ties (steel tie every 10 ft.), with mine-rock and fine fireclay ballast and Nos. 3 and 4 frogs. In fact, 60-lb. steel eventually will be laid to the mouths of all room panels, at which time relay locomotives will be discontinued and main-line units will run directly into the working sections. Included in reconstruction to date was grading 4,000 ft. of main line, including cutting to a maximum of 15 ft. in the roof and filling 11 to 12 ft. to reduce the maximum grade on this stretch to 7 to 8 per cent. In panel entries and rooms, standards call for 30- and 35-lb. rail and Nos. 2½ and 3 frogs (all openings, regardless of purpose, are turned on a 45-deg. angle).

Knox Consolidated No. 1 mine—and No. 2 as well—also follow the practice of laying 60-lb. steel to the mouths of the room panels. Construction standards call for 5x6-in.x 6-ft. creosoted ties, ashes and road cleanings for ballast, No. 4 frogs and grading as necessary to limit the maximum inclination to 3 per cent. In fact, on 1,800 ft. of track recently completed at No. 1, the track was raised a maximum of 7 ft. to reduce the grade to 0.9 per cent. Lives of twelve to fifteen months with heavy trips, cross rails are sons for adopting creosoted ties. As a result of an installation on a main-line curve two years ago, where the haulage locomotive runs full open with heavy trips, cross rails are being welded under the running rails in all permanent track at the Knox Consolidated mines. Using scrap rail, one man can install ten to fifteen cross rails per shift. The track is stabilized and held to gage and cross-bonding is not required. Panel entries at the Knox Consolidated mines are laid half way up with 40-lb. rail, followed by 20-lb., with No. 2½ frogs and wood ties throughout. Rooms are laid with 20-lb. rail, also on wood ties.

Heavy Rail Installed

New Hope, also laying 60-lb. rail to the mouths of the panel entries, uses No. 5 frogs. Panel entries and rooms are laid with 40-lb. rail in the No. 5 workings and 35-lb. in the new No. 6 workings. The same main-line practice is followed at the Glendora mines, with the exception that Nos. 2½ and No. 3 frogs are used—this from the fact that very bad roof



Hitch-drill timbering in a reopened haulage road at Miami No. 10, showing the use of pins and stringers on the chain-pillar side (right) and single holes on the barrier-pillar side (left). The left side was widened 3 ft. after the crossbars and lagging were installed.

conditions made it necessary to leave the minimum area of top without support. Panel entries and rooms are laid with 35-lb. rail at Glendora.

Zinc-chloride-treated 5x7-in. ties are used in 60-lb. track at the Saxton mine, with gravel ballast, Nos. 3 and 4 frogs (some No. 5s) and grading to 1½ per cent against the loads. In this mine, also, heavy rail is laid around the turns into the panel entries. In the latter entries, routes over which relay locomotives operate are laid with 35-lb. rail on wood ties with No. 2½ frogs. Ahead of the relay tracks, 25-lb. rail and wood ties are employed. In rooms, Bethlehem steel ties and switch sets are used entirely.

Welded Nos. 3 and 4 frogs made in the mine shops are used in the 60-lb. main-line track at Talleydale. Treated ties were used from the start in main-line construction at Talleydale, and now, in 5,000 ft. under construction to open up a new working territory, 5x7-in.x6-ft. ties impregnated with either creosote or—in the latest installations—"No-D-K" are being installed. The latter has been chosen because it seems to offer a comparable life, in the opinion of mine officials, with a substantial reduction in cost. (The method of obtaining material treated with this preservative will be outlined later in this article.) Maximum cut on the new haulage road is 2 ft. 9 in.; maximum fill is 5 ft. 4 in. Talleydale is another operation carrying heavy steel to the working sections, where panel entries and rooms are laid with 40-lb. rail on steel ties. West Virginia steel-tie turnouts with Talleydale No. 2½ welded frogs are used throughout.

Main lines at Kings Station are laid with 70-lb. rail, with 60-lb. on secondary routes to the mouths of the room panels. The use of 5x7-in.x6-ft. treated ties was started about six years ago and as yet none has been taken out because of decay. Grades on all 70- and 60-lb. roads are cut to 3 per cent or less, which has involved taking down as much as 10 to 12 ft. of top. Recently, the practice of Thermit-welding all joints on 70- and 60-lb. track was adopted. Cost of such a joint—to date mostly done by the wiremen in their spare time—has been about 50 to 75c. more than a standard joint with angle bars and bond. Mine officials like particularly the smoother trip operation resulting, the reduction in damage to track in case of derailments, the permanent electrical conductivity of the joints without bonding and supplementary inspection, and the elimination of angle bars and bolts in favor of a permanent continuous rail.

Panel entries and rooms are laid with 30-lb. rail on steel ties, using No. 2½ frogs. In this connection there has been developed at the mine a sectionalized steel-tie turnout now being marketed by the West Virginia Rail Co. As a start, a complete standard steel-tie turnout (including rail braces, slide plates, risers under switch and closure rails, and heel and toe blocks for bracing closure rails and serving as rerailers) was laid out and then marked up into convenient two-man sections. A commercial version of the result is shown in Fig. 2. It was proposed that all parts of the turnout sections would be permanently fastened together: i.e., ties and fishplates to the rails, etc. (welding is preferred at Kings Station), and that the turnout would be assembled by overlapping the tie ends and using bolts in addition to bolting the rail sections together at the joints. As compared with Fig. 2, Kings Station has specified cast frogs on all future turnouts. A turnout may be laid in 30 minutes merely by the use of bolts.

Three Rail Weights

Mines in Indiana using three weights of rail are nearly as numerous as those employing only two. At Dresser, as an example, main lines are laid with 60-lb. rail on 5x7-in.x6-ft. ties, using Nos. 4 and 5 frogs, mine-rock ballast and grading to reduce maximum inclinations from around 6 to 1¾ per cent. Enough bottom is taken up (average seam thickness is 4 ft.) to give a clear height over the rail and under the crossbars of 5 ft. Cross entries are laid with 40-lb. rail on steel ties (West Virginia steel-tie turnouts and Dresser welded frogs) around the curves into the panel entries. Panel entries then are laid with 20-lb. rail on steel ties with 20-lb. welded frogs.

At Buckskin, the 5,000-ft. main-haulage road is laid with 70-lb. rail on 5x7-in.x6-ft. creosoted ties, using mine-rock ballast. Use of treated ties was started in 1936, as untreated units had a life of only about two years. All main-line road is graded to a maximum of 6 per cent, and new line when laid is equipped with brass and bronze welded joints costing about $2.50 each. Secondary routes at Buckskin are laid with 40-lb. rail on plain wood ties, with 30-lb. rail on wood in the panel entries and up to near the face in rooms, after which steel ties are used.

Crown Hill No. 6 mine is another recent convert to the heavy-rail philosophy, having replaced 3,000 ft. of 35-lb. track with 70-lb., grading in the bottom as necessary. Secondary routes at Crown Hill are laid with 35-lb. rail; panel entries and rooms with 20-lb. rail. At Jackson Hill No. 6, 35-lb. main lines are used; with 20-lb. elsewhere. Peabody No. 48 mine uses 40-lb. rail on its main lines; 30-lb. in its panel entries and 20-lb. in rooms. This mine is another using low-number frogs (No. 2) because of bad roof. Also, because of a hard bottom, all grading is done by taking down top. At Miami No. 10, the standards are 40- and 30-lb. rail on main and secondary routes and 20-lb. on steel ties elsewhere.

Both treated and untreated 5x6-in.x6-ft. ties are used under 60-lb. rail in the main lines at the Standard mine. Refuse from the coal-washing table (minus 1½-in.) is used as ballast where the roadbed is dry (if wet, the resultant formation of acid would eat up the steel), with mine rock where water is encountered. No. 3 frogs are installed in main lines. Panel entries are laid with 40-lb. rail on wood ties and rooms with 30-lb. rail, also using wood ties except under the last two sets of rails next to the face—laid with steel ties. Standard also has started the use of the sectionalized steel-tie turnout developed at Kings Station.

Indiana Uses Hitch Drill

Indiana makes probably the widest use of hitch-drilling methods in the timbering of haulage roads of any mining district in the country. The reason primarily is the occurrence of weak or downright bad top in many of the mines, forcing the use of much timber of a permanent nature, in turn involving a substantial cost. The hitch drill offered a means of substantially reducing this cost (by one-half to two-thirds) and at the same time assuring a permanent job without the use of legs. The latter consideration, incidentally, is given heavy weight by many operators, inasmuch as when legs are eliminated derailed cars or locomotives have no opportunity of bringing down the timbers and top, with consequent danger to men and damage to equipment, not to mention the possibility of tying up an entire mine for some time.

Hitch-drilling in Indiana (*Coal Age,* June, 1935, p. 237) was pioneered by the Binkley Mining Co. at its No. 8 mine, since worked out, where the type of drill on which most companies in Indiana have modeled their equipment was developed. Originally, timbering with the hitch drill was done by drilling a hole for each end of the bar, one usually 18 in. deep and the other 36 in. Then one end of the bar was put in the deeper hole and shoved to the bottom, after which the bar was pulled back until it went to the bottom in the short hole, thus giving a bearing of about 18 in. on both ends. While this system still is used under certain conditions, most companies employing hitch-drilling methods have gone primarily to the "pin-and-stringer" system adopted at Dresser mine in 1932. Under this latter plan, pins are set in the ribs on which stringers are laid as supports for the crossbars. While requiring about 25 per cent more steel, fewer holes are needed and the bars to be handled naturally are shorter. With the pin-and-stringer system also, recovery of the steel bars and stringers, if and when it should become necessary, is a much simpler task.

Steel used in timbering in Indiana consists of 60- to 90-lb. relaying rail, both at mines with and without hitch drills, with a very few exceptions. The usual size at hitch-drilling mines is 60- or 70-lb., with up to 90-lb. for pins and stringers in certain cases, due to the heavier load they are called upon to carry. Pins, where employed, usually are tightened in the holes with wooden wedges. Some mines, such as Talleydale, concrete the pins in place. Pins usually are cut to give a 4-ft. bearing in the hole, although some longer pins are used under certain conditions.

In opening a new territory at Miami No. 10 it was necessary to clean up and widen the haulage road in the Main South entry. This task involved reopening about 1,600 ft. of haulage road, 300 ft. of aircourse and a crosscut at the head for an air return. The openings had been standing about fifteen years and the top had fallen for an average of 5 ft. and in some places up to 20 to 25 ft. The material was loaded with a 7BU loader and a crew of three men, one running the loader, one breaking rock and the other operating the locomotive. Production was about 80 cars (2½ tons per car) per shift, whereas by hand two men would have got 5 or 6 cars per shift.

In timbering the opening with the hitch drill, the pin-and-stringer system was used on the chain-pillar side. On the barrier-pillar side of the heading, the holes—one for each bar—were drilled 5 ft. deep before widening was done and the bars were installed. One end of each bar consequently rests on a stringer and the other end in a single hole, as shown in an accompanying illustration. With the timbering in place, the heading was slabbed 3 ft. under the protection of the bars—an operation easily possible only with hitch-drill methods. Bars were put up on 4- and 4½-ft. centers, and two men installed an average of about 24 per day, including drilling the holes and setting pins and stringers, this where only the normal lagging was required. The centers noted above were chosen to permit the use of the normal 5-ft. posts as lagging.

Timbering with the hitch drill is done on all mains and cross entries at Dresser up to the mouths of the room panels. As indicated above, this mine uses the pin-and-stringer system almost exclusively. Bars are set on 2½- to 3-ft. centers. Both single bars and the pin-and-stringer system are employed at the Glendora mines, with bars usually on 4-ft. centers. The short life of wooden legs, in addition to the possibility of having them knocked out, forced the Glendora management to hand-cut hitches many years ago in spite of

New aircourse timbering system at Talleydale, showing treated wooden bars with three treated legs which replaced steel-rail bars on two untreated legs.

the expense. As about three hitches 12 in. deep were about all that one man could cut with a pick in a shift, use of the hitch drill, started in 1932, naturally resulted in a great saving.

Hitch-drill timbering is carried clear into the panel entries at Saxton mine, using mostly single bars with some pin-and-stringer installations. Bar spacing is 4 ft. to permit use of old 3x5-in. wood ties as lagging. Two men at this mine can set an average of about four bars a day, including wedging down and loading slate, drilling, assembling material and lagging.

Bars on 5-Ft. Centers

Talleydale is another mine to use hitch-drill timbering on all main and secondary haulage roads, with bars on 5-ft. centers. The pin-and-stringer system is employed as a rule. Talleydale also has changed its plan of timbering aircourses to eliminate the use of the more expensive steel bars which, as a rule, can never be recovered, and also get the advantage of the longer life of treated legs. Now, instead of a steel-rail bar and two untreated legs, the mine uses wood bars 5 in. thick with 5-in.-wide flat faces on the top and bottom held up on three treated legs—one at each end with the third in the center. This arrangement gives practically the same strength as the original steel bar, as far as can be determined.

Cost of a steel-bar set is made up of one 11-ft.-long 60-lb. bar at \$2 and two 6-ft. legs at \$0.48 (assuming the use of the treated type for purposes of comparison), or a total of \$2.48. Cost of the treated wood bar is \$0.75, and of three treated legs (5-in. minimum diameter or equivalent) is \$0.72 (winter price), or a total of \$1.47. The saving in materials cost thus \$1.01. The same type of wood bar—untreated, however—also is being used in rooms, inasmuch as it apparently is as cheap as the steel bar over the long run (taking in steel losses) and because the wide faces result in more stable installations.

Like the ties noted above, timber at Talleydale is treated with "No-D-K." The treating liquid is purchased by the coal company, which also installs treating tanks with steam coils at the mills of its timber suppliers. Timber and ties, after peeling (more difficult peeling in winter accounts for a small increase in prices in that season) and sawing, are allowed to season at least three weeks. They then are dipped 1½ hours at a temperature of about 200 deg. F.

At Kings Station mine, hitches are made with a regular coal drill equipped with a large-diameter Airdox auger making a 4½-in. hole. The drill is mounted on an attachment fitting a gathering locomotive, as outlined in the item appearing on p. 118 of this issue. A coal drill with a special bit also was used in drilling hitch holes in the rock slope connecting the Nos. 5 and 6 workings at New Hope mine.

Where the hitch drill is not employed, steel bars on wooden legs naturally are the established practice for timbering haulage roads, although at the Knox Consolidated mines, where timbering is required, hitches are cut by hand. At Peabody No. 48, 60- and 70-lb. rail crossbars are set on peeled white-oak legs on 4-ft. centers. Stringers are run between the bars over each rail to complete the job.

Cleaning up of certain headings and aircourses at the Crown Hill No. 6 mine was accompanied by the installation of 70-lb. rail crossbars on legs made of creosoted railroad ties for permanency. The Main East aircourse clean-up, started in May, 1937, totaled 3,600 ft. and included moving both top and bottom (heaved) material with a Joy 7 BU loading machine. A total of 4,679 cars of refuse were loaded out and 750 timber sets were installed in 1,180 man-shifts. In the Northeast, two headings were cleaned up and retimbered (400 sets) on the same basis, involving 2,600 ft. of opening and the loading of 4,200 cars of material. Man-shifts to complete the job, including timbering, totaled 950.

VENTILATION

+ Indiana Deep Mines

RELATIVELY small quantities of air are used in ventilating Indiana mines, although, with some exceptions, gas is found in small to medium quantities. This arises from concentration of workings growing out of the use of loading machines and a practice of sealing mined-out panels, which leaves but a small area to be ventilated. At four of the large mines in the State, air-conditioning plants are used during the warm months to reduce falls of roof. In the last two years several mines have improved ventilation efficiency by installing new fans or by cleaning up old aircourses with mobile loaders.

Kings Station mine of the Princeton Mining Co. furnishes an example of the relatively small quantity of air required under Indiana operating practices per unit of production. The hoisting shaft is the deepest in the State, 439 ft., and the production is 5,800 tons per day of two loading shifts. Air volume is 110,000 c.f.m. and the pressure is 2 in. w.g. Methane percentage is 0.2 in the Main South return and 0.5 in the Main Southwest return. Other examples indicating ventilation characteristics and conditions are as follows: Saxton Mine, Saxton Coal Mining Co.—30,000 c.f.m.; 1½ in. w.g.; methane in main return, 0.50 per cent; shaft depth, 193 ft.; production, 2,300 tons one shift; Knox Consolidated No. 2 mine, Knox Consolidated Coal Corporation—90,000 c.f.m.; 1½ in. w.g.; methane in main return, 0.15 per cent; shaft depth, 224 ft.; 2,100 tons per day; Standard mine, Standard Coal Co.—85,000 c.f.m.; 1.1 in. w.g.; methane in main return not detectable but 0.1 per cent highest from a section; shaft depth, 235 ft.; production, 2,350 tons per day; Buckskin mine, Buckskin Coal Corporation—30,000 c.f.m.; ¾ in. w.g.; shaft depth, 218 ft.; production, 1,400 tons per day; methane in main return, 0.3 per cent. The entire production from these mines is loaded mechanically.

Panels of 20 to 24 rooms on each side and pillars left standing is the usual practice. Except in special cases the inby end of the usual two headings of a panel entry are not cut through to the adjacent main and therefore but two permanent seals are required per worked-out panel. Whether to seal panels immediately, thus eliminating danger from that panel as soon as possible, or to wait until the adjacent panel is completed, thus minimizing risk if by mistake the new workings cut into the old, is a debated question in the State. At some mines—for example, No. 48, Peabody Coal Co.; Miami No. 10, Binkley Mining Co.; and Glendora No. 27 and No. 28, Templeton and Glendora coal companies—sealing is done immediately after rapid withdrawal of materials.

In all but two of the larger mines, in which two there is little or no gas and thin brick or concrete-block seals are used, seals are of concrete ranging in thickness from 2½ ft. to 7 ft. and are reinforced with steel at 50 per cent of the mines, Seals against gas alone range up to 3 ft. in thickness and those to hold back both water and gas range from 3 to 7 ft. In most mines, the latter are termed bulkheads. Their construction is described in the article on mine drainage and bulkhead protection (p. 67).

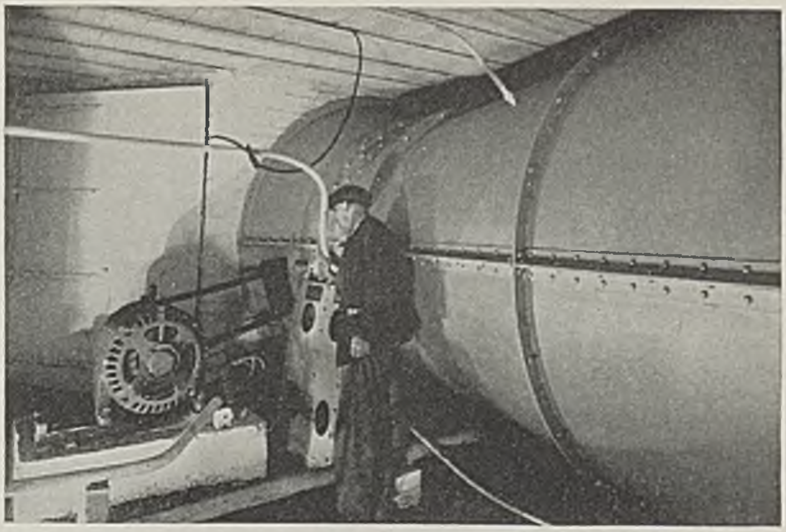
Concrete seals and/or bulkheads 2 to 5 ft. thick cost about $100 per foot of thickness as a rule, but this figure naturally is subject to wide variations due to differences in coal thickness and top conditions. Instead of wooden forms the common practice is to use forms consisting of inside and outside walls of brick or concrete blocks. Mechanical methods of cutting hitches for the seals are detailed in the drainage and bulkheading article. In several of the mines line brattices are used to ventilate all seals.

Secondary Seals Installed

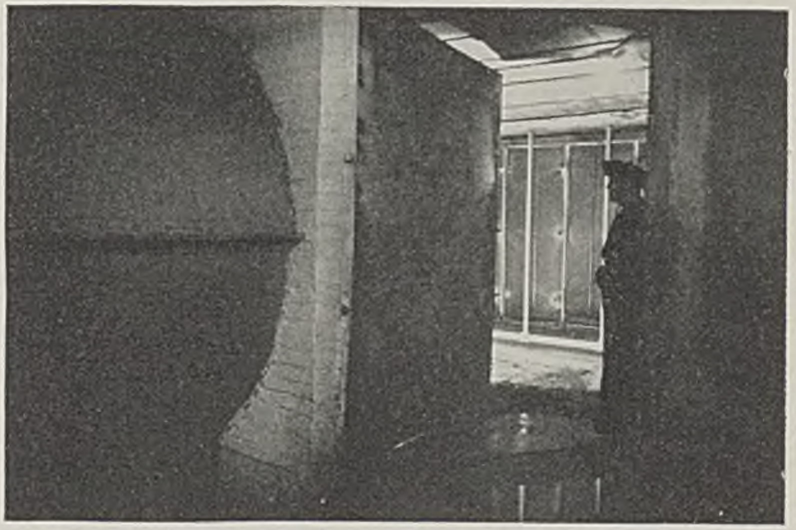
In Kings Station mine, the "squeeze-pillar" system is used: that is, pillars are left between the tenth and eleventh rooms on each side of the panel entry and at that point there are two panel headings instead of four. If after working the ten back rooms on each side it appears that the roof might break, temporary, or secondary, seals of concrete 24 to 30 in. thick and reinforced with 30-lb. rails are built across the two headings at this midway point. Substantially this same practice is followed at the several other mines using squeeze pillars (see article beginning on p. 43).

For the most part the mine fans of the State are of the centrifugal type, are steam-driven and, with one exception, are located on the surface. All fans operate blowing.

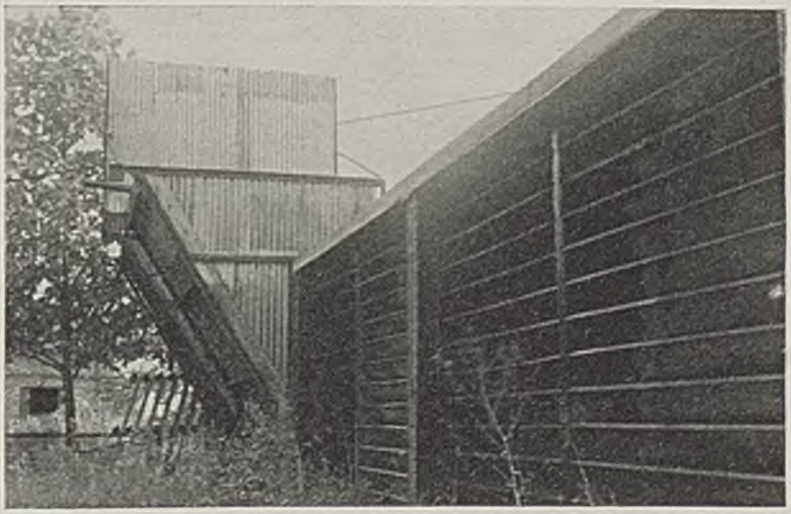
Talleydale mine of the Snow Hill Coal Corporation, where all equipment is electrically driven with purchased power, is ventilated by a 6-ft. Jeffrey single-stage Aerodyne on the surface. The drive is a 30-hp. 440-volt motor with V-belt connection. A fan of the same type and size in-



Installed underground at Knox Consolidated No. 2 this fan cut the ventilation power cost in half.



Underground at Knox Consolidated No. 2. Door of fan motor room opened temporarily to show the air-conditioner sprays in the aircourse.



At Kings Station, mine air cools the water—and water cools the mine air. Return air that has passed through the water cooler is discharged through the corrugated chimney at the left. Fresh air enters the conditioner through the louvered openings in the foreground.

Primary gas seal in Kings Station mine. A line brattice at the right causes ventilating air to sweep the seal. The top is protected by rails set on wing walls.

Cutting hitches for seals at Kings Station. This air-driven paving breaker is used for cutting top and bottom. The rib hitch (right) was outline-drilled and shot.

stalled not long ago at Knox Consolidated No. 2 mine to displace a 6x14-ft. centrifugal fan cut the ventilation power cost in half. At this mine the Aerodyne, driven by a 40-hp. 220-volt motor, is installed at the shaft bottom, so eliminates the big chance of leakage in the curtain wall of the airshaft, one compartment of which is a return and is used for man-and-material hoisting. The old centrifugal fan on the top, with two electric drives and a steam drive, is maintained in working order as a spare in case of trouble with the underground unit.

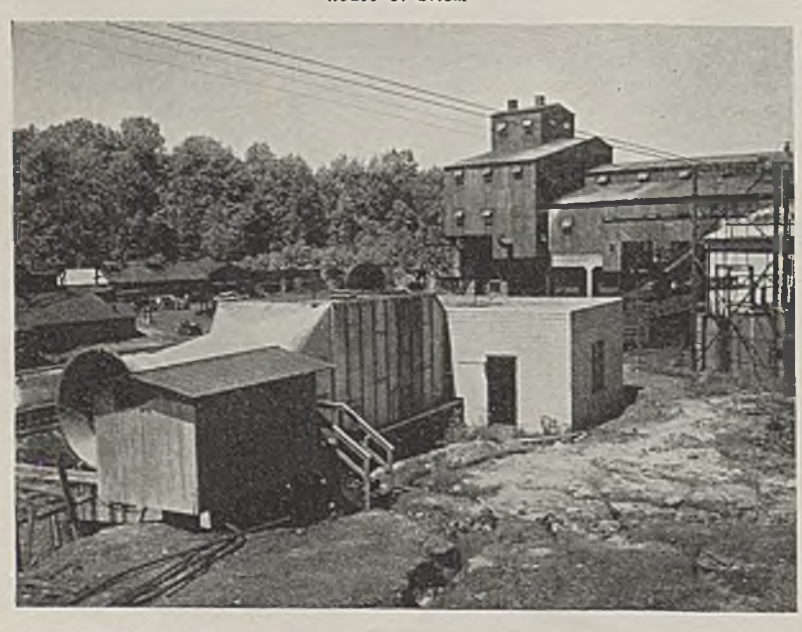
Cleaning airways in Crown Hill No. 6 mine of the Clinton Coal Co. cut the mine resistance to the extent that the centrifugal fan was slowed 20 r.p.m. The job was done between May and December, 1937, with Joy loaders. On the Main East, 3,600 ft. of single heading was cleaned and on the Third and Fourth Northeast a total of 2,600 ft. was cleaned. During the time since the mine was opened in 1912 considerable material had fallen from the top and in places the bottom fireclay had heaved as much as 3 ft. These cleaned aircourses were timbered with sets consisting of 70-lb. steel-rail crossbars supported on creosoted railroad-tie posts. Eleven hundred and fifty of these sets were installed.

Temporary tracks were laid in the aircourses for the cleaning, including small partings and stubs in crosscuts for car changing. Four men constituted a loading crew; one driver, machine operator, car pusher and one timberman. On the Main East, 1,180 man-shifts were expended in the loading and timbering, and the material filled 4,679 cars. On the Northeast the performance was 950 man-shifts and 4,200 cars.

Saxton, Talleydale, Knox Consolidated No. 2, and Kings Station mines have conditioning plants to cool the intake air during summer to eliminate the deteriorating effect of the air upon the roofs. Whether the trouble is due to temperature or to moisture deposited from the air, or to both, is a debated question. Observations of "rock rains" before and after installing the conditioners have confirmed the benefits as forecast by the engineers of the Allen & Garcia Co., who designed the first conditioner installed, this in 1927 at Saxton mine. The valve and pump controls of this Saxton job were made fully automatic in 1930.

The air is cooled by deep-well water at 58 deg. F. sprayed into an air intake chamber adjoining the fan. Sprays are grouped in two banks, one inby and the other outby. Pumping from chamber sump to sprays, admission of fresh water and the circulation and mixture of sump and fresh water to the outby sprays all are controlled automatically by thermostats. When the outside air entering the chamber rises above 61 deg., a valve opens to admit a small quantity of fresh water at 60 lb. pressure into the inby sprays and a pump starts to recirculate this water at 30-lb. pressure to the outby sprays. At higher outside temperatures, when this first arrangement fails to hold the mine intake air to 61 deg., the fresh-water valve opens wide if need be to reduce the temperature. At still higher outside temperatures another fresh-water valve opens to admit a fixed percentage of that water into the outby sprays.

During warm weather intake air is cooled at Talleydale. Left to right: fan, motor house for fan drive, air conditioning chamber of steel construction and pump house of brick.



Total cost of installing this air conditioner was $4,800 and the estimated operating cost for a year is $2,400. The tangible saving by fewer timbermen and slate cleaners during the warm months has been at least $2,000 per year. The total of intangible savings possibly exceeds that amount. With an air circulation of 40,000 c.f.m., for which the conditioner was designed, outside air at 83 deg. was cooled to 63 deg. and the relative humidity raised from 63 to 98 per cent. As the air passed through the fan, drift and downcast there was a rise of slightly over 4 deg. Last summer when the outside temperature rose to 90 deg. the conditioner cooled the air to 74 deg.

Cooling Stops Falls

After a new air conditioner of substantially the same type as at Saxton was put into operation at Talleydale mine in May, 1937 (*Coal Age,* April 1938, p. 47), the "rock rains" there decreased materially and major falls, which had not been uncommon, ceased during the cooling period. Water pumped by a deep-well turbine unit 5,000 ft. over the surface through an 8-in. pipe in a covered trench arrives at the air conditioner at 58 deg. The well (225 ft. deep) taps an abandoned area of No. 4 coal under the Wabash River, into which a drillhole from the surface on the opposite side of the river admits water from the 113-ft. top-lying strata of sand and river gravel. During hours that the mine is in operation the water, after passing through the sprays, is pumped to a tank supplying the preparation equipment. When the tank is full the water wastes by overflowing from the conditioner sump.

Differing from the Saxton installation, the spray chamber at Talleydale is under air pressure; that is, it is on the inby side of the blowing fan (Jeffrey 6-ft. single-stage Aerodyne). In the first step of cooling 600 g.p.m. of fresh water flows through two banks of sprays of the inby half of the chamber. If the temperature of the cooled air rises above 62 deg., a 300-g.p.m. 10-hp. centrifugal pump starts and recirculates half the water from the sump for the inby sprays to one bank of the outby sprays. When the outside air temperature rises to the point where the cooled air reaches 64 deg., a second 10-hp. pump starts and recirculates the balance of the inby spray discharge to a second bank of the outby sprays. Water through the sprays and destined for washery use is pumped to the tank by a 600-g.p.m. 15-hp. centrifugal unit in the same pump and control room with the other two pumps. All operations of the three pumps and valves are fully automatic.

Air volume at Talleydale is 60,000 c.f.m. The fan water gage is 1½ in. and the mine water gage 1 in. The difference is the loss through the air conditioner chamber, which, in addition to the sprays, contains two banks of moisture eliminators consisting of steel sheets crimped in zigzag fashion. When the outside air temperature was 91 deg. the conditioner reduced the mine-intake temperature to 64 deg.

At Knox Consolidated No. 2 mine the air conditioner is underground near the shaft bottom and on the inby side of a Jeffrey 6-ft. single-stage Aerodyne fan delivering 90,000 c.f.m. against a pressure differential of 1½ in. This installation, made in the spring of 1936, is manually controlled and the sprays are not divided into sections. With an outside temperature of 100 deg. the air leaving the conditioner registered 74 deg. The mine makes little water but sufficient is available for the air conditioning and for sprinkling the working places after shooting. For the air conditioner water is obtained from back of seals of worked-out areas. After going through the conditioner it is pumped to the sprinkling system or to storage sumps.

An air conditioner installed on the surface on the outby side of a blowing fan at Kings Station mine in 1936 cools 110,000 c.f.m. of air. Water is cooled for re-use by blowing mine return air through it while respraying in a second chamber. Shortage of water dictated this recooling.

Two 800-g.p.m. pumps move the water. One picks it up from the sump for the intake air cooling chamber and delivers it to the sprays of the water-cooling chamber and the other returns it to the sprays of the first chamber. At an observed outside temperature of 92 deg. the conditioner was reducing the intake air to 72 deg. When a peak of 100 deg. was hit the intake air registered 77 deg. As to results, it is estimated that falls of roof in the main aircourses have been reduced 70 per cent.

Return air for the water-cooling chamber is sucked by a 6-ft. Aerovane fan from the man-hoisting and upcast-air compartment of the auxiliary shaft. The other compartment is the downcast for intake air from the main blowing fan. The suction duct is cut into the man-hoisting compartment 15 ft. below the top of the collar. Plans were made for completely inclosing the top of the shaft but it was necessary only to make an inclosure 12 ft. high around the sides. The Aerovane fan pulls practically all of the upcast air into the water cooler without there being any top on the shaft inclosure. Air speed through the water cooler is 500 f.p.m. and through the air cooler is 750 f.p.m.

DRAINAGE

+ Indiana Deep Mines

BUILDING bulkheads that must stand pressures up to 90 lb. per square inch is a major water expense at several of the larger Indiana mines. At three mines, deep-well turbine pumps are used for dewatering a worked-out area adjacent to the mine or in a seam above. Approximately 2 tons of water per ton of coal is the maximum quantity pumped to the surface from the active workings at any of the mines covered by the *Coal Age* survey. In numerous instances water from the workings is disposed of by pumping it into abandoned areas back of bulkheads. At one mine a prospecting core drill is used for cutting a 2¼ in. hole through coal pillars so that water can be pumped to a sealed panel.

Among the mines in which the strongest bulkheads are installed are Saxton, Saxton Coal Mining Co.: Dresser, Walter Bledsoe & Co.; and Talleydale, Snow Hill Coal Corporation, all near Terre Haute and the first two in the Wabash River valley. In Dresser mine, since it was opened in 1925, a total of 175 seals, 50 of which are of the high-pressure type costing $400 to $1,000 each, have been installed. Saxton mine contains well over a hundred seals.

In the local parlance, "seals" include installations intended primarily to hold back gas only, and also the heavier constructions (bulkheads) in-

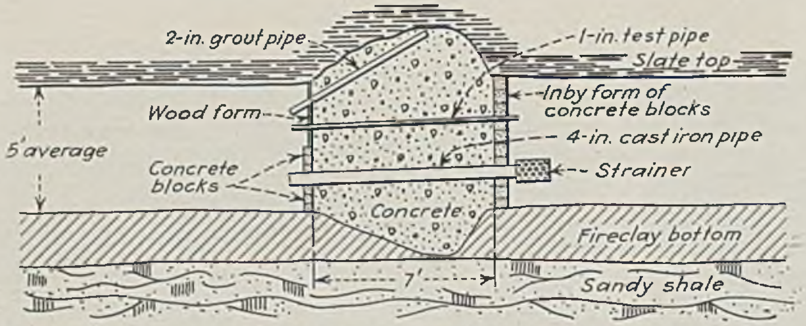


Fig. 1—Side view of a bulkhead in Saxton No. 1 mine for which the hitchings are made with a cutting and shearing machine. Rib hitchings in coal have the same shape and taper.

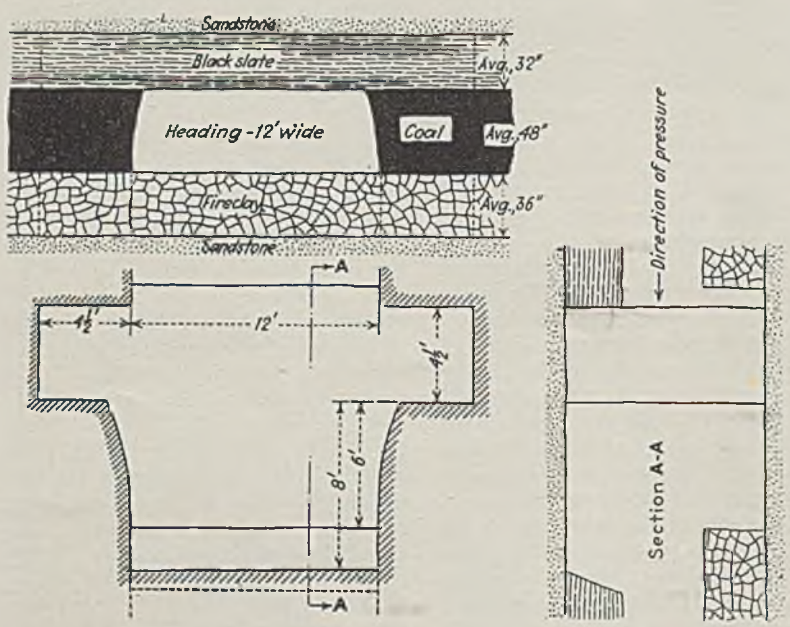


Fig. 2—Excavation for bulkhead under average conditions in Dresser mine.

tended for holding back both gas and water. Seals are placed across the usual two headings forming the entry to each panel as soon as the mining of the panel has been completed. In like manner cross entries are sealed after all panels of a section are completed.

Saxton mine produces 2,300 tons per day (normal operating schedule) by mechanical loading from 5-ft. No. 4 seam coal. Cover averaging 190 ft. consists of hard shaly strata over the coal 20 to 110 ft. thick and then water-bearing sand and gravel to the surface. The Wabash River keeps this upper stratum filled with water and when the river overflows the head is increased by many feet. Mining is not done where the solid top is less than 30 ft.

Original practice, when the bulkheading was new at the mine, was to build the bulkheads 10 ft. thick and reinforce with steel. Those built in the last four years, however, have been constructed without reinforcing, and during the last year the total thickness was reduced to 7 ft. A large part of the mined-out area back of the older bulkheads has filled with water and in some instances the pressure on the bulkhead has risen to 72 lb. per square inch when the river was at high stage. Mine entries are 10 ft. wide.

To seal off the gas from a panel and to act as a back form for the concrete, a curved wall of concrete blocks is built with the curve against the direction of pressure. The front form, to a point about half way up to the roof, also is of concrete blocks but is built straight across the heading instead of curved. Wood is used for the balance of the form, and after the concrete is rammed into place against the roof as far as possible, grout is pumped in through several 2-in. pipes to form the final top seal.

Bulkheads are hitched into the coal 3 ft. and into the top and bottom to solid strata, usually about 2 ft. but in some cases where clay veins and slips are encountered up to 10 ft. For 15 ft. or more on each side of the bulkhead the top is timbered with 60-lb. rail crossbars spaced 5 ft. apart and set on treated posts. In a few instances of bad top it has been considered necessary to construct wing or rib walls and a roof arch outby the bulkhead for 10 to 25 ft. This arch is pressure grouted to the top in the same manner as bulkheads. Bulkhead hitches in both coal and shale are cut with track-mounted cutting and shearing machines and thus naturally are tapered, with the greatest depth of cut at the back.

Of the ten gathering pumps now in use at Saxton and ranging in size from 2 to 15 hp., six discharge back of bulkheads into panels or areas where but little water has accumulated. To accommodate a pumping connection each bulkhead is equipped with a 4-in. cast-iron pipe and valve. Where long pipe lines would be required to reach a bulkhead it is the alternative practice to drill a 2¼-in. hole through the coal barrier to the abandoned area into which water is to be discharged. This drilling is done with an air-driven Sullivan No. 6 prospecting core drill using steel bits. Drill-rod equipment totals 175 ft. and some barriers nearly that thick have been penetrated. The water connection to the finished hole is a 2-in. steel pipe inserted 5 ft. and made tight by driving long slender pine wedges around it. Use of a 2-in. pipe (outside diameter, 2.37 in.) is possible because the hole is drilled somewhat larger than the nominal 2¼-in. size, especially at the outside end.

At Dresser, the average unit cost

Rib walls and arches increase the leakage path around bulkheads in Dresser mine. A glass gage tube just above the water valve indicates the water level, which in this case is maintained by pumping.

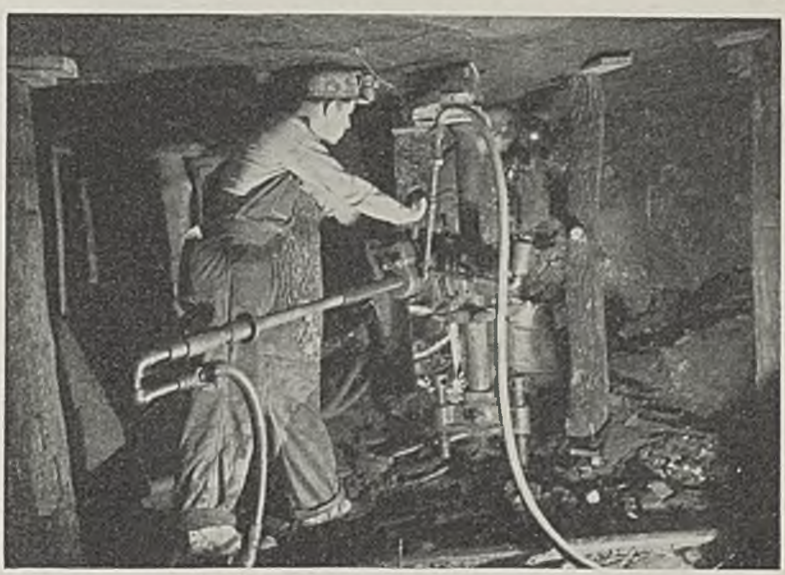
of four typical high-pressure seals, or bulkheads, of the type noted above, was $549.45 and the cubic-foot cost was 44c.

Wing walls and an arch on the outby side of the bulkhead are regular practice. These increase the leakage distance and lend support to the top. Seldom is any timbering placed back of the bulkhead, and the main section of the structure is heavily reinforced with steel rails.

Dresser mine works the No. 5 coal, averaging 4 ft. The cover of 200 ft. is about the same character as at Saxton except that at Dresser the water usually breaks through if there is less than 65 ft. of solid material protecting the coal from the water-saturated gravel above. All coal is loaded mechanically, no pillars are taken and the recovery averages 60 per cent. The bottom fireclay, 36 to 60 in. in thickness, softens and the pillars in abandoned areas squeeze down and allow the top to break. In many cases, these breaks extend up to the water-bearing deposit. With the Wabash River in flood (hoisting shaft is 600 ft. west of the river), some bulkheads have been called upon to withstand 90 lb. per square inch. Normal river stage develops a pressure of 72 lb. Calculations indicate that the bulkheads would stand a maximum pressure of 500 lb. per square inch.

Cutting of coal rib hitches, 4½ ft. deep to equal the thickness of the bulkhead, is done with a hitch drill with 12-in. auger at Dresser. Holes are drilled to overlap. The black slate top averaging 32 in. is removed by light charges of explosive supplemented by pick work; the fireclay bottom is cut with a paving breaker.

Several grouting pipes in the top half and a water pipe in the bottom section can be seen in this 6-ft. bulkhead just completed in Saxton mine. The panel is filling with water and the pressure probably will reach 60 lb.



In Saxton mine, coal pillars sometimes are core-drilled to provide a short cut in disposal of water from live workings to a sealed area.

To cut a rib hitching for a seal in Kings Station mine, the place is outline-drilled with a 4¼-in. coal drill and a few holes in the center are loaded lightly with powder for shooting.

Brick is used for building the back form and temporary gas seal, which is straight across. Wood forms in sections for quick installation, recovery and re-use are employed on the front and under the arch.

Sand, gravel and standard cement in a dry state are mixed by machinery on the surface and this dry mixture is transported into the mine and to the place of construction in cars. For building the lower three-fourths of the seal the dry material is shoveled into the form, water is added and the concrete is worked up by treading and tamping. For the upper half, the concrete is prepared in a mortar box instead of in the form. Dry mixing, as compared to mixing in the mine, has the advantages of lower cost and greater working speed.

Low-pressure seals at Dresser, intended primarily for gas, are 24 to 36 in. thick, are hitched into the solid and would withstand a pressure of 40 to 50 lb. As far as possible, high pressures are not allowed to build up back of the bulkheads but instead the water is pumped to the surface. In the one case where there is a high head permanently on a bulkhead a second one was built, leaving a sump area between.

Water that has stood in workings exposed to oxygen is quite corrosive. Six-inch outlet pipes through important bulkheads consist of Toncan iron welded to steel pipe with the weld positioned in the center of the concrete and the Toncan section project-

Result of a shot to make a rib hitching for a seal in Kings Station mine.

ing out to a gate valve. V-shaped strainers 36 in. square at the base and made from old shaker plates with 1½-in. round openings are fixed over the inby end of the outlet pipe. Less important bulkheads and low-pressure seals have 2- or 4-in. outlet pipes with iron stop cocks.

Very little water occurs in Talleydale mine but the permanent seals are built as water bulkheads because of the remote possibility of a break extending up through an upper seam of coal and into the surface material, which contains water. These bulkheads are 4 ft. thick and are reinforced with 60-lb. rail which, in its former service as crossbars, had become bent so that it approximates the curvature of the back arch of the dam. Hitches are made 4 ft. into the rib, 3 ft. into the bottom and to the solid in the top, which means from 18 in. to 12 ft. The few gathering pumps used in the mine pump back into sealed areas, in some cases as storage until the water is later pumped to the surface. Some seals have cost over $850. The cost of two seals picked at random from the records are shown in Table I.

Overlying a part of the Talleydale No. 3 seam workings is a worked-out area of No. 4 seam which is kept pumped out by a Peerless deep-well turbine pump at the old Bardyke mine shaft, which is 300 ft. deep. This pump, rated at 350 g.p.m., is driven by a 40-hp. 440-volt U.S. motor. The pump is not affected by corrosion, but after the first eighteen months of service it had to be pulled for reaming a rust-colored sediment from the 6-in. column pipe. A 350-g.p.m. 50-hp. centrifugal pump inside the No. 3-seam workings delivers water from areas back of bulkheads to the No. 4 area from which the deep-well pump draws.

Although pillars are taken in part in Miami No. 10 mine of the Binkley Mining Co. and the recovery is 85 per cent, very little water enters the workings. But there is a pumping problem at the mine because it is connected with several of the old Miami company's mines which are worked out or permanently shut down. The water from this basin of worked-out mines is pumped through the air shaft of the old No. 6 mine by a 273-ft. 840-g.p.m. Fairbanks-Morse deep-well turbine powered by a 75-hp. 2,300-volt motor of the same manufacture. Because the water is extremely corrosive, the seven bowls and impellers of the pump are bronze and the steel column pipes are treated with special protective coatings. The pump is 1¼ miles from Miami No. 10.

Another deep-well turbine pump is in use at Submarine No. 2 mine of the Clinton Coal Co. It dewaters the abandoned workings in the No. 5 seam 90 ft. above the present workings in the No. 4 seam. The No. 5 was mined from the same shaft, so it is necessary to prevent any accumulation of water therein, principally because it would back up to the shaft and cause leakage around the seals. The pump house is in a ravine about 800 ft. from the hoisting shaft and generating plant. The pump is a Fairbanks-Morse 6-in. 1,750-r.p.m. unit powered by a 50-hp. 275-volt motor. Before this turbine pump was installed it was necessary to do the pumping through the hoisting shaft.

Table I—Costs of Two Typical Seals in Talleydale Mine

Secondary seal (principally for gas) 18 ft. long, 7 ft. high, 2 ft. thick:	
15 yd. gravel	$26.25
85 sacks cement	45.90
3.000 brick (paving)	30.00
Sand	1.75
Reinforcing steel, used and bent 60-lb. rails	6.00
Labor	124.30
Total cost	$234.20
Cost per cubic foot	46c
Primary seal (gas and water bulkhead), 23 ft. long. 11 ft. high, 4 ft. thick; hitched in coal rib, 4 ft.; in bottom, 2¼ ft.; in roof, 1½ ft.:	
20,000 brick	$240.00
150 sacks cement	81.00
10 sacks lime	4.00
22 yd. sand	38.00
Steel	12.00
Labor, 70 shifts at $5.57	389.90
Total cost	$764.90
Cost per cubic foot	50c

Officials of Standard mine of the Standard Coal Co. have a problem in the quantity of water and its acid content. Lead-lined stub pipes are used in seals and plans are now under way for installing underground 2,200 ft. of 3-in. Transite pipe extending back from the shaft bottom. It will be installed 18 in. above the floor and will be supported on crosspieces nailed between pairs of posts. Above the pipe and on the upper crosspieces a wood board will be laid to protect the pipe from roof falls.

Water is not allowed to accumulate back of gas seals at Standard, although they are built 5 ft. thick and are hitched in the ribs 3½ ft. and in the top and bottom 1½ to 3 ft. to the solid. The entire seal is built of concrete blocks. Each row is plastered heavily with cement before the next outer row is placed. Only in one case is water pumped back of a seal and that because no rights are owned at that point permitting discharge of water to the surface. This water drains on through an adjacent panel, from which it is pumped to the surface. Water is discharged to the surface at the shaft and at three boreholes, and the pump drives are 10- and 15-hp. motors, some d.c. and others 220-volt a.c. Seven gathering pumps are in use and they are driven by 5- and 7-hp. d.c. motors.

At the Buckskin mine of the Buckskin Coal Corporation, where the acid concentration gets troublesome if water is allowed to stand in a sump, a 2,200-ft. line of Michigan wood pipe conducts water to the main sump. Because some of the small steel lines from the gathering pumps are eaten out in a year, the management is considering Transite. At the main sump, which is ½ mile from the shaft, a 30-hp. 220-volt a.c. centrifugal unit rated at 290 g.p.m. pumps through a 254-ft. borehole and works 14 hours per day.

Pipe loop used as a precaution against gas leakage in disposing of water to a worked-out panel in Kings Station mine. Both of the stop cocks are fitted with padlocks.

ELECTRIFICATION

+ Indiana Deep Mines

DEEP MINES in Indiana spent approximately 8.06c. per ton for power during the last nine months of 1937. Power costs for that period at mechanized underground operations, as reported to the National Bituminous Coal Commission, averaged 8.01c. per ton; hand-loading underground operations spent 8.33c; strip mines had an average of 7.91c., and the weighted average for all classes of operations in the State was 7.98c. per ton. During the same nine months, the average for all classes of operations in Illinois was 7.88c.; western Kentucky reported an average of 6.59c., and Iowa averaged 11.93c. per ton. The breakdown between mine fuel and purchased power is shown in Table I.

Steam-generated power for hoisting and ventilation is standard practice at most mines in the State. Three of the larger mechanized operations, however, use electric power for these duties and at two of these mines electricity is employed in conditioning the ventilating air. Several of the mechanized mines generate their own power. Purchased-power costs at mines using steam for hoisting and ventilation covered by this *Coal Age* survey ranged from 5 to 8c. per ton; for the three completely electrified operations, the range was from 7.4 to 9.5c.

At these latter mines, power requirements are 5.2 to 6.2 kw-hr. per ton (see Table II). Average requirements, of course, are affected by the severity of the pumping load, regularity of operation and the extent of the mechanical cleaning and drying equipment installed. At the mines using steam for hoisting and ventilation, electric power consumption is between 3 and 5 kw-hr. per ton. Net costs of purchased power generally range between 1.28 and 1.91c. per kilowatt-hour.

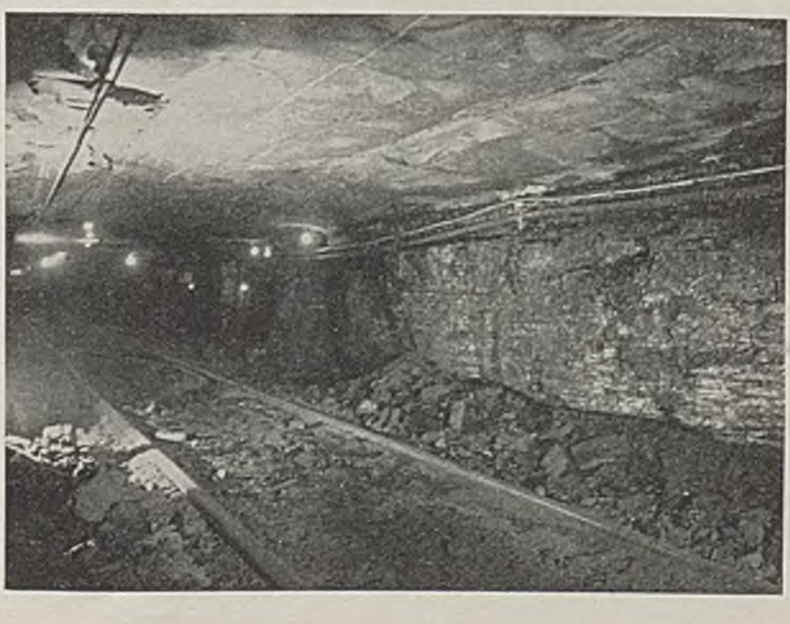
Not all Indiana power schedules include power-factor clauses. The rate sheet of one utility supplying several mines calls for $1.50 per month per kilowatt, 30-minute calculated demand—arrived at by multiplying the metered demand by 80 and dividing by the power factor. Installation of a capacitor by one operation—Standard Coal Co.—buying on this schedule has enabled the mine to maintain unity power factor. Another—Buckskin Coal Corporation—where the substations are all motor-generators averages 98 per cent power factor.

The capacitor at Standard, a General Electric 90-kva. 2,300-volt unit installed in 1932, paid for itself in six months in reduced power bills. At this mine the power company was delivering a voltage considerably above nominal rating; when this was reduced closer to nominal, it was found advantageous to take out of circuit enough capacitor units to reduce to total to 60 kva. With a combination of proper voltage and unity power factor, all a.c. motors dropped to a noticeably lower operating temperature.

In the field of substation equipment, Indiana can claim credit for the first perfected portable design put into underground service. This was a full-automatic d.c. substation using a converter designed by James Hyslop, now manager of operations, Walter Bledsoe & Co., and built by General Electric for installation in the Bledsoe Dresser mine in 1929, where the coal averages 4 ft. thick.

Since its original installation, the portable set has been moved four times. With the concrete floor slab and rails ready, the unit can be moved over a week-end with 60 man-hours of labor. Moving the 12x22-ft. steel room is the biggest part of the

In Saxton mine, parkway cables carrying 2,300 volts to substations, as well as telephone circuits of the same type, are hung on the haulway across from the trolley. In this view the telephone cable almost covers the steel messenger supporting the power cable.



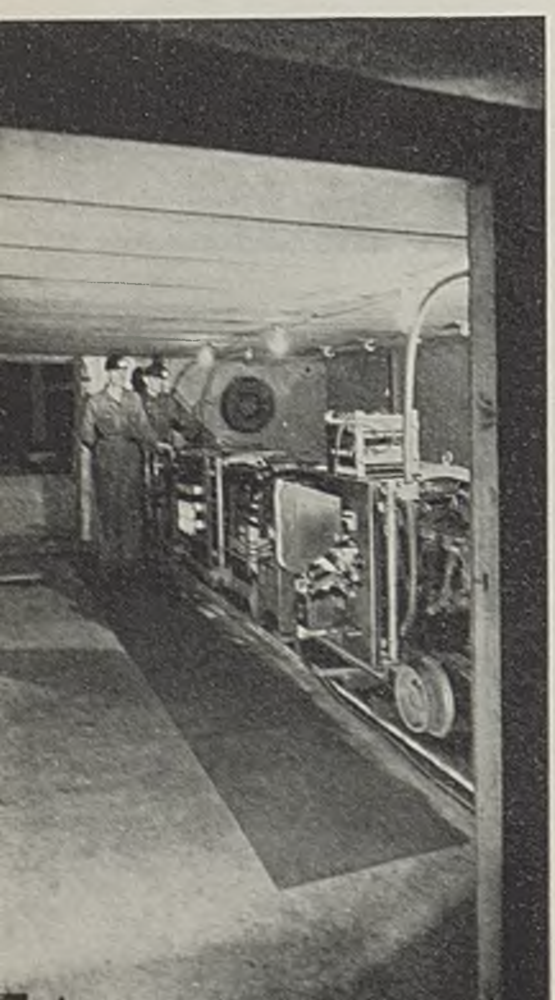
job. The highest point of the portable unit—the d.c. automatic reclosing panel, which is on a side of the 8-ft.-long truck carrying the 150-kw. synchronous converter—is only 39 in. above the rail. The truck carrying the special low-type transformers and a.c. panels is 10½ ft. long.

At all substations, portable and stationary, 2,300-volt oil switches are mounted on the wall outside the room so that in emergency the unit can be stopped without entering the substation itself. Standard d.c. distribution voltage at Dresser and other Indiana mines is 275.

Approximately 70 per cent of the substations in the State are underground. Most mines, however, have at least one unit in the hoist house and it usually supplies the bottom. At the Buckskin and Standard mines, however, all the substations are on the surface. Over 70 per cent of the d.c. substation units, it is estimated, are converters; the rest are m.g. sets. Some mines use both types. Saxton has standardized on m.g. sets located in fireproof underground rooms; bearings on these units are protected by thermostats set to operate at 100 deg. C. One Saxton set (200-kw.) is full automatic (General Electric board). The Standard Coal Co., which formerly used both types, a few years ago replaced its m.g. sets with rotary converters from a worked-out mine as an aid to lower power consumption and increased operating efficiency. Converters also are standard at the Kings Station operation of the Princeton Mining Co. (5,800 tons from two loading shifts per day), where seven such units have been installed underground.

Automatic reclosing circuit breakers are in use in substations at most of the mines. Two I.T.E. breakers tie the three substations at Saxton together and ten breakers of the same make are installed on the entries for ties and sectionalizing in the Kings Station mine. At Dresser all d.c. circuits are sectionalized by safety switches in steel boxes. A number of Ohio Brass safety feeder switches also are used at Saxton.

Looking through the doorway into the sectional-steel-plate room containing the portable substation at Dresser mine. Nine years old, "It has not given one minute's trouble."



Large Wire Installed

Five of the mines covered in the *Coal Age* survey use No. 6/0 trolley wire—principally on main haulage. No. 4/0 is the usual choice for room panels. Feeders of 500,000 and 1,000,000 circ.mil. in parallel with the trolley carry the power to the mobile-loader sections. Several companies carry copper negative returns paralleling the main-haulage rails. The Dresser mine, for example, carries one 4/0 wire tied to the track crossbonds every 300 ft. Rail-joint bond conditions for the 300-ft. sections of track are checked by measuring the currents in the return wire on each side of the tie to the track with a clip-type ammeter (see p. 116).

From one to three 4/0 wires are used along with the rails of the main haul at Glendora Nos. 27 and 28 mines of the Templeton and Glendora coal companies, respectively. In Miami No. 10 mine, 4/0 return wire is installed along the rail in rooms. Welded rail joints are replacing bonds on the main-haulage at Buckskin mine. At the time field work on this study was being done, 600 ft. of new 70-lb. track had been installed, and the joints, without angle or splice bars, had been welded with a gas torch using bronze rod. A cutting torch first is used to V the ends of base, web and ball of both rails. Material and labor cost per joint is $2.50; if joints were made with angle bars, bolts and long bonds, the material cost alone would equal that figure.

Track bonding with steel-weld bonds is standard practice throughout the coal fields of Indiana. On main-line track, short U-bonds tucked under the rail and with angle bars notched to accommodate them are used at Talleydale, Snow Hill Coal Corporation; Crown Hill No. 6, Clinton Coal Co., and Kings Station. At Crown Hill, these bonds have been applied to 3,000 ft. of new 70-lb. track. At Kings Station the short bonds are concealed beneath the rail so that the track-cleaning machine (see p. 118) will not hit them.

Table I—Per-Ton Costs of Mine Fuel and Purchased Power in Indiana, Western Kentucky, Iowa and Illinois.

	Cost per Ton Purchased Power	Cost per Ton Mine Fuel *
Indiana:		
Strip mines	$0.0688	$0.0103
All deep mines	0.0611	0.0195
Mechanized deep mines	0.0631	0.0170
Hand-loading mines	0.0513	0.0320
All mines	0.0647	0.0151
Western Kentucky, all mines	0.0542	0.0117
Iowa, all mines	0.1048	0.0145
Illinois:		
Strip mines	0.0836	0.0040
All deep mines	0.0516	0.0242
Mechanized deep mines	0.0513	0.0224
Hand-loading mines	0.0521	0.0287
All mines	0.0596	0.0192

* At market price.

Conveyor Control Flexible

With the exception of the Submarine No. 2 mine of the Clinton Coal Co., where chain-flight conveyors are employed, most of the larger active deep mines in the State use mobile loading machines. In addition to the standard section load of drills, cutters and loaders, three of these operations—Miami No. 10, Kings Station and Standard—also have 50-hp. Airdox compressors for breaking down the coal face. Fig. 1 shows the wiring and control method used in the four-room conveyor set-up at Submarine No. 2. The control panel at the loading station includes a main-drum and a knife switch. Ordinarily, the drum switch controls everything but the mining machines; in case any of the inside equipment must be operated with the main conveyor stopped, the knife switch is opened and a jumper placed from the inside feed line to the trolley wire.

Thirteen-ton locomotives are the largest on main-haulage work. Relay or swing locomotives usually are 6-tonners, but there also are some 10-, 8- and 4-ton sizes in this service. The largest cable-reel locomotive is a 10-tonner, gathering large drop-bottom cars in new workings in an upper seam in Talleydale mine. Most cable-reel locomotives used are the 6-m.p.h. speed, but there are some 4-m.p.h. units in service at both Dresser mine and Knox Consolidated No. 2, Knox Consolidated Coal Corporation.

Table II—Purchased Power Requirements at 100-Per-Cent Electrified Mines

Mine	Kilowatt-Hours per Ton Shipped	Tons Produced per Day	Shaft Depth, Feet	Coal Hoisting Type	Coal Hoisting Drive
Talleydale, Snow Hill Coal Corporation	5.2	3,000	341	Car	700-hp. induction
Knox Consolidated No. 2, Knox Consolidated Coal Corporation	6.2	2,300	224	Car	Ilgner-Ward Leonard 500-hp. m.g. set
Standard, Standard Coal Co.	5.5	2,300	235	Car	250-hp. induction

Note: At all three mines all of the coal is loaded by mobile loaders. All coal is cleaned mechanically at Talleydale, with one size so treated at the other two mines.

Table III—Power Consumption, Individual Metering, Talleydale Mine, 1937.

	Energy Consumption Kw-Hr. Total	Energy Consumption Kw-Hr. Per Ton	Per Cent of Total
Water supply for air conditioner and washer	164,080	0.24	4.7
Coal hoist	544,000	0.81	15.4
Mine ventilation	130,070	0.19	3.7
Preparation	808,000	1.20	22.9
Miscellaneous surface	145,440	0.21	4.1
Underground	1,609,510	2.39	45.5
Dewatering workings in seam above	130,100	0.19	3.7
Totals	3,531,700	5.25	100.0
Total tons hoisted			672,831

Storage batteries are used exclusively at the No. 6 mine of the Jackson Hill Coal & Coke Co. and also are employed to a limited extent at Buckskin and Kings Station. Jackson Hill has eleven (nine Whitcomb and two Ironton) 6-ton battery locomotives, but not all are in use. Batteries are Exide-Ironclad and two are in use which are eight years old. Six are 29-plate 48-cell and two are 23-plate 42-cell. Charging is by resistance from 275 volts d.c. generated at the mine. Kings Station has one Atlas and two Ironton gathering locomotives with Philco batteries. The Atlas unit is used on the surface to handle supplies. Two Irontons with Exide-Ironclad batteries also are used in surface supply duty at Dresser.

At the Wick mine of the Ingle Coal Co.—the first Indiana operation to install rubber-tired haulage (*Coal Age*, October, 1938, p. 29)—tractors are powered with 27-plate 24-cell Exide-Ironclad batteries. These have capacities sufficient for a 7-hour run and are charged by a 30-kw. 68½-volt motor generator consisting of a 2,300-volt 60-hp. G.E. motor and a "Diverter Pole" (Electric Products Co.) generator. This m.g. set is mounted on flanged wheels.

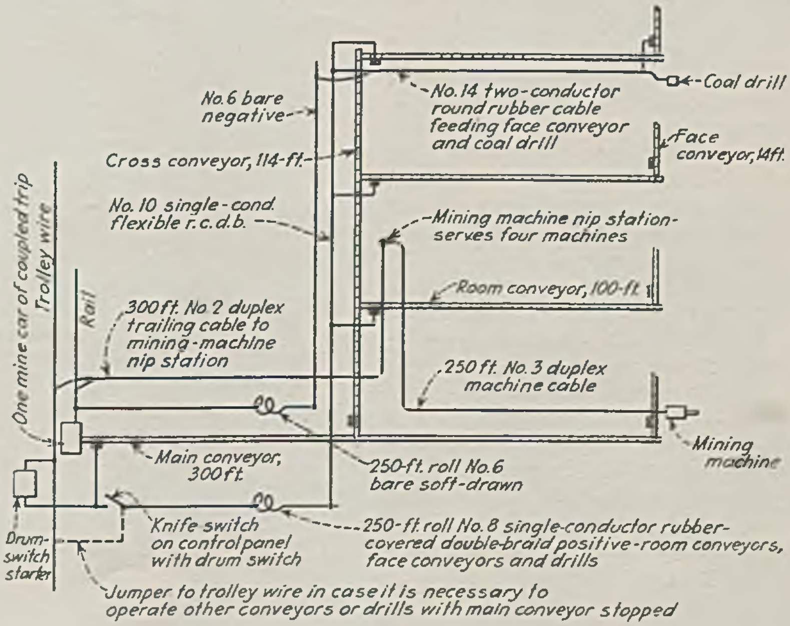
Alternating current, which has been used for cutting machines since the mines were opened twenty years ago, also feeds drills and mobile loaders at Knox Consolidated Nos. 1 and 2 mines; the voltage is 240. Portable transformer stations consist of three 2,300/240-volt 37.5-kva. oil-type units in a steel case, mine-truck mounted, with oil switch, fuse, safety switch and terminals mounted outside at one end.

Carrying 2,300 volts along headings underground for feeding substations, portable transformer stations, etc., is general practice in Indiana. At Miami No. 10, however, trenchlay cable is buried in an aircourse 2 ft. below the mine bottom. Talleydale suspends non-metallic-protected cable from the roof. This same cable and suspension is used at the No. 48 mine of Peabody Coal Co., where the cable is on the haulway and across the track from the trolley wire. Wire-armored cable suspended overhead is used at the Knox Consolidated mines. In a number of other mines, parkway or trenchlay cable is hung overhead on haulways. At Saxton, this cable, together with parkway telephone cable, is suspended on steel messenger on the side across the track from the trolley; it is protected at track crossings with 3-in. standard pipe which in turn is insulated on the outside to prevent grounding to the d.c. distribution.

Until recently, practically all 2,300-volt cables suspended in shafts and boreholes were of the wire-armored lead-sheathed type. All new boreholes and replacements at the Glendora mines, however, are being equipped with rubber-sheathed cables. These are ordered with molded potheads at the top, and the cable is suspended by the conductors, which are looped over spool insulators. Boreholes average 250 ft.

Synchronous motors outside of d.c.-station m.g. sets are not common at Indiana mines. There are, however, two Allis-Chalmers 125-hp. 2,300-volt synchronous units with semi-automatic starting control driving circulating pumps in the Talleydale preparation plant. Glendora No. 27 mine has a 110-hp synchronous motor as a standby for the steam engine which regularly drives the ventilating fan. At Knox Consolidated No. 2, a G.E. 250-hp. Type B.T.S. brush-shifting adjustable varying speed motor, which formerly was used for regular duty, now serves as the drive of a standby fan. The electric hoist at the same mine is driven by an 800-hp. 550-volt d.c. motor with Ilgner-Ward Leonard control. The flywheel set is driven by a 500-hp. 2,300-volt wound-rotor induction motor controlled by a liquid rheosat slip regulator. Talleydale uses a 700-hp. Allis-Chalmers induction hoist motor operating at 514 r.p.m. with a rated pull-out torque of 1,800 hp.

Fig. 1—Wire and cable layout for a four-room chain-flight conveyor unit, Submarine No. 2 mine.



MAINTENANCE AND SUPPLIES

+ Indiana Deep Mines

MAINTENANCE of equipment at deep mines in Indiana reflects to a considerable extent the high degree of mechanization of loading at these operations. In many cases, maintenance of these loaders is handled exclusively underground. A few mines have machine shops on the surface where complete loaders are overhauled or "units" rebuilt. Arc-weld filling of locomotive tires is a regular practice of long standing at one mine, but the use of demountable tires is quite common over the State. Mining-machine bit practice largely appears to be in a transitional stage from standard to patented renewable-point bits. Because of accessibility to supply companies and branch warehouses, inventories of spare and repair parts are comparatively small.

Few companies have gone to the practice of making complete general overhauls of loaders after definite periods of time or after handling a fixed tonnage. In some cases the reasons are that the loaders are still fairly new or at least not old enough to have demonstrated just how often complete rebuilding will be necessary. At the Kings Station mine of the Princeton Mining Co., however, loading machines have been in use since 1924 and for some years have been operated on a two-shift basis, and here overhauls are made on neither a time nor tonnage basis but instead when inspection and operating reports indicate a condition warranting rebuilding. Ten loading units are operated and the loading equipment at the mine consists of two Goodman Type 260-A, two Joy 11BU, two Joy 10BU and eight Joy 5BU machines. Four loaders, usually 5BU, are held in reserve.

A master mechanic is in charge of all underground maintenance and to him report the three chief electricians, one for each shift (the third shift is not a loading but a maintenance and supply shift). Two men, using a special loading-machine lubricating truck, service all loaders with the exception of two in an isolated section, which are hand-lubricated. The special truck is equipped with three tanks for three grades of oil and grease, and has an air compressor and power grease gun.

General overhauls are made in a main shop near the shaft bottom. This shop is adjacent to a central supply room but does not include machine tools such as lathes, etc. Parts, such as the heads of loading machines, are sent to the surface for rebuilding at a shop about a mile from the mine. A new repair kink at Kings Station is the reclaiming of heat-treated shafts and other parts which are scored at the bearing fits or on other wearing surfaces. For certain jobs of this character an arc- or gas-welding build-up is not satisfactory because the heat destroys the heat-treatment and reduces strength and/or causes warping. The hot-metal spraying process, whereby the surface to be built up is first sand-blasted to provide a secure anchorage, has already been applied to a number of loading machines and other underground d.c. equipment parts. The work is done by a commercial shop.

At No. 48 mine of the Peabody Coal Co., the Joy 5BU loading machines work one shift per day and are given a complete overhaul in the top shop once a year. Underground repairs are made in a central shop near the shaft bottom and minor jobs are done at temporary shops in each section, at which points a few "urgent" repair parts are kept. The production of 2,400 tons per working

At Miami No. 10, the chief electrician "grabs" this chance during lunch hour to inspect the controller of the loader.

day is attained with a maintenance force of fourteen men, including top and bottom mechanics, electricians and helpers. Underground work is under a chief electrician who has no duties on top. Five men comprise the night maintenance crew.

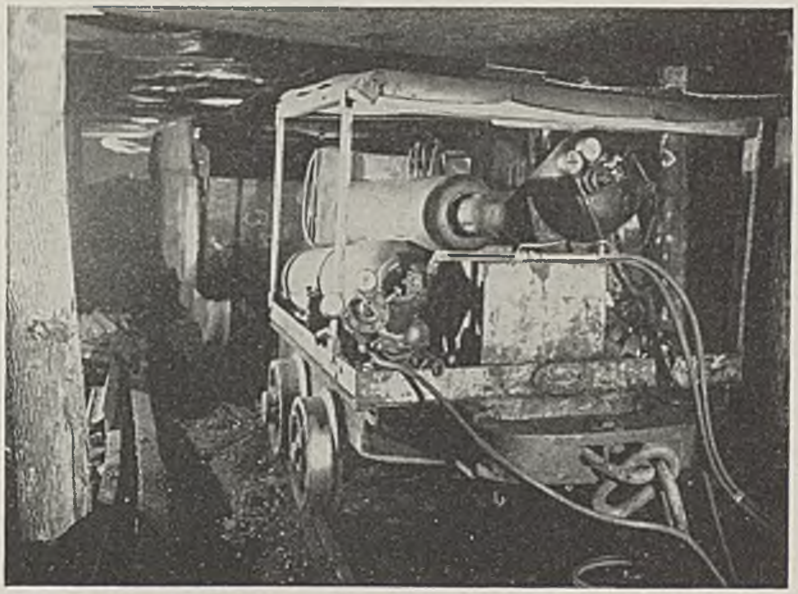
At the Talleydale mine of the Snow Hill Coal Corporation, which has on hand thirteen Goodman Type 260-A loaders (seven in use producing 2,800 tons per day), experience since the mine was opened in 1935 indicates that it will be economical to overhaul each loading machine every eighteen months under normal operating conditions. At this mine, maintenance is under the supervision of a mechanical and electrical specialist whose title is chief engineer. Under him is a force of twelve men in the top shop and an electrical engineer in charge of underground electrical and mechanical maintenance. The electrical engineer has an assistant and during the day shift six men work under the direction of the two. One of the six men spends most of his time in the underground shop to be available for emergency calls.

An underground night foreman has a crew of six men, four of whom are service men working principally at loading-machine lubrication and inspection. Eight men work in the top shop on the day shift. Two are electricans, two are machinists, one is a floorman, two are welders, three are bit sharpeners and in addition there are one helper and one blacksmith. The night force of this top shop consists of two machinists and two helpers. The company does practically all of its own repair and rebuilding work, including most of the armature winding.

The top shop is in a 40x120-ft. brick building with corrugated asbestos roof supported on structural-steel trusses. Material is handled by a full-electric bridge crane. Equipment includes one lathe, a radial drill, screw press, etc. Locomotives, mining machines and loaders are hoisted to the surface for general rebuilding in this shop. Arc-welding equipment consists of two 300-amp. units and from these units in the shop for a maximum distance of 500 ft. into the preparation plant low-voltage cables are installed to connection stations for these welders.

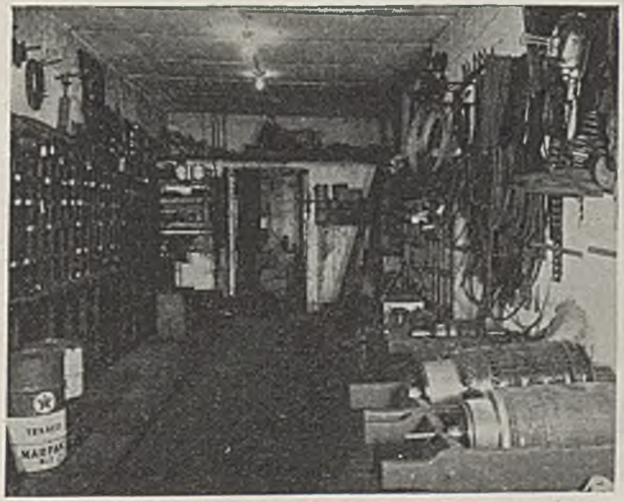
At Talleydale, the average total of mechanical and electrical maintenance delays to loading machines usually is held under 2 per cent; in other words, to about 8 minutes in 7 hours. If the delays mount to more than 2 per cent, special attention is given the problem until the delays are reduced to normal.

Maintenance delays to six Joy 7BU loaders producing about 1,700 tons per day in Miami No. 10 mine of the Binkley Mining Co. have averaged about one hour of down time per 100,000 tons loaded. At this mine there is no spare machine and therefore inspections are frequent and thorough in order to forestall failures. In six years' operation of these machines, all of this time under direction of the same chief electrician, only one renewal of a ball bearing has been required and only two armatures have been changed. The armatures required only turning of the commutators. The chief electrician, who spends most of his time underground, reports directly to the superintendent.

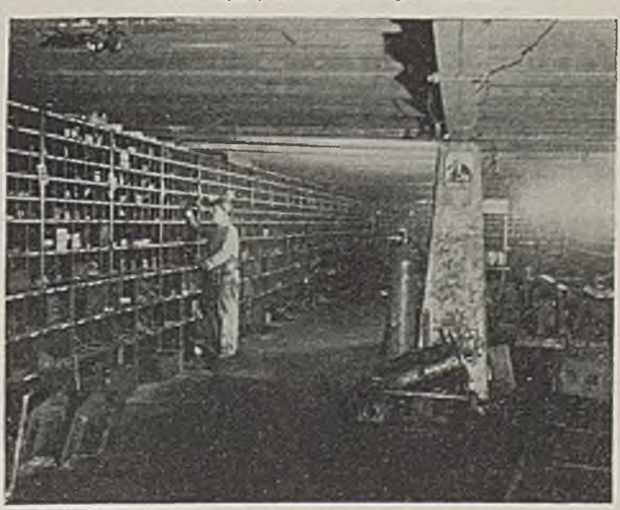


In a working place in Saxton mine this truck carrying tanks, torches and a resistance welder is being used to repair a loader. One such truck is part of the repair equipment kept in each section.

Saxton mine carries only a small stock of parts and these are stored underground.



Steel bins occupy 196 ft. of wall space in the underground central supply room at Kings Station.



At Dresser mine, Walter Bledsoe & Co., the officials report an average of 1.4 per cent maintenance delays to 8BU loading machines. At the Saxton mine, Saxton Coal Mining Co. (Whaley "Automat" and Jeffrey 44-D loaders), the reported average is 4 per cent. For the first six months of operation with new 8BU loaders in No. 6 mine, Jackson Hill Coal & Coke Co., the average delay was 11 minutes per 7-hour shift.

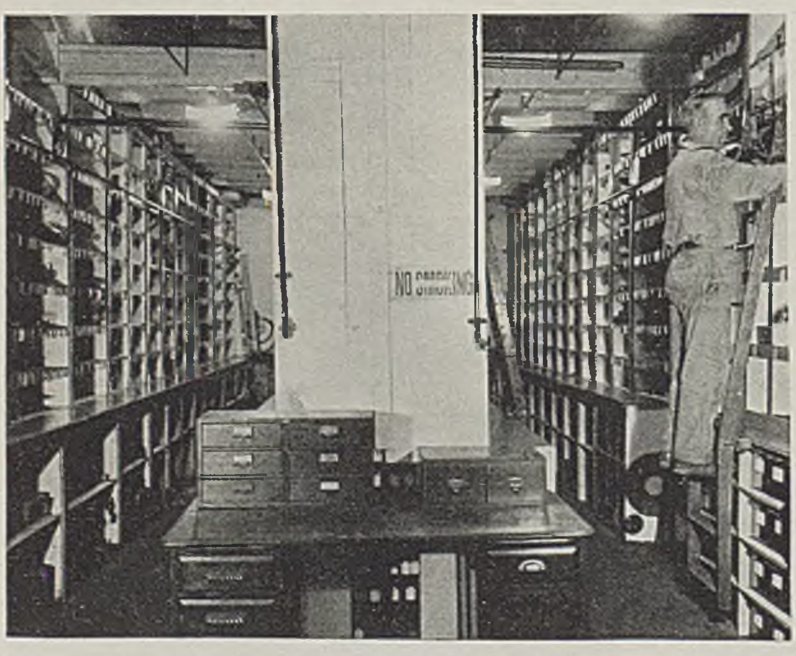
At at least seven mines the standard bits are sharpened, hardened and drawn substantially in accordance with the system introduced in the State by James Hyslop, now manager of operations for the Snow Hill Coal Corporation and Walter Bledsoe & Co. At the Talleydale mine of the first-mentioned company a silicon-manganese steel is used, and the bits, after being heated in an oil furnace, are sharpened in a roller sharpener. After being allowed to air-cool, the bits are reheated to 1,300 deg. F. and submerged in a tank containing 50 gal. of quenching oil. Cool-water circulating pipes in the tank maintain the oil temperature at 150 deg. The hardened bits, carried in a wire basket, are next immersed in a bath of molten salt, which becomes a liquid at 275 deg. When the bits are first immersed they reduce the salt temperature to 350 deg. In about 15 minutes the temperature rises to 400 deg. and at that point the bits are removed and allowed to air-cool. Formerly, two untreated bits were used per ton of coal mined. Treating reduced the figure to 1.06 bits per

Patented renewable bits are tipped at Saxton.

ton. Consumption of bit steel was reduced 40 per cent.

At Dresser mine, where the Hyslop method was first installed, 0.85-carbon steel is used and the sharpening and tempering is the same as at Talleydale except that the bits are quenched directly from the roller without reheating. A chain carrying the bits from the machine to the quenching tank is timed so that the point of the bit has time to reheat from the heat left in the shank. At Peabody No. 48, the same method is used and the bit steel is of the following composition: carbon, 0.75 to 0.90 per cent; both sulphur and phosphorus, 0.03 or less; manganese, 0.40 to 0.60 per cent. Table I details the performance and savings.

Peabody's supply room is in the same building with the mine office.



At Standard mine of the Standard Coal Co., where 0.40-carbon steel is used, bits are quenched without reheating after traveling 10 ft. on a chain. They are drawn in a fusible salt at 500 deg. F. At both Miami No. 10 and New Hope, Linton-Summit Coal Co., the bits are reheated before quenching preparatory to the drawing.

Among the mines using new renewable-type bit points exclusively are Buckskin, Buckskin Coal Corporation; Wick, Ingle Coal Co.; Saxton; and Glendora Nos. 27 and 28, Glendora and Templeton coal companies. At Saxton, Bowdil and "Star" bits are hard-surfaced with "Stoodite." At Miami No. 10, some hard-surfacing of Duplex bits after the first wear is done with "Stellite." Kings Station makes a regular practice of hard-surfacing conventional bits, using borium.

Locomotive tires are filled by arc-welding as a regular and long-established practice at Wick mine. The work is done manually entirely by filling: i.e., no rolled band is applied, using 5/16-in. No. 17 chromium-steel welding rod. Recently a 400-amp "Shield-Arc" welder was purchased for the work, previously done with a 200-amp. machine.

Table I — Comparison of Ordinary and Heat-Treated Machine Bits, Peabody No. 48 Mine

Bit Steel:	Eight Months, No Heat-Treatment	Nine Months, Bits Heat-Treated
Cost of bit steel, cents per pound	3.85	2.75
Pounds used	15,000	5,292
Sharpening and Machine Repairs:		
Cost of sharpening labor.	$651.40	$450.62
Cost of mining-machine repairs	$4,140.71	$1,504.44
Total cost of sharpening and repairs	$4,792.11	$1,955.06
Tons produced	224,810.60	166,622.95
Cost per ton	$0.0213	$0.0113

When axles need no building up the filled tire surface is not turned nor ground, which condition results in a noticeable roughness for about two shifts. If axles also are built up, then both those and the welded tires are turned at a commercial shop to which the truck is sent. At Saxton mine some tire filling is done by applying bands, and recently the tires of a few trucks have been filled at Kings Station by manual welding.

At several mines tires are used for but one wear and then junked. This is true at Miami No. 10, where all but one locomotive have wheels outside of the frame and therefore the worn tires can be cut off with a gas torch and new tires shrunk into place without removing the truck. At Submarine No. 2, Clinton Coal Co., the locomotives accommodate only a thin tire which allows but one wear. Indiana ranks high in the use of demountable tires. At several mines 50 to 90 per cent of the tires are of that type. Reports on their service and economy are all favorable.

Because more than 50 per cent of the mines in the State charge out parts and supplies when received, current mine records on the total stock are not generally kept. At four mines where figures on total inventories (including rails and mine timber) were available these figures divided by the daily production resulted in the following: $6, $8.20, $10 and $25. Where figures were available on spare and repair parts and small supplies, but not including rails and timber, they ranged from $6 to $8.80 per ton of daily output.

At six mines there are supply houses with clerks in charge who keep the stock by perpetual inventories posted daily. Five of these supply houses are on the surface and one is underground. The latter is at Kings Station, where all repair and spare parts and other small supplies required underground are kept in steel bins in a 25x90-ft. concrete-floored room protected by steel crossbars and steel plates in the top. Wall space totaling 196 ft. is occupied by 56 steel bin sections each 3½ ft. wide and 7 ft. high. In a wing to this supply room there is a steel box, or room, 11x11 ft. by 7 ft. high where armatures are stored. Electric-heater coils keep this room 10 to 20 deg. above mine temperature in order to prevent collection of moisture. A supply clerk, using the "Insite" card system, keeps a perpetual inventory of all items.

Parts to be delivered to various sections inside the mine are tagged as to destination and placed on a table beside the empty track. Also, the destination of a part is marked on a blackboard back of the table. One or more of three lamps—red, green and clear—are lighted to signal the respective main-line motormen to stop and pick up the parts and unload them as designated. Because the loading machines are operated two shifts there is a supply clerk on the second shift also, but all requisitions are made by the first-shift clerk. On the third, or maintenance, shift the chief electrician acts as clerk and keeps a general ledger of parts taken out.

The "Kardex" system is used to keep a perpetual inventory in the top supply house at Peabody No. 48. Here the wareroom is in the same building with the mine office.

OPERATING PRACTICES

+ At Indiana Strip Mines

STRIPPING in Indiana, which accounts for approximately half of the State's coal output, may be divided, on the basis of the capacity and type of stripping units employed, into two general types. One stripping group is distinguished by the use of shovels with large-capacity dippers for removing the overburden, while the other group largely employs draglines powered by internal-combustion engines, usually with buckets not exceeding 5 cu.yd., for the same purpose. The methods used by this latter group are the subject of an article beginning on p. 92.

Recovery of coal by the stripping method is practiced in practically every producing district in Indiana. Stripping depth, which naturally varies with the thickness, value and size yield of the coal, sometimes runs up to 70 ft. or more for short distances when cutting through ridges, etc. However, the average overburden thickness at nine properties out of ten in the large-equipment group is 28 or 35 ft., with coal thicknesses varying from 3 to slightly over 6 ft.

Few companies contemplate regular stripping of overburden as thick as 50 ft., which in most cases is the limit adopted for shovels in the absence of assistance from other equipment. The Binkley Mining Co., Enos Coal Mining Co. and the Patoka Coal Co., however, are among the companies which have set their stripping limits, aside from infrequent thicker areas of short duration, at 60 ft. In each case, however, average thickness of the overburden is 35 ft. Coal thickness at Enos and Patoka averages 5 and 4½ ft., respectively; at Binkley, the average is 3 ft., making the overburden-to-coal ratio when stripping at the upper limit almost 17 to 1.

Even thinner coal with a greater ratio prevails at the Old Glory No. 17 mine of the Maumee Collieries Co., which recovers the 2½- to 3-ft. Brazil Block vein. Overburden ranges from 40 to 58½ ft., with very little of it under 50 ft. Consequently, the stripping ratio seldom is less than 20 to 1; economic operation at this ratio is possible largely because of the high yield of coarse coal from this vein.

The high ratio was the major reason for the installation of a Bucyrus-Monighan all-electric walking dragline with a 165-ft. boom and 12-cu.yd. bucket in October, 1936 (*Coal Age*, January, 1938, p. 67), to replace steam equipment which had exhausted all the territory to which it was suited: i.e., under 40 ft. of overburden. As most of the remaining territory was over 50 ft. in thickness, the company felt that the dragline, in spite of certain limitations not applying to shovels, was the most suitable machine, inasmuch as it is able theoretically to operate in overburden 80 ft. thick.

Lower ground pressure and maximum stability during operation were the major reasons for the selection of the walking machine, which makes a 65-ft. cut in overburden containing an average of 35 ft. of slate, with 40 ft. or more not unusual. The dragline works on a bench made by removing the clay and surface material down to the slate, if possible. Where this is not feasible, a 2-ft. layer of slate is dumped on the clay to keep the machine from sliding around in wet weather. As the dragline works along the bench it also makes the next bench cut before each move-up. Thus, the bench always is kept at least one cut ahead of the one being used. Under this system, the clay is deposited on top of the rock in the spoil bank, thus reducing the possibility of slides. As natural conditions make it impossible to enter the pits except from one end, the dragline is walked back at 800 to 1,000 ft. per hour to the starting point after completing each cut and is followed by the loading shovel, so that haulage is behind the stripper the biggest part of the time.

Dippers used on Indiana stripping shovels vary from 8 to 30 cu.yd. in size. The latter unit (welded Man-Ten alloy with counterweight) is installed on the Bucyrus-Erie 950B shovel used by the Binkley Mining Co., which has a 105-ft. boom and 64-ft. dipper handle. Except for 95-ft. booms on the 750B and 320B shovels used by the Patoka Coal Co., and one or two other exceptions, Indiana has practically standardized on a boom length of 90 ft., while handle length usually is 60 or 64 ft., with one as short as 56 ft. and another as long as 68 ft.

With a very few exceptions, including the new Binkley shovel, every stripping machine in Indiana has been equipped with a larger, lighter-weight dipper. The two Marion 350 shovels of the Sunlight Coal Co., for example, were equipped with 10.8-yd. aluminum-alloy dippers weighing 23,870 lb. in 1935 and 1936. These dippers, with manganese lips and Finkl teeth, replaced 8-yd. plain-steel dippers which, in accordance with usual practice in the State, are kept in reserve for use when the new dippers need repairs or overhauling. Hard material in the banks at Sunlight is predominantly slate and shales, with some sandstone, limestone, etc. Installation of the larger dippers, with changes in swing-gear ratio to speed up acceleration, increased shovel yardage 16 to 17 per cent.

High-strength alloy steels, in many cases with extra abrasion-resisting qualities, have been combined with welding where possible to lighten most of the new dippers installed. Reduction in dipper weight usually is sufficient to make the loaded weight approximately the same for both the smaller and larger units. The Patoka Coal Co., for example, replaced an 8-yd. dipper in its 320B stripper with a 10-yd. alloy unit, while a new 16-yd. unit was installed on its 750B machine to replace a 12-yd. dipper. These Pettibone-Mulligan dippers were the first to be put in service in the State and handle predominantly slate, shales, limestone and sandstone. Marion 5480 stripping shovels at the Staunton and Ayrshire plants of the Electric Shovel Coal Corporation were equipped with 15½-yd. dippers supplied by the same maker, replacing in each case 12-yd. units with a weight saving of around 8,000 lb. Shales predominate in these pits, with slate, sandstone and other types of rock as runners up.

Bucyrus-built welded "Man-Ten" dippers with a capacity of 17 cu.yd. have replaced the 12-yd. dippers on the two 750B strippers used by the Central Indiana and Sherwood-Templeton coal companies, and on one similar stripper at Enos. A second Enos 750B machine with counterweight has been fitted with a 22-yd. dipper, replacing an 18-yd. unit with a weight saving of 10,000 lb. Shales and soft sandstone prevail in the Central Indiana and Sherwood-Templeton pits, while at Enos, although shales usually are the hard materials encountered, hard heavy sandstone and limestone in considerable thicknesses are not infrequent.

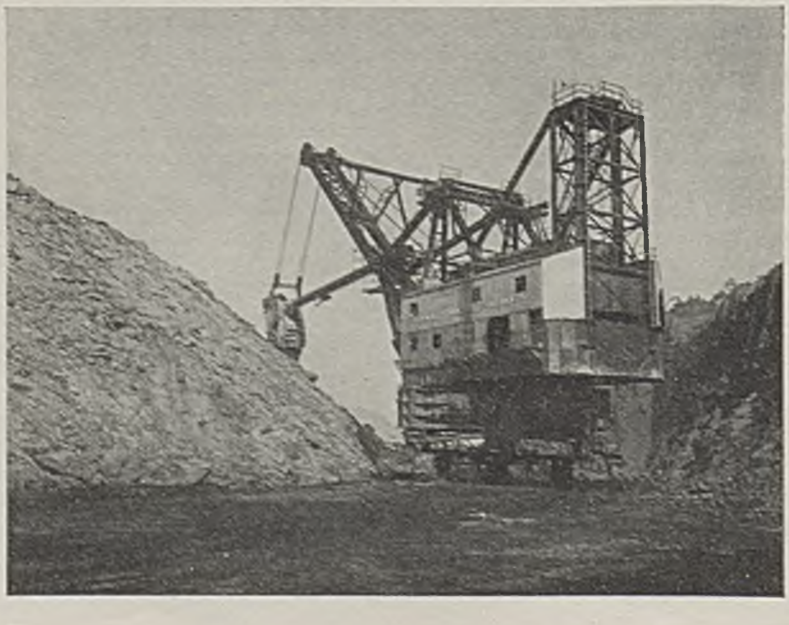
Weight Less; Capacity Greater

As still another example of dipper replacement, the 5480 shovel working in Pit A at the Chieftain No. 20 mine of the Maumee Collieries Co. has been fitted with an 18-cu.yd. American Manganese Steel dipper weighing 47,000 lb., against 59,500 lb. for the old 14-yd. dipper. The principal hard material in Pit A at the present time is 3 to 8 ft. of limestone. In Pit B, the Marion 300 steamer has been fitted with a Maumee-built 9-yd. dipper ("Hi-Steel" and "Man-Ten") instead of the old 6½-yd. unit. At No. 23 mine, another 14-yd. dipper on a 5480 shovel was replaced with a 19-yd. "Amsco" unit. Loaded weight in each case was 101,000 lb. Maumee also has fabricated a number of alloy-steel coal-loading dippers, such as the 4-yd. "Hi-Steel" and "Man-Ten" units equipped with Finkl hollow-ground teeth on the 490 loader in Pit A, Chieftain No. 20 mine, and on the 480 loader (replacing 3-yd. dipper) at No. 23. Loading-dipper size also has been increased by certain other companies by the installation of lighter-weight alloy equipment.

Dipper size on loading shovels at Indiana operations using large-capacity stripping equipment ranges from 1¾ to 5 cu.yd. Maximum width of cut which can be made by these shovels without backtracking ranges from 40 to 50 ft., with the usual average as 45. (At Enos, for example, the 45-ft. cut has been found the most efficient, as it permits the loader to dig and dump with the dipper in the best position the maximum possible time.) Consequently, stripping width also is 40 to 50 ft. as a rule, particularly when demand is good and the coal is being loaded as fast as it is uncovered.

Width of the stripping cut may, however, be increased materially by a number of companies in the summer time, particularly as a means of uncovering a reserve of coal, in which case an attempt usually is made to adjust stripping width to give the loader two reasonably wide coal cuts. And in certain other cases, such as at Old Glory No. 17 mine, the strip-

This Bobolink stripping unit is equipped with a 30-cu.yd. welded alloy-steel dipper with counterweight.



ping unit always makes a cut (65 ft. wider than the loading unit—which is limited to 42 ft.—can handle at one pass. At No. 17, consequently, the loader regularly takes the coal in two stages. No. 17 also is characterized by still another departure from usual practice: namely, the use of a Marion 461 diesel-electric loader with rheostatic control and 2½-cu.yd. Maumee-built dipper.

At Binkley, cut width has been narrowed to 28 ft. in the territory now being stripped because of overburden near the stripping limit and the presence of large quantities of rock. The No. 4 coal at this operation (30 to 49 in. thick, with an average of 36 in.) is overlaid by 1 to 40 ft. or more of sandy shales grading into sandstone, over which are clay and surface material. The shales and sandstones are not particularly hard but are very abrasive. In places, the top 8 to 10 ft. of clay and surface is underlaid by 2 to 4 ft. of quicksand. This quicksand, when saturated with water, frequently permits the top layer of material to slide into the pit, and the same material, when placed in the spoil, causes these banks also to slide.

Stripping at the Ayrshire pit. The 15½-cu.yd. dipper on this electric shovel replaced a 12-yd. unit. As holes are "double-decked," 8 to 10 ft. of shot material is left at the top of the bank, as detailed in the accompanying article.

How Slides Are Handled

As a result of this condition, two methods of handling slides have been employed. One was based on the use of a 12-cu.yd. LeTourneau "Carryall" scraper pulled by a Caterpillar RD-8 tractor fitted with a LeTourneau "Angledozer." The scraper first was used in the pit to pull the slide material into the spoil zone. But, while feasible under certain conditions, the material frequently formed an unstable base for the spoil dumped by the shovel. Consequently, the alternative of having the stripping shovel pick up the slide material and deposit it on the bank was adopted, where it is spread by the "Angledozer." Placing the material on the bank permits drainage and spreading it completes the drying job, in addition to facilitating handling by the shovel on the next cut. The scraper also has been used to help out the shovel by pulling top material out beyond the end of the cut, as well as for road building, ditch construction, etc.

Berm width carried in Indiana strip pits varies from as low as 15 ft. to as high as 35 ft. In general, however, where automotive transportation is employed (see p. 83), the berm width usually is sufficient to permit the haulage units to pass without difficulty and, if necessary, to turn on the berm, as the majority of the pits have but one haulage entrance.

Stripping shovels in Indiana usually make their cuts without assistance, even in the deepest overburden, although there are exceptions where utility draglines are called in when the overburden thickens. In case the shovel must go it alone, however, outside curves are arranged for, cut width is narrowed or both steps are taken. At the Staunton mine of the Electric Shovel Coal Corporation, on the other hand, when 50- to 55-ft. overburden must be moved, a Marion 37 dragline with 1¾-cu.yd. Page automatic bucket is moved onto the spoil bank where it drags back the material deposited by the shovel. The Maumee Collieries Co. keeps a utility dragline on hand not only for ditching, dam building, etc., at its various properties but also for helping out the shovels when they get in material much over 50 ft. The same limit is the signal for the use of a Bucyrus-Erie diesel dragline with a ¾-yd. bucket at the Friar Tuck mine of the Sherwood-Templeton Coal Co. At the Allendale pit of the Central Indiana Coal Co., however, equipment is on hand for regular tandem operation when conditions warrant. This equipment consists of a Bucyrus-Erie 320 electric dragline with 150-ft. boom and 8-cu.yd. bucket. This machine may work either on the bank or in the pit in taking off the clay and surface over the hard material.

Indiana also presents one example of recovery of two seams over the same area by stripping: i.e., at the Nos. 23 and 24 mines of the Maumee Collieries Co. (*Coal Age*, September, 1938, p. 29). The No. 4 seam operated by No. 23 mine is partly overlaid by a rider seam of good quality about 17 in. thick under an average of 16 ft. of overburden. Interval between the two seams is about 20 ft., and the rider operation is termed the No. 24 mine. Coal from the two mines is prepared on seperate days or separate shifts. As the character and thickness of the rider made its recovery desirable, a contract for stripping it was let to L. C. Miles, who employs a Page 620 walking dragline with a 100-ft. boom and 5-yd. bucket. Eventually, the shovel uncovering the No. 4 will work through the area in which the rider has been stripped and loaded, and in effect will handle practically the same overburden as if the rider had not been recovered to augment the output of the property.

As might be expected in a State which pioneered the method, Indiana uses the sidewall method of drilling overburden almost exclusively. This method of drilling was developed in 1930 at the Sherwood stripping properties (Sherwood-Templeton and Central Indiana—*Coal Age*, January, 1933, p. 7), while the Enos Coal Mining Co. and Patoka shortly afterward purchased the first commercial sidewall drills. One of the latest to adopt sidewall drilling was the Binkley Mining Co., which purchased a Sullivan "Stripborer" to replace two well drills. In overburden of about 40 ft. or over, containing as much as 30 ft. of material varying from sandy shales to sandstones, each well drill could put down about two holes per shift. Consequently, they were hard put to keep ahead of the

Spreading slide material on the bank at Bobolink mine.

stripper in addition to being difficult to handle in the soft material encountered on the bank, particularly in wet weather. With the new sidewall drill, eight 6-in. holes the depth of the cut (28 ft. at present) can be drilled per shift on 35- to 40-ft. centers, depending upon the thickness of the hard material, and particularly the sandstone. As a result, the drill easily is able to keep ahead of the shovel.

A number of companies, however, have made their own sidewall drills to suit their own convictions as to the proper design for their conditions, while others have adopted light-type gasoline or electric drills supplied by various manufacturers. At the Staunton mine of the Electric Shovel Coal Corporation, for example, a "Parmanco" three-speed gasoline-driven drill is used. Hole diameter is 5 in., and the machine has drilled as many as 8½ holes 40 to 50 ft. deep in soft sandstone and shale in seven hours. A similar drill, except with electric drive, is used at the Minnehaha plant of the Hickory Grove Coal Mining Corporation.

Overburden which can be dug without shooting is the exception rather than the rule in Indiana, which uses both fixed explosives and liquid oxygen to break it up so the shovels can handle it. As one of the few operations still shooting with vertical holes, and contracting its drilling, the Chieftain No. 20 mine of the Maumee Collieries Co. uses Hercules 60-per-cent gelatin to break up 3 to 8 ft. of limestone over a foot of slate resting on the coal. Hole spacing varies from 18 to 24 ft., and drilling is done only where the hard material is sufficiently thick to warrant it.

Hole spacing at the Staunton mine, where hard material varies from shale to heavy sandstone and the bank thickness averages 45 ft., ranges from 18 to 21 ft. As noted above, these holes are made with a horizontal drill and are 5 in. in diameter. King "Detonite" in 4x17-in. sticks is used for shooting. At the Bobolink mine of the Binkley Mining Co., where the cut width at present is 28 ft. and a horizontal drill is used, hole spacing is 35 ft. where the bank is 50 ft. thick and contains 40 ft. of sandstone. If the sandstone is thinner than 40 ft., hole spacing is increased to 40 ft. Holes are loaded with Atlas "Apex C" in special waterproof bags designed to prevent the entrance of moisture for a period of 80 hours. However, no shots are let stand more than 10 hours. Yield per pound of explosive at Bobolink is 10 cu.yd. of bank material. "Apex C" in 5x16-in. sticks also is used at Minnehaha, where an average of 35 ft. of overburden contains 12 ft. of shale and 10 ft. of sandstone.

Hole spacing at the Friar Tuck mine of the Sherwood-Templeton Coal Co. (horizontal drilling) varies from 17 to 21 ft. (5½-in. hole), depending upon the thickness of the bank and its make-up. In general, the coal at Friar Tuck is overlaid by 2 to about 8 ft. of shale, followed by 0 to 20 ft. of soft yellow sandstone. In some places, the sandstone, which shoots into sand, comes down onto the coal and replaces the shale. Holes are chambered if the bank condition warrants it, and are loaded with 40- or 60-per-cent gelatin, depending largely on height, where the holes are wet; otherwise with FFF powder in 4¼x16-in. cartridges weighing 8½ lb. each. Yield of bank material per pound of explosive varies from 9 to 12 cu.yd.

Shooting crews are furnished with charts giving standard explosives charges per hole adjusted in accordance with the nature of the hard material in the bank and its thickness. These charts, however, are only starting points, with the shooters themselves and the pit superintendents having the final say in the light of their knowledge of conditions and the results attained in terms of shovel performance. At the Allendale pit of the Central Indiana Coal Co., another Sherwood operation, black powder is used almost entirely for such overburden shooting as is required.

Shooting Supervisor Employed

The Patoka Coal Co. is one of several operations in Indiana where bank conditions warrant the employment of a special shooting supervisor to secure maximum results in breaking up the overburden, which averages 35 to 36 ft. but runs up to a maximum of 60 to 70 ft. in places. The coal is overlaid by slate with a maximum thickness of 3 ft., a gray shale, a streak of limestone, then more shale or in some places sandstone. Where bank thickness is over 35 ft., a rider seam comes in, followed by more shale. As a rule, clay and surface material make up 6 to 14 ft. of the bank thickness, with the remainder classed as shooting material. Hole diameter (horizontal drilling) is 5 in. Spacing varies from 16 to 25 ft., depending upon the material to be shot and the height of the bank. Where the bank thickness warrants it, holes are chambered to concentrate the explosive force at the back and thus kick out the material in loose condition. Holes are loaded with Trojan 40-per-cent and Trojan CC, and the yield of bank material per pound is approximately 10 cu.yd. Under Patoka conditions and using only horizontal drilling, the characteristics of these types of explosives, it has been found, enable the company to get the proper fracture of the harder material in the overburden without "double-decking": i.e., the drilling of a second series of holes on an upward angle over the regular horizontal holes.

Liquid oxygen is used for breaking overburden in the pits of the Enos Coal Mining Co., which pioneered this shooting method in the stripping industry in 1926 (*Coal Age*, April 7, 1927, p. 497). While the nature of the overburden varies from place to place at Enos, the coal in practically all cases is overlaid with

1 to 3 ft. of black slate, usually followed by 1 to 4 ft. of gray shale. In some places, the gray shale is overlaid by a 6-in. band of very hard rock, followed in some areas by 18 in. to 4 ft. of limestone. Over the limestone, where it occurs, is a shale layer with a maximum thickness of 10 ft. This is followed, in banks over 40 ft., by a rider seam, in turn overlaid by gray shale and surface material. In places, however, the materials enumerated above may be replaced by sandstone as thick as 30 ft. resting on the black slate over the coal. In other localities, the hard material may be made up of shales and sandstones with the limestone absent.

In view of the variations, overburden shooting must be carefully controlled. Consequently, an engineer is employed to lay out the drillholes with a transit, calculate the volume of the bank and fix the quantity of explosive in advance of shooting. Where the nature of the bank warrants it, drillholes are "double-decked," particularly in high banks where it is necessary to break up the material over the rider seam. In double-decking, the usual 6-in. horizontal holes are supplemented by a second row of holes, which are staggered with respect to the first and are drilled upward at an angle of as much as 10 deg. Angle holes are started at a higher level; if possible above a hard seam of rock if one is present in the desired position. L.O.X. cartridges as fired contain approximately 9 lb. of oxygen and 3 lb. of carbon, and the yield per cartridge for the year 1937 was 132 cu.yd. of bank material.

"Airmite" (liquid oxygen) cartridges used at the No. 11 mine of the Sunlight Coal Co. usually contain 11 lb. of oxygen when fired, and yield about 7½ cu.yd. per pound of active material. The coal at No. 11 usually is overlaid by 2 to 3 ft. of black slate, followed by a gray slate in which the 6-in. horizontal drillholes are placed. The gray slate is followed by thin shales and a limestone band about 1 ft. thick lying an average of 20 ft. over the coal. Above the limestone is more shale, overlaid by sandstone if present, followed by a brown sandy shale and clay and surface material. Hole spacing is 20 ft. in all cases.

Overburden at the Ayrshire stripping of the Electric Shovel Coal Corporation also is shot with "Airmite," the cartridges as fired containing 11 to 11½ lb. of oxygen and 3 lb. of carbon. Hole size is 6 in. and the spacing is 18 to 24 ft., which is governed by the depth of the holes primarily, with character of the overburden as another variable. Holes are drilled just over the characteristic No. 5 "steel band," if it is present.

Holes Double-Decked

A shooting supervisor also is employed at Ayrshire, and double-decking of holes is the usual practice in banks of 45 ft. or better. The coal is overlaid by about 2 ft. of gray shale, 2 to 4 ft. of slate, and shales of various kinds up to the rider seam, which generally is 20 to 22 ft. above the No. 5 coal being stripped. Over the rider in the lower banks is gray shale, sandy shale and surface material; in high banks, gray shale, sandstone, sandy shale and surface.

While some double-decking may be done in bank under 45 ft. thick, depending upon the material encountered, it usually is necessary over that limit because then the material over the rider hardens sufficiently to give trouble in digging. In shooting with horizontal holes, the rider apparently acts both as a cushion and a plane of separation, with the result that when horizontal holes only are employed the material over the rider is for all practical purposes merely lifted up slightly to settle back in large masses.

In double-decking at Ayrshire, horizontal holes are drilled 4 to 6 ft. above the coal. Angle holes are started about 4 to 5 ft. above and are staggered as compared with the horizontals, and the angle is adjusted so that when the hole is drilled to the limit from 10 to 20 ft. is above the rider. This brings the charge fairly well toward the front of the bank and in the absence of some preventive measure would tend to result in said front being kicked forward more or less in a mass rather than broken up. So the practice at Ayrshire is to leave a layer of shot material from the previous cut against the bank, as indicated in Fig. 1, to provide sufficient resistance to allow the explosive charge to break up the material rather than just move it out. By adjusting the shovel cut, the shot material is feathered down from 8 to 10 ft. at the top of the bank to 1 to 2 ft. at the drilling level, so that the drill does not have to go through too much loose material. Yield at Ayrshire is 9 to 10 cu.yd. of bank material per pound of oxygen.

Double-decking also was inaugurated this summer at Maumee's Old Glory No. 17 mine, particularly where the shale runs 35 ft. or thicker, which frequently is the case. In the Old Glory double-decking, the charge previously loaded in one 6-in. horizontal hole now is split between a horizontal and an angle hole, with the result that the output of screenings has been reduced approximately 10 per cent: i.e., the screenings percentage was reduced 10 points from the former figure. Other results were a reduction in the quantity of explosive required and a gain of 5 ft. in width per cut, due to the fact that the dragline is able to work to the full depth of the holes, in addition to the best digging condi-

Fig. 1—"Double-deck" shooting plan used at Ayrshire mine.

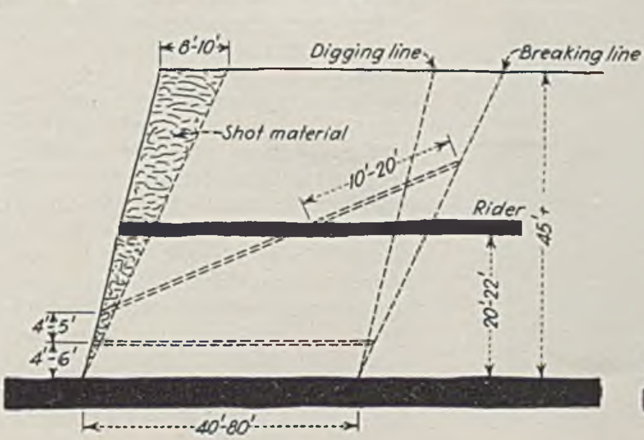
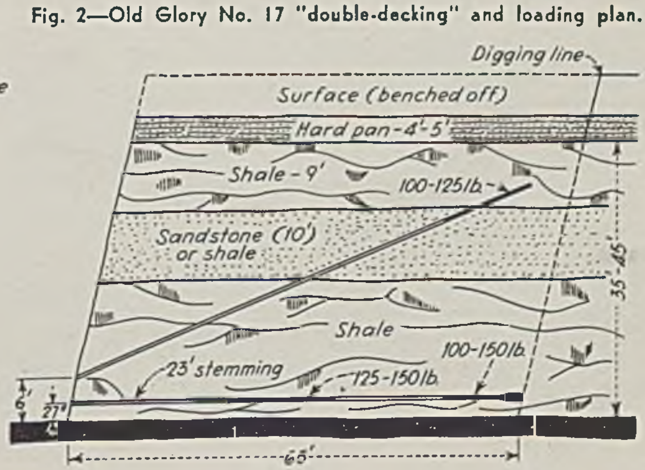


Fig. 2—Old Glory No. 17 "double-decking" and loading plan.



tions for the dragline in the history of the operation.

As noted earlier in this article, overburden thickness seldom is less than 50 ft. at Old Glory, and the material seldom includes less than 35 ft. of tough shale with, in some places, sandstone next to the top of the bank as an added starter. Where the sandstone occurs it is about 10 ft. thick and lies about as indicated in Fig. 2. Under the previous shooting system, horizontal holes were drilled 65 ft. deep (the usual width of the cut) on 25-ft. centers, and were charged with 400 to 450 lb. of 40-per-cent gelatin. Even with this loading, good fragmentation of the shale (and sandstone, if present) was hard to secure, and in addition the coal was subject to severe shock. Furthermore, the bank tended to break up at the back on a line slanting toward the front edge, which resulted in a loss of about 5 ft. in cut width to get the proper bank slope.

Under the present system, horizontal holes on 25-ft. centers are drilled 65 ft. deep about 2½ ft. above the coal. Then angle holes are drilled directly above each horizontal hole, starting about 6 ft. above the coal and going upward on a slope of about 1 to 2 or 2½. The angle hole in each case is drilled to a point about 1 ft. beyond the end of the horizontal hole. In the first cut to be double-decked, horizontal and angle holes were staggered, with the result that where double-decking was discontinued, one hole was left with an extra burden, so it is planned to drill the holes one above the other in the future.

The horizontal hole is chambered at the back to accommodate 75 lb. of Hercules 40-per-cent gelatin in 4½x16-in. sticks weighing 12½ lb. per stick. Then 25 to 75 lb. more is strung out in front of the chamber charge, after which a space is left and a column containing another 125 to 150 lb. is placed. Twenty-three feet of stemming always is placed in front of this second column, any difference in column length resulting from a variation in charge being taken care of in the gap between the two charges. Dividing the explosive in the horizontal hole into two charges in this fashion brings part of the force out to the front to break up that part of the cut. Otherwise, with the depth of hole used, the result would be excessive fragmentation in the back and poor breakage in front. Even where double-decking is not the practice and the overburden is shot with horizontal holes only, the charge still is split, a particularly important point when, as sometimes is the case, the shale thins down and thus makes the distance upward after the surface is benched off substantially less than the depth of the hole, with resultant unbalance of burden.

The angle-hole in double-decking is loaded with 100 to 125 lb. of explosive in a single column at the back of the hole. In addition to generally better fragmentation, this hole also breaks the overburden back to the proper bank slope and enables the dragline to dig to the full width. Yield at Old Glory No. 17 is 5 cu.yd. of bank material shot per pound of explosive. This yield is a rough approximation of the relative fineness to which the material must be broken for dragline stripping, as compared with shovel stripping, where much larger pieces may be handled without too much difficulty.

For more efficient shooting, overburden holes at Enos are spotted with a transit, and yardage and charge per hole are figured by an engineer.

Coal cleaning in the pit in Indiana follows very closely conventional practice, in which roughing is done with tractors (such as the Caterpillar or International types) and some form of bulldozing equipment (such as Bucyrus-Erie or LaPlante-Choate bulldozers, Bucyrus-Erie "Bullgraders," LeTourneau "Angledozers," etc.). In tractors, the trend is toward the use of diesel types. Bulldozing completes the job at operations where the coal is washed. If hand-picking and screening are the practice, bulldozing usually is followed by hand shoveling and brushing or brooming, with air in a very few instances as an added starter.

Shooting Before Loading

Indiana operations are divided about 50-50 on shooting the coal before loading. Where this is the practice, air drills commonly are used, although a few companies have changed to electrically operated vertical coal augers. This list includes Enos (Hardsocg drills) and the Binkley Mining Co. The latter has built its own coal auger and has found in using it that drilling is faster and there is less trouble with holes clogging.

Pellet powder with electric squibs are almost universal for shooting coal, although there are some exceptions, such as at the Clinton mine of the Electric Shovel Coal Corporation, where duPont FF powder is employed. At the Sunlight Coal Co. mine, U. S. pellet in 2x10- and 2x8-in. sticks is used. Squibs are placed in the 2x10 sticks at the factory. Usual loading, with an 8- to 10-ft. hole spacing, is one 2x10 stick in coal 4 ft. or under, and one 2x10 and one 2x8, or fraction thereof, in coal over 4 ft.

Pit dewatering in Indiana also follows what might be called standard practice, with main ditches and laterals, together with dams, embankments, etc., on the bank to catch and carry off surface water and water pumped out of the pits. Portable electric pumping units usually are employed in pit dewatering. Pump discharges are in almost all cases of the hose type, although steel or spiral-welded pipe is employed in some installations, particularly where the pump is in a permanent or semipermanent location. Portable pump size runs from 2 to 6 in. as a general rule, with a few larger units at permanent sumps. Some 1- and 1½-in. pumps are used directly behind shovels where conditions warrant them.

TRANSPORTATION

+ At Indiana Strip Mines

TRANSPORTATION at Indiana strip mines employing shovels with large-capacity dippers for removing overburden has been characterized in recent years by wide changes to automotive equipment in line with the trend in the industry generally. Several steam-haulage installations, however, still operate where the coal is regular in its lie and fairly thick—conditions tending to favor steam haulage over the automotive type. Indiana also possesses three dual-haulage installations: i.e., installations in which coal is hauled from the pits to a field transfer station where it is loaded into rail equipment for the final stage to the preparation plant. In two of these installations, steam equipment is used in the final stage, while in the third, special electrically operated trains are employed over a 4½-mile haul.

Straight steam-haulage operations include the Ayrshire and Staunton mines of the Electric Shovel Coal Corporation; Chieftain No. 20 mine, Maumee Collieries Co., and the Friar Tuck and Robin Hood Mines, Sherwood-Templeton Coal Co. Heisler geared locomotives are used in all cases, with Chieftain No. 20 and Staunton employing standard railroad cars. At Ayrshire, where the round-trip haul is four and five miles to the respective pits, 44-ton A.C.F. drop-bottom cars (25 in number) are made up in trips of five, each with locomotive. These five haulage units handle 3,700 to 3,800 tons of cleaned and prepared coal in seven hours. At Staunton, three engines handle about 1,500 tons (shipped coal) per shift over a round-trip route of seven miles. Sanford-Day 40-ton or standard railroad cars are used at Friar Tuck, where the round-trip haul is about two miles and the output is about 2,300 tons of prepared coal per shift, representing about 3,000 tons of mine-run.

In the majority of the Indiana pits, however, automotive haulage, either alone or in combination with rail haulage for the final stage, has shown definite advantages from the standpoints of both cost and practibility. In many cases, extremely rolling conditions of the coal bed are encountered, with grades up to 25 per cent or more, which pose an almost impossible problem for steam equipment. The greater flexibility of automotive units enables them to cope better with these extreme conditions, although, as previously stated, level and fairly thick coal may throw the advantage to steam locomotives and large-capacity cars.

Where conditions are favorable, cost savings resulting from a change to automotive haulage may be substantial. At the Old Glory No. 17 mine of the Maumee Collieries Co., for example, where steam stripping and loading equipment was abandoned when operations were transferred to a new coal area with thicker overburden, the adoption of automotive haulage brought the cost per ton down to around 7c., as compared with 16c. for the year ended Aug. 31, 1937, during which steam equipment was employed. Coal is hauled at Old Glory in two 20-ton Austin-Western trail cars pulled by Walter four-wheel-drive tractors, assisted by a third International 10-ton end-dump truck, which hauls refuse from the tipple to the pit and returns with a load of coal. Having the refuse-disposal truck haul coal on the return trip is almost universal practice in the State.

Details of the other semi-trailer operations in the State are given in Table I. At the No. 11 mine of the Sunlight Coal Co., where coal at least as rolling as any in the State

Loading 44-ton standard-gage cars in one of the Ayrshire pits.

30-ton truck unit at Sunlight receives its load. Note pitch of coal.

Tandem haulage units in one of the Patoka pits.

is encountered, the management adopted the straight truck in 1935 (*Coal Age,* May, 1936, p. 189), deeming it even more flexible than the tractor - semi - trailer combination. These trucks (Mack "AC") were equipped with a W-shaped body of the coal company's own design, with two air-operated side-discharging doors on each side of the body. Capacity of the bodies installed in 1935 was 15 tons. In October, 1937, in view of the successful operation of the eight smaller units, two 30-ton trucks substantially similar in design but with tandem driving-wheel sets, were put in service. The ten Sunlight trucks deliver around 4,000 tons of mine-run to the tipple per shift, yielding around 3,100 to 3,200 tons of cleaned, screened and shipped coal. The round-trip haul is approximately four miles.

Automotive haulage was first introduced in Indiana in the summer of 1934 by the Patoka Coal Co., which also operates one of the three dual systems in the State, as well as the only tandem haulage units. Production comes from two pits at Patoka. Loading equipment in one pit is served by seven International tractors, each pulling one 20-ton Sanford-Day semi-trailer and one similar 11-ton full trailer. At the other pit, the loading shovel is served by either three or four tandem haulage units consisting of an International tractor, a 16-ton semi- and a 16-ton full trailer.

Tractor-trailer units haul to field transfer stations on the Algiers, Winslow & Western R.R. These stations consist of dump hoppers and car-loading conveyors. One station is two miles from the pit and six miles from the tipple, while the other is half a mile from the pit and three miles from the tipple. Coal moves over the A. W. & W. to the tipple on a milling-in-transit rate. The ten or eleven haulage units at Patoka handle 3,000 to 5,000 tons per shift, depending upon the season or other conditions, with the maximum number in use usually in winter.

At the Allendale pit of the Central Indiana Coal Co., pit haulage is performed by four White tractors, each pulling a 15-ton Sanford-Day semi-trailer, and two Euclid tractors with Euclid semi-trailers. One Euclid unit is diesel-powered and was put in service on the strength of experience at the affiliated Little John Coal Co., in Illinois, which indicates a substantial saving both in cost of fuel per gallon and in consumption per mile as compared with gasoline. The six tractor-trailer units handle about 2,650 tons of mine-run (about 2,000 tons of cleaned and shipped coal) per shift over a 1.8-mile round-trip haul to the field transfer station. From the transfer station the coal is taken 3½ miles one way to the preparation plant in 36-in.-gage Sanford-Day drop-bottom cars pulled by rod locomotives. Two reasons were back of the installation of automotive equipment at Allendale. One was to obtain information for the guidance of the management in the future and the second grew out of the fact that making a proper entrance to the pit for steam equipment would involve the sacrifice of too much coal.

Use Dual-Haulage System

The Enos Coal Mining Co. went on the dual-haulage basis in January, 1935, using one 40-, one 37- and four 31½-ton rod locomotives and 150 5-cu.yd. two-way side-dump cars (exclusive of spares) for the haul from the transfer station to the tipple, a distance of 4.508 miles. Steam was continued on a provisional basis only, however, with the idea that it would be replaced if another medium could be found that would offer a reduction in prevailing cost, in which maintenance of the steam locomotives and small cars then in use was no mean item. Electric haulage finally was chosen and went into operation in June, 1937, with a saving of 50 per cent in main-haulage cost (*Coal Age,* April, 1938, p. 50).

Pit haulage at Enos, where two stripping and loading units are in operation, is part company and part contract. Company equipment consists of eight Autocar tractors pulling 20-ton Austin-Western trail cars. Contract haulage equipment comprises four Ford trucks with 10-ton side-dump bodies and three International tractors pulling 10-ton Sanford-Day bottom-dumping semi-trailers. Average round-trip haul for company equipment is 2½ miles, and the fifteen units deliver, when all are in service, from 4,500 to 5,000 tons of coal (shipped basis) to the transfer station in a shift. The dump hopper at the station is arranged with two openings to accommodate both the side- and bottom-dumping equipment. From this hopper a conveyor elevates the coal to a train-loading hopper equipped with four feeders for the actual loading operation. Train-loading capacity with the four feeders running is 30 to 40 tons per minute, although the capacity of the elevating conveyor connecting the dump and train-loading hoppers is only 1,100 tons per hour.

From the transfer station to the tipple the coal is hauled in times of maximum demand by three electric trains, each consisting of a Differential electric locomotive, supplying the tractive power and also carrying a pay load, and three cars. Both cars and locomotives dump to either side. This summer, however, one train was removed from service, two of the cars being taken from it and added, one to each, to the other two, making the summer trains each consist of the locomotive and four cars. Cars and locomotives each have a level-full capacity of 30 tons, but the average loading is around 36 tons in actual practice.

With three trains in operation, the electric system is designed to haul an average of 5,000 tons (shipped coal) in seven hours over a one-way distance of 4.508 miles. The three trains actually, however, have handled as much as 5,300 tons in seven hours. Round-trip running time, in the absence of waiting on coal or other delays, is approximately 28 minutes, including loading, dumping and running in both directions. Track gage is 36 in.

Enos field transfer station, with one of the electric trains loaded ready for its 4½-mile trip to the preparation plant.

From the standpoint of gasoline consumption by automotive equipment, the average apparently does not exceed ½ gal. per mile, or, putting it another way, operators get a maximum average of about two miles per gallon. The low for tractor-trailer combinations reported in the course of the *Coal Age* survey was 1½ miles per gallon average at the Allendale pit. Mileage per gallon, however, is subject to wide variations in accordance with grades, condition of road and weather—the last

Table II—Steam-Haulage Data for Certain Indiana Strip Mines

	Type	Engine Weight, Tons	No. in Use	Type Cars	Car Cap. Tons	Avg. Round-Trip Haul, Miles	Avg. Daily Mine Output, Tons*
Electric Shovel Coal Corporation:							
Staunton	Heisler	42	3	R. R.	50	7	1,500
Ayrshire	Heisler	42	5	A. C. F.	44	4 and 5	3,700–3,800
Maumee Collieries Co.:							
Chieftain 20, Pit A	Heisler	50	2	R. R.	50	2	2,650
Sherwood-Templeton Coal Co.:							
Friar Tuck	Heisler	40	...	Sanford-Day or R. R.	40 or 50	2	2,300

* Cleaned and prepared coal ready for shipment, which may in certain cases represent as low as 75 per cent of the mine-run total.

Table I—Automotive-Haulage Data for Certain Indiana Strip Mines

	Type Truck	Type Tractor	Type Trailers	No. Units in Use	Avg. Round-Trip Haul, Miles	Avg. Miles per Gal. Gasoline	Avg. Daily Mine Output, Tons*
Maumee Collieries Co.:							
Old Glory No. 17	....	Walter	Austin-Western, 20-ton	2†	2	2	1,250
Maumee No. 23	....	Autocar	Austin-Western 21½-ton	3†	1½	...	2,000
Electric Shovel Coal Corporation:							
Clinton	....	Autocar	Austin-Western, 20-ton	3	3¼	...	1,500
Binkley Mining Co.:							
Bobolink	....	White	Sanford-Day, 16-ton	5	1.37–1.63	...	2,000
Hickory Grove Coal Mining Corporation:							
Minnehaha	....	Autocar	Austin-Western, 20-ton	3	¾	1¾	1,900
Sunlight Coal Co.:							
No. 11	Mack 15-ton	....	....	8	4	1.6	3,100–3,200
	Mack 30-ton	....	....	2	4	1	
Enos Coal Mining Co.:							
Company	....	Autocar	Austin-Western, 20-ton	8	2½	2	4,500–5,000
Contract	Ford 10-ton	....	....	4	...	...	
	....	International	Sanford-Day, 10-ton	3	...	...	
Central Indiana Coal Co.:							
Allendale	....	White	Sanford-Day, 15-ton	4	1.8	1.5‡	2,000
	....	Euclid	Euclid, 15-ton	2	1.8		
Patoka Coal Co.:							
Patoka	....	International	Sanford-Day, 20- and 11-ton	7	4	2	2,200
	....	International	Sanford-Day, 16- and 16-ton	3 or 4	1	2	3,300

* Cleaned and prepared coal ready for shipment, which may in certain cases represent as low as 75 per cent of the mine-run total.
† Coal also is hauled on the return trip by a 10-ton International end-dump truck, which brings refuse to the pit.
‡ Exclusive of one diesel-powered Euclid unit.

a major item. Consequently, while at Patoka, for example, the average is two, the range is 1 to 3 miles per gallon. At Sunlight, using straight trucks, the average is 1¼ miles per gallon for the 15-ton units and one mile for the 30-ton jobs.

Tire mileage is as yet a matter of speculation at some operations where automotive equipment has been installed only recently. At Sunlight, however, considering only the 15-ton straight trucks, the 13x24 rear tires give 10,000 to 12,000 miles, with 14,000 for the 11.25x24 front tires. On the semi-trailers at Allendale, 13.50x24 tires have a life of 18,000 to 20,000 miles, while the 18x24 casings give 25,000 miles. Patoka tractors are fitted with 10.50x20, 11.25x20 and 11.25x24 casings, with a life of around 16,000 miles. Trailers (semi- and full) are fitted with 9.75x20, 10.50x20 and 12x24 casings, which average 24,000 miles.

Runway systems are in the minority in Indiana. Bobolink, however, normally employs runways through the spoil area, while at Patoka the greater part of the operations are reached by runways through the spoils, which eliminate turning haulage equipment in the pits and thus reduce the round-trip time. At all other strippings operations, the practice is to enter the pit at one point and operate on the coal thereafter, although occasionally empty haulage units may come in on the bottom. Loaded units, however, invariably run on the coal, unless in emergency.

Main-Haulage Road Costs

Main-haulage roads are built in several fashions in Indiana, the cost running as low as $4,000 per mile and up to $10,000 or more, depending upon width, type of material employed, how much fill and how many bridges must be constructed, etc. At the Clinton mine of the Electric Shovel Coal Corporation, the road is "red dog." Old Glory No. 17 mine and the Minnehaha mine of the Hickory Grove Coal Mining Corporation use red dog with a gravel surface.

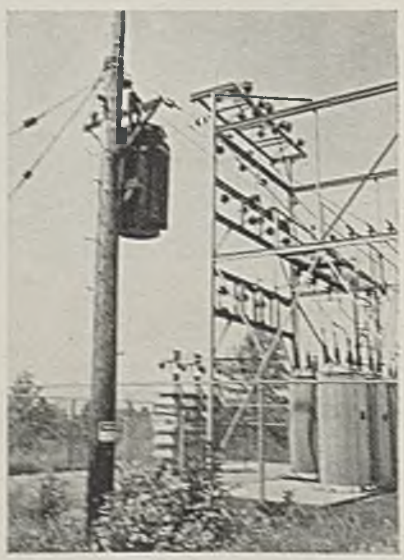
At Sunlight, where the main road involved considerable fill-and-dam construction, the base is 1½ to 2 ft. of preparation-plant refuse. Over this is laid about 7 in. (after rolling) of crushed limestone, as follows: 4 in. of 4x1½-in. limestone on the gob, then 2 in. of 1½x0, followed by a top dressing of ½x0. About 1 lb. of calcium chloride is applied per square yard to stabilize the road surface.

Pit rock, either one-man or run-of-the pit size, seems to be the most popular road-base material in Indiana. Patoka, for example, puts down about 3 ft. of pit rock and follows this with 3 to 4 in. of crushed limestone dressing. At Bobolink, about 2 ft. of run-of-pit sandstone is laid down and dressed with 1 ft. of red dog. Such roads cost about $8,000 per mile to build. At Enos, one-man rock is laid 12 to 15 in. thick on the subgrade and is followed by 6 in. of gob. The gob then is covered by a layer of cinders to fill the voids, and finally the road is surfaced with 3 to 4 in. of crushed limestone (about 1½x2½ or 3 in.). Cost on this basis is about $6,000 to $7,000 per mile.

ELECTRIFICATION

+ Indiana Strip Mines

ELECTRICAL - ENERGY consumption at the larger stripping operations in Indiana ranges between 5 and 14 kw.-hr. per ton of coal shipped, depending on the thickness and character of the overburden and the regularity of running time. These figures include the power used for the mechanical cleaning plants, which represent 20 to 50 per cent of the total energy consumption. Net costs at mines purchasing from non-affiliated power companies* range from 0.97 to 1.40c. per kilowatt-hour. During the last nine months of 1937, Indiana strip operations reporting to the National Bituminous Coal Commission had an average purchased-power cost of 6.88c. per ton. Mine-fuel cost was 1.03c. Strip mines in the neighboring State of Illinois spent an average of 8.36c. per ton for purchased power during the same period. The mine-fuel outlay was 0.04c.



Reactor mounted on pole adjacent to power company's substation at Enos mine.

The voltage received by the coal company's line at the main transformer substation usually is not less than 4,160, with upper limits of 4,700 to 4,800 volts. Four thousand volts (nominal) is used to drive the synchronous motors of the m.g. sets on the large stripping shovels. Although 440 volts is usual for the loading shovels, Chieftain No. 20 mine of the Maumee Collieries Co. uses 2,300 volts for a 4-yd. Marion 490 loader and 4,000 volts is used on a Bucyrus-Erie 75B machine at Bobolink mine of the Binkley Mining Co. and on a Marion 482 loader at the Minnehaha mine, Hickory Grove Coal Mining Corporation. With the exception of one company using 220 volts, the standard for other pit equipment, such as pumps, drills and channeling machines, is 440 volts.

Consumes 7,742,200 Kw.-Hr.

Consumption at the Enos mine—the State's largest single stripping operation—for the twelve months ended July 31, 1938, was 7,742,200 kw.-hr. During that period production was 1,015,363 tons. The Enos power load includes not only shovels and preparation plant but also a 4¼-mile electric haul from the truck-dumping station to the preparation plant. Power at 600 volts d.c. to operate the electric trains is generated at a substation near the center of the haul. This substation has two 300-kw. synchronous motor-generators with manual control. The Differential electric trains are driven by two 125-hp. G.E. motors connected to the front trucks of the load-carry-

* All the Indiana strip pits covered in this Coal Age study use purchased power. Two strip and four shaft mines are supplied by the Antioch Power Co., which is controlled by the same interests that own these particular stripping operations. See article on "Power Generation," page 108 of this issue.

ing locomotives only. Operating details of this transportation system, which is credited with cutting main-haulage costs in half, are given on page 83 of this issue.

Strip-Shovel Power Demands

Strip-shovel power requirements in Indiana range from 2.67 to 3 kw.-hr. per cubic yard of overburden removed. More material is handled per kilowatt-hour in thicker cover because dippers are more easily filled and less cleaning up is required. Maximum 15-minute demands of 1,500 kw. and greater are registered at mines with two electric strippers. The largest Indiana stripper—the 30-yd. Bobolink machine—has a 1,000-hp. 4,000-volt synchronous motor driving the m.g. set and carries a total of 33 motors and generators exclusive of two fractional-horsepower motors.

Use of a pole line with laterals is general practice at Indiana stripping operations. Three of the Maumee pits, however, use field cables instead. One mile of main cable in 900-ft. lengths is the maximum, and this cable system is fed by a pole line from the main substation. Both trenchlay and spiral wire-armored cables have been installed, but the former is preferred at the Maumee pits. Two 900-ft. all-rubber field cables, however, are now being tried out. The 900-ft. field cables at Linton Supreme No. 23 and Old Glory No. 17 are connected by G.E. portable junction boxes. Each has two 4,000-volt multi-pole outlet plugs to serve pit equipment. An oil switch which controls the feed to both plugs is mounted on the same sled as the box. Mine-made junction boxes with Anderson plugs are used at Chieftain No. 20 mine.

Where pole lines are used instead of field cables it is customary to space the laterals 750 ft. apart, with an oil switch between the lateral pole line and the shovel cable. An oil switch also is used in the 4,000-volt feed to the loader or to transformers supplying the loader or other pit equipment. At one large pit, however, the rubber-covered strip-shovel cable is connected directly to the wires of the lateral pole line without an oil switch or fused cutouts in the circuit between cable and pole-line wires. At two pits of another operation, only fused cutouts are used in the circuit and these are carried in a low sled-mounted wooden box kept within 20 to 30 ft. of the end pole of the lateral line.

Oil switches generally are back in the field and usually close to the end of the lateral line. Maumee, however,

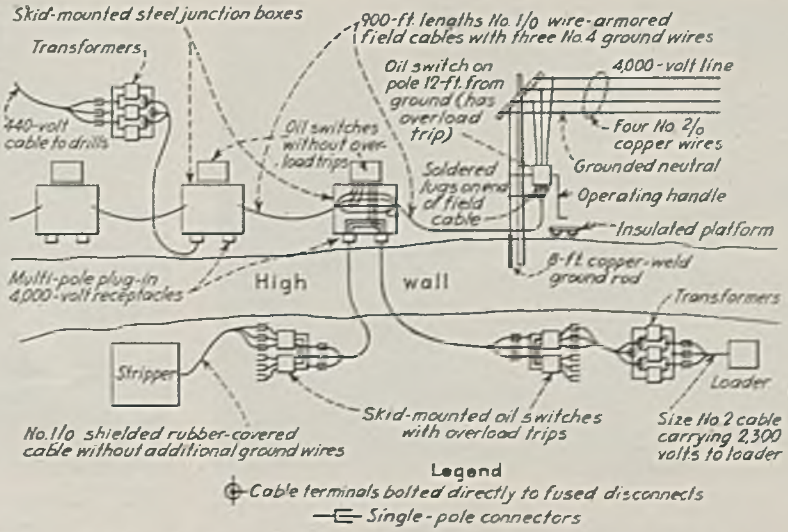


Fig. 1—Schematic diagram of pit service at Chieftain No. 20 mine, Maumee Collieries Co.

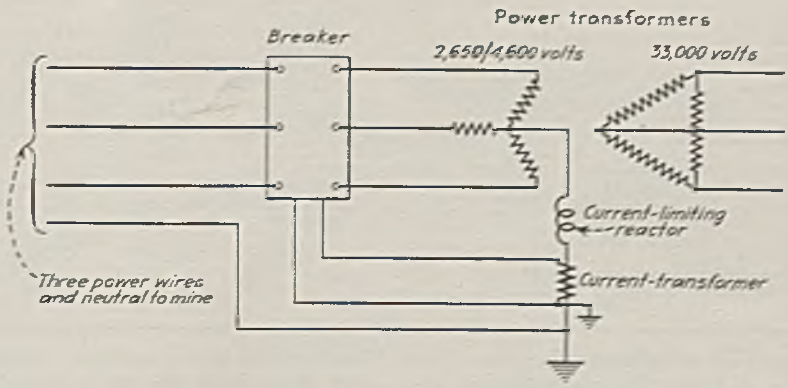
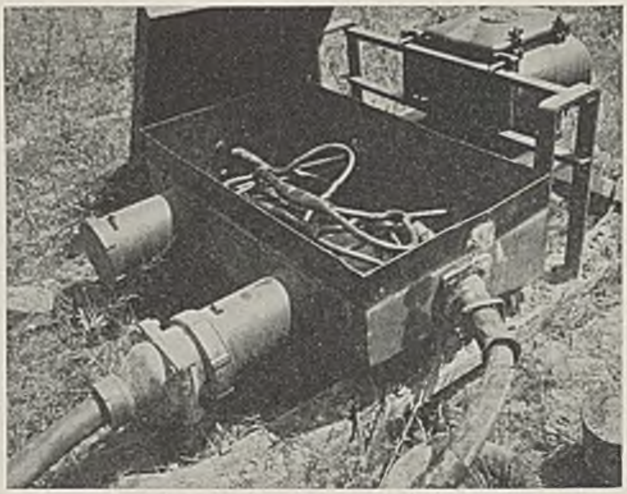


Fig. 2—Indicating connections of current-limiting reactor at transformer substation to reduce danger from shock.

Pit breakers mounted in pairs on a skid are standard practice in feeding strippers and other pit equipment at the Maumee mines.

Portable junction box and drill transformers "in the field" at Maumee's Chieftain No. 20 operation.



Cover removed to show permanent connections inside of a Chieftain No. 20 field cable junction box.

Table I—Power Requirements at Strip Mines of Sherwood Interests

	May, 1938	June, 1938	July, 1938
Allendale Mine—Central Indiana Coal Co.:			
750B stripper, kw.-hr.	52 300	63,900	61,000
Other pit machinery, kw.-hr.	32,500	20,900	14,200
Tipple, kw.-hr.	34,960	25,840	25,840
Total power used, kw.-hr.	119,760	110,640	101,040
Tonnage shipped	17,477	13,266	16,718
Kilowatt-hours per ton of coal	6.84	8 35	6 05
Cubic yards stripped	129,340	171,425	156,705
Cubic yards per kilowatt-hour used by stripper	3 97	2 68	2 56
Friar Tuck Mine—Sherwood-Templeton Coal Co.:			
750B stripper, kw.-hr.	90,900	105,800	89,400
Other pit machinery, kw.-hr.	15,500	65,500	30,400
Tipple, kw.-hr.	106,400	171,300	119,800
Total power used, kw.-hr.	212,800	342,800	239,600
Tonnage shipped	21,364	26,296	25,093
Kilowatt-hours per ton of coal	10 0	13.5	9 55
Cubic yards stripped	184,448	328,845	197,933
Cubic yards per kilowatt-hour used by stripper	2 03	3 10	2 21

sets these switches in the pits where they are easy to reach in case of trouble. Two oil switches are mounted on each sled and the 4,000-volt terminals, both incoming and outgoing, are Miller single-pole connectors. All connectors on the sled at Chieftain No. 20 are female, but the incoming connectors at Linton Supreme No. 23 are male. Use of male connectors on the pit oil-switch end of the power cable coming down over the high wall at No. 20 was adopted because the female connectors formerly used were plugged with dirt when the cables were disconnected and moved along the wall.

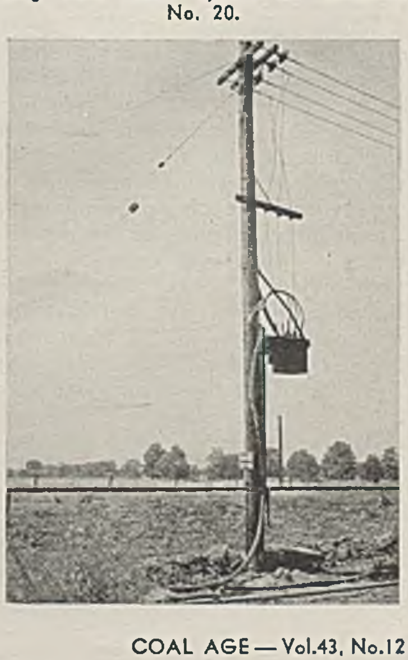
Trailing cables with and without conductors shielded against corona are used to carry 4,000-volt power. Some companies who were early users of shielded cables now buy the unshielded type because of maintenance difficulties encountered with the shielded cable. The largest trail cable now in use is a No. 2/0 unit which was part of the original equipment on the 30-yd. shovel at Bobolink. Each conductor consists of 259 strands, not shielded, and the cable contains three No. 6 23-strand ground wires. Most large strippers, however, now use No. 1/0 cable, as the difficulties of handling the larger cable are considered to outweigh the advantage of a lower voltage drop.

Solid neutral systems—i.e., a neutral wire from the grounded center of the star-connected main substation transformer secondaries to the stripper frame—are used by Binkley, Maumee and Enos. Addition of the neutral wire is under consideration by two other companies. To reduce the chances of shock, with resultant serious or fatal injury from contact with high-voltage equipment, some companies are installing reactors in the solid neutral to limit the voltage from strippers or other 4,000-volt equipment to ground in case of a grounded phase conductor.

The first such installation in a coal stripping in this country was made last February by the Sunlight Coal Co., which was followed by Enos. The Sunlight reactor—a G. E. unit—is rated 50 amp., 2,360 volts, 135 kva. and is designed to hold the potential from the stripper frame to about 100 volts in case of a grounded cable or motor. A 5-second ground relay at the power-company substation is set to open the power-company oil circuit breaker at 43 amp. neutral current. One-second relays at the pit circuit breakers will open the latter at 20 amp., thus preventing the opening of the main substation breaker except as a last resort.

Wooden sled-mounted switch houses large enough for a man to enter and stand at full height are in limited use in the "field" at two pits. From the standpoint of safety, of course, these houses have a distinct advantage over the low-type steel switch house when making connections during heavy rains or when the ground is sloppy and wet. Usually these houses contain only a set of disconnects and open overhead buses to which the pit cables are attached by hot clamps. Principal disadvantages are the liability to fire set by an arc and their size and weight limit portability, although a team of horses can drag the wooden house over any ordinary ground.

Pole terminal breaker feeding the mile-long field cable system at Chieftain No. 20.



An innovation in a portable oil switch for use in the stripper cable is a two-man-carry wood-covered low-type unit introduced at the Ayrshire mine (see p. 111). This unit serves as the connection between the 750-ft. stripper cable and a 350-ft. cable extending to the end of a lateral pole line. This oil-switch unit usually is in the pit within quick reach, but in some cases where access to the top of the high wall is easy the switch is placed in the field close to the wall.

Total connected load at the larger strip mines operating two pits is between 2,500 and 4,500 kw. Because the strip shovels generally work 24 hours per day, the load is a desirable one for the public utility. Except for a few old steam shovels still in use, the larger companies now do all their stripping by electricity. Diesel and "oil-burner" power are preferred by the smaller producers, principally because the areas they work are too small to justify the use of electric-power lines.

MAINTENANCE AND SUPPLIES

+ Indiana Strip Mines

WHEN $250,000 or more is invested in one machine and upon that machine depends the entire production of a plant, it is fundamental that the machine be operated with a minimum of delays; proper maintenance, therefore, is imperative. That is the situation with a big stripper, and successful maintenance depends more upon prevention of breakdowns than upon details of methods employed to make the actual repairs. Since even on the best regulated jobs there is a normal wear and repetition of strains which require replacements and repairs of certain parts, it also is important to find the best and quickest ways to handle these jobs.

Introduction of light-weight aluminum or high-tensile-steel buckets to increase digging capacity has intensified the maintenance problem because these buckets are more affected by unnecessary punishment. The Sherwood-Templeton and Central Indiana companies, for example, meet this situation with strict rules governing handling of the strippers. Overburden must be shot properly so that the shovel is not called upon to break up strong materials. Dippers must not be bounced when hard digging is encountered. Operators are not allowed through haste or carelessness to slap the doors.

Two operators are on duty for each of the three shifts. They do one-hour turns at the controls and so are always alert to drive the equipment to its full capacity and do it with the utmost regard for its well-being. The "off" operator oils and inspects the machinery and descends to the ground to supervise all moves. All maintenance is under a shovel foreman who is experienced in the actual operation of the machines. The Enos Coal Mining Co. also uses two operators per shift but does not require that one go on the ground during moving. Repairs on 11-cu.yd. aluminum buckets used by the Sunlight Coal Co. on two Marion 350 electric shovels consist principally of renewing the steel linings, teeth and other wearing parts.

Welded dippers having doors and bodies of USS "Man-Ten" alloy steel are in use on three-fourths of the large strippers operating in the State. Specifications for this alloy are: carbon, 0.35 per cent; manganese, 1.25 to 1.70 per cent; silicon, 0.10 to 0.30 per cent; copper, 0.01 to 0.25 per cent; molybdenum, 0.00 to 0.40

Arc-welding the 30-yd. dipper at Binkley's Bobolink strip mine.

The Clinton-mine stripper was completely rebuilt in 1938.

Painting the trenchlay field cables at Linton Supreme No. 23 to reduce abrasion of the jute covering.

per cent; vanadium, 0.00 to 0.20 per cent; tensile strength, 90,000 lb. per square inch; yield point, 55,000 lb. per square inch; elongation in two inches, 20 per cent.

Hard-facing dipper teeth with tungsten-carbide materials has been tried. Use of two-part dipper teeth with renewable points is now the standard practice over the State. On loaders, the points usually are sharpened by "forging out" at a low heat which will not destroy the structure of the steel. Stripper points usually are junked when worn short and dull and are replaced by new points. On the 30-yd. bucket at Bobolink mine of the Binkley Mining Co., where an extremely abrasive sandstone is being handled, the performance per set of six points was increased from 60,000 cu.yd. to 300,000 cu.yd. by changing from the original steel to heat-treated manganese steel. A point weighs 50 lb. and a tooth base wears out six points. The Patoka Coal Co. now uses Kensington "Eversharp" teeth, which have to be changed only every 500,000 yd. and therefore have made it possible to discontinue the practice of building up teeth.

Builds Up Dipper Teeth

One exception to the practice of not repairing the points of stripper teeth is the Maumee Collieries Co., which at its central shop at Jasonville builds up all dipper teeth by arc welding with "Manganal" rod. For abrasive digging, the points sometimes are coated with a mixture of cast iron and manganese. This company uses tungsten-carbide compounds for facing latch plates of dippers. For welding manganese-steel parts—for instance, shanks of teeth and manganese castings where applied to steel plates—the practice at this shop is to use stainless-steel electrode, principally of the "18,080" strength.

On a new Marion-built 9-yd. bucket put into use in October, 1937, at the Minnehaha mine of the Hickory Grove Coal Mining Corporation, the cutting edges of the points are renewed by lopping them off with a gas torch and welding on an edge cut to size from diamond-shaped cast-manganese-steel bar stock. Side surfaces then are built up to compensate for wear. From 3 to 6 man-hours is required to complete the repairs to one tooth.

General maintenance practices at the Maumee pits differ somewhat from those of other companies because of the central shop at Jasonville. This shop includes a brass foundry where all bearing brasses are made. Practically all renewal parts except gears and pinions are made at the shop. Dipper handles, booms, etc., are among the larger parts being built. The company operates two Marion 5480 strippers and for these carries in stock at the shop two extra crawlers (one right and one left). These weigh 26,000 lb. each but can be rushed to a mine on short notice on a special truck and exchanged for a broken or worn-out crawler.

Central Shop Control

In the Maumee organization the mechanical department is separate from the superintendency of the pits and all pit repairs are made by or under supervision of men from the central shop. Arc-welding machines are not kept constantly at each pit but instead one or more of the ten machines owned by the company are transported by motor truck from the shop to job. One is a gasoline-driven set; all others are motor-generators.

Welding Rods, Electrodes, and Hard-Surfacing Materials Stocked at Enos

(All types are carried in three diameters, ⅛-in., 3/16-in. and ¼-in. unless otherwise noted)

Bronze for gas welding:
Oxweld No. 25M
Airco No. 27

General purpose, gas welding:
Airco No. 5 cast iron
Airco No. 17 copper coated
Nico stainless steel

Electric, coated:
Fleetweld No. 7 (fillet welding)
G. E. Electric No. 27 (fillet welding)
Airco No. 82 railroad rod (repairing switches)
Airco No. 84 general purpose
Airco No. 87 general purpose

Electric, bare:
Airco No. 41 (low tensile)

Hard surfacing:
Gas: Stoody self-hardening
Electric: Stoody self-hardening
Stoody Borium, screen size 30-40 (3/16-in. only)
Stoody Borod (3/16-in. only)

Arc welding a crack in the front girder of the revolving frame on the Clinton stripper.

Extensive use of Dardelet "Rivet-bolts" is a new practice of the Maumee mechanical department. Eight thousand of these rivet-bolts were used recently to repair the 12-yd. dragline at Old Glory No. 17. They are considered more efficient and are 40 per cent stronger than rivets. These rivet-bolts are carried in stock at Jasonville in the following sizes: ¾-in. diameter in lengths of 2 3/32 to 4 in.; ⅞-in. diameter in lengths of 25/32 to 4¼ in. For rebuilding dipper handles flanged long-grain steel has been found superior to other types that have been tried.

Spot Maintenance Favored

Most companies operating large strippers have concluded that it pays to repair or renew worn or broken parts as they show up rather than to defer that maintenance where possible and then give the machine a general overhauling. In only a few cases have the larger machines been given a general overhauling or rebuilding. In 1935, the Sunlight Coal Co. rebuilt a stripper, then eight years old, which was dismantled and shipped from a worked-out pit. A Marion 350 stripper built in 1925 was completely overhauled this year upon resumption of operations at the Clinton mine of the Electric Shovel Coal Corporation at a cost of approximately $70,000. A Marion 5480 shovel which has been in use ten years at Staunton mine of the same company has had the circle rails renewed once. Circle rails also were renewed on the 30-yd. shovel at Bobolink after 21 months of operation, during which time 13,000,000 cu.yd. of dirt was moved.

A nine-year-old shovel of the Patoka Coal Co. has handled over 30,000,000 cu.yd. of material and has never been rebuilt. Neither of the two strippers of this company has been down more than two weeks at one time for repairs. A practice of keeping the shovels clean and well painted is considered highly important in promoting closer inspection and better care. That same policy—"keep machinery clean"—also is a maintenance gospel at mines of the Sherwood interests.

At some mines large increases in rope life have been secured on the old strippers by careful study and appropriate action regarding rope construction, lubrication and operating conditions. On the 30-yd. stripper at Bobolink, for example, rope lives are as follows: crowd, 1 to 1¼ million cubic yards; retriever, 3 million; hoist, 1½ to 2 million; and counterbalance, 1 to 1¼ million. On a 750B Patoka shovel the hoist ropes move 1¾ to 2¼ million cubic yards. Here it is the practice to cut 3 ft. from a cable after each 200,000 yd.

Maintenance Routine

Electrical maintenance — as distinguished from moving lines, cables and equipment—is only a small fraction of the mechanical maintenance outlay. Inspections of the motors, generators and control apparatus on the strippers and loaders are made once a day at practically all pits. As a rule, this work is done by the chief electrician or pit electrician during the early morning. At most mines the shovel crew handles the lubrication and cleaning of electrical equipment along with their regular duties of taking care of the mechanical parts, but at Bobolink the crew bothers with none of the electrical equipment. Once a week electricians blow out with compressed air and inspect motors and generators. They grease the electrical units once a week, except the ring-oiled bearings of the motor-generator set. In summer the oil of these m.g.-set bearings is changed every two months and in winter every three months. Those bearings which are greased once a week are of the type lubricated by pressure gun.

An electrical-maintenance practice observed at Chieftain No. 20 and followed at some other mines is shifting the shortest brushes to the holders closest to the inspection plates. These brushes then serve as pilots and are in a position where they are easily changed if they get too short before the time for a general check up.

Vulcanizing trail-cable splices was adopted a few years ago by several companies but is now almost a thing of the past. The objection is the longer service delay as compared to making a non-vulcanized joint. Any but a thorough job of applying phase insulation to a portable 4,000-volt cable does not pay, hence most strip operators consider it impractical to make a temporary joint and then do a vulcanizing job later when more time is available. Maumee Collieries Co., however, continues to vulcanize, but at its Linton Supreme No. 23 operation, for instance, only the outer jacket is vulcanized. The phase insulation is made up in the ordinary way with rubber tape unvulcanized.

Cutting the dull end off a dipper point at Minnehaha.

A cast-manganese end, or cutting edge, has been "tacked" in place ready to weld at Minnehaha. The point is held in a special clamp on the bench so that the weld can be peened. Welding the new cutting edge and building up the face will complete the pointing job.

Splicing practice at Bobolink is typical of that at several mines. Here an electrician and two helpers can complete a splice in the No. 2/0 trailing cable in 1½ to 2 hours. The conductors are joined by pigtailing—that is, half of the strands of each end are twisted and lapped back one direction and the other halves twisted and lapped the opposite direction. The joint is served with small wire with turns far apart and then spaces are pried into the strand to facilitate soldering, which is the final operation in joining the conductors. Rubber tape is used entirely except for a few layers of friction tape over the outer jacket.

Life of cables depends to a great extent upon natural conditions in the pit. The original No. 2/0 cable on the Bobolink stripper, installed in November, 1935, was still in use at the time of this writing but had twelve splices and had been turned end for end. Slides covering up the cable have been the principal cause of trouble. The damage is done when digging or pulling the cable out from under the slides.

Repair and Spare-Parts Stocks

Stocks of repair and spare parts and supplies at Indiana strip mines range from $10,000 to $80,000, depending upon age of equipment, number of strippers and physical factors. Only a few of the operations maintain regular supply houses in charge of supply clerks and only one or two have perpetual inventories posted daily. Several, however, have semi-perpetual inventories. At single-stripper operations the managements usually are of the opinion that a possible reduction in losses of supplies and any advantages of orderly arrangement would not equal the cost of maintaining supply clerks.

Enos has a well-arranged supply house where a semi-perpetual inventory is maintained and is checked by a physical inventory once a year. One man having both the duties of purchasing agent and storekeeper has his office in a section of the supply room. The Patoka Coal Co. maintains a central warehouse at its central shop and office, which location is away from both tipple and pits but handy to all. This warehouse is in charge of a supply clerk and he posts the inventory once a week, and oftener if he finds time. The stock of tires for coal haulage by truck and trailer from pit to steam railway loading point sometimes totals $6,000. Sunlight also has a supply clerk in charge of the warehouse and he maintains a perpetual inventory.

DRAGLINE STRIPPING

+ In Indiana Coal Fields

STRIPPING with draglines equipped with buckets of 5 cu.yd. or less and powered by internal-combustion engines has become a fairly important factor in Indiana in late years, both in the "bituminous" and "block" fields, and accounts for a sizable annual tonnage at the present time. In the Brazil Block field, in fact, the small dragline gets a large share of the credit for reversing the downward trend in output which began shortly after the World War, with the result that production from this region was higher in 1937 than in 1918. Dragline stripping usually is confined to areas too small to support large equipment, although this is not always the case. In general, these areas fall into two major classes: small pockets or fingers of virgin coal, in many cases unworked because of top too soft for deep mining; and fringes around old deep mines, again usually left intact because of soft top.

Depth of cover is another factor influencing recovery by dragline equipment. In bituminous coal, few operators attempt anything over 35 ft. In block-coal areas, however, many dragline operators go up to 50 ft. This limit, which also is as much as many companies operating large equipment care to tackle, is made possible by the higher size realization from block veins, as well as the favorable position block holds in the domestic market. Automotive haulage is the invariable rule, generally with end-dump units rated at 1½ or 2 tons but built up to around 5 tons as a rule. Haulage distances from pit to tipple may run up to 10 miles or more, and some operators with a number of pits maintain several tipples to which the product of any pit may be sent. And, while a number of dragline men rely solely on sales to trucks, there has been a tendency in late years to secure a rail connection as well and thus widen opportunities for distribution.

Exact figures on small draglines in use, of course, are difficult to get, inasmuch as the picture changes from month to month or even week to week. But a census taken with the assistance of a representative of one equipment manufacturer in the course of the *Coal Age* survey of mining in Indiana showed, as well as could be determined, about 72 small draglines in the State, of which some 65 were in more or less regular operation. In all but probably half a dozen cases, each dragline was accompanied by a loading shovel. Of the total dragline equipment installed, approximately half was engaged in the recovery of block coal, particularly in the Brazil Block field, with several units in outlying block areas as far south as Spencer County. Below are presented a number of examples of operations in both the bituminous and block fields.

One of the major operators in block coal, with two bituminous operations also, is the G. & F. Coal Co., of Brazil, working a total of six draglines. At the Nickosin pit, operated by this company, the Brazil Block coal ranges from 12 to 54 in. in thickness, averaging about 48 in. Overburden averages 30 ft., but varies from about 10 ft. at the outcrop to a maximum of 45 ft. Hard material in the overburden runs up to about 25 ft., including slate over the coal followed by gray slate, sandstone, "gray rock," and sand and surface material, the latter underlaid by a stratum of quicksand.

Stripping equipment consists of a Marion 40A dragline (oil engine) with 75-ft. boom and 3-cu.yd. Page bucket. Loading is done by a Marion 450 gas-electric machine fitted with a 1½-cu.yd. dipper. Coal from the pit, with an average output of around 350 tons per day, usually is hauled three miles to the Hickory tipple in 1½-ton end-dump trucks built up to 5 or 6 tons. About one to two acres per month is uncovered, depending upon the thickness of the overburden.

The overburden naturally must be drilled, and for this purpose a Mac-

Loading and stripping in the Nickosin pit, G. & F. Coal Co.

beth horizontal unit making a 4-in. hole is employed. Pit width usually is 70 to 75 ft., and for this width three holes about 30 ft. deep are drilled in the face. As is usual in practically all cases where dragline operators find it necessary to shoot, the holes are drilled ahead under the dragline rather than in the sidewall. Thus, the overburden is shot in lifts varying in length with the hole depth. As soon as one lift is dug up and spoiled, another round of holes is drilled. Usually, drilling is done on one side of the face while the dragline works on the other, etc. Holes at Nickosin are loaded with King "Detonite," usually 50 to 75 lb. each, depending upon overburden thickness and character. Hand shoveling is employed to clean the coal. Loading, as is general in dragline stripping operations, is based on taking the entire width of cut uncovered, the trucks operating on the fireclay bottom. Pit dewatering is accomplished by 3-in. gasoline-powered pumps, with hoses for suction and discharge lines.

Output from the McKinney pit, operating the Upper Brazil Block, averaging 4 ft. in thickness, includes both coal and pottery clay, the latter coming from a deposit under the coal and being loaded after the coal. Coal output is around 200 tons per day. Overburden averages about 40 ft., with 45 about the maximum, and consists of blue shale up to a rider about 8 to 15 ft. over the regular vein. Above the rider, as a rule, is 8 to 10 ft. of sandstone. Stripping is done with a Marion 38 dragline with 65-ft. boom and 2-yd. Page bucket. A gasoline engine powers the stripping unit and consumes about 180 gal. of fuel a day. Coal and clay are loaded by an Osgood gas shovel with 1-cu.yd. dipper.

Averages One Acre Monthly

Stripping performance is around one acre per month under average conditions at the pit. Average pit width is 40 ft., and for this width the face is shot with two horizontal holes about 20 ft. deep, which usually provides enough material for one move of the dragline. Hole diameter is 4½ in., and they generally are loaded with 40 to 50 lb. of Austin 40-per-cent gelatin in 2x8- and 2x 16-in. sticks. Haulage equipment is the same as that used at Nickosin, and the coal may be taken to any one of three tipples: Hickory, Harmony or National. The usual haul is 8 to 9 miles. As at Nickosin, all the coal is loaded the full width of the pit.

As is usual in most dragline operations, all the coal is being loaded in the Beech Coal Co. pit.

Three-inch gasoline pumps are used.

With a thickness of 3½ to 4 ft. of Brazil Block coal, the Beech Coal Co. strips an average of 40 ft. of overburden with a Link-Belt K-1 dragline with "Speed-O-Matic" control, 65-ft. boom and 2-cu.yd. bucket. Coal is loaded with a Koehring 301 gas shovel with ¾-cu.yd. dipper, first being cleaned by hand shoveling and brushing. Haulage equipment comprises seven 5-ton end-dump trucks, and the distance to the rail tipple is three miles. All the coal is loaded the full width of the pit and the trucks operate on the fireclay. Water is kept down by 3-in. gas pumps. Pit width averages 30 ft., and the overburden includes a layer of gray slate about 20 ft. thick. To shoot the overburden, one horizontal hole 3 in. in diameter and about 30 ft. deep is drilled in the face and loaded with 40-per-cent gelatin.

At the Hoosier Queen mine, the Possum Hollow Coal Co. strips a 24- to 28-in. semi-block coal under 13 to 35 ft. of overburden. In fact, 35 ft. is the stripping limit. Production is variable, depending upon truck sales, but in the summer averages around 50 to 100 tons per day six days a week. In the winter, production climbs to a maximum of 250 tons per day.

Stripping is done by a P&H Model 705 diesel dragline with 50-ft. boom and 2-cu.yd. bucket. A P&H gas loader (206B) with 1-yd. dipper is used in the pit, with an International T20 tractor and Bucyrus-Erie bulldozer for cleaning off the coal and other pit and stripping work. Hauling is done by 5-ton end-dump trucks, the number depending upon the output. Most of the hauling is done on the coal, Hoosier Queen furnishing an example of the practice adopted by several operators of leaving a narrow berm until the shovel has gone through the pit and then completing the operation by loading out the berm with the trucks operating on the bottom. Pit width at Hoosier Queen is 36 ft. on the average, and the overburden contains about 10 ft. of slate that must be shot. A standard jackhammer drill supplied with air by a Sullivan compressor is used for this purpose, the holes being drilled vertically in the sloping face left by the dragline and loaded with 40-per-cent gelatin. Drilling and shooting are repeated as often as the dragline gets into unbroken material.

With an average daily output of 650 to 700 tons, the Mariah Hill Super Block Coal Co. recovers a 30-in. block seam in Spencer County, southern Indiana, using a Bucyrus-Monighan 5-W walking dragline (diesel) with 105-ft. boom and 5-cu.yd. bucket for stripping and a Marion 331 shovel with 1-yd. dipper for loading. Overburden ranges from 30 up to 50 ft., the stripping limit, and consists mostly of shale and about 10 ft. of surface material.

The dragline makes a 50- to 60-ft. cut and a 12- to 15-ft. berm is left as a haulage road for the 10-ton end-dump trucks employed to haul the coal seven miles to the tipple, all but one mile over paved highways. The overburden is drilled with a "Parmanco" horizontal drill making a

Shooting at Mariah Hill Super Block, with the 5-yd. walking dragline in the background.

4-in. hole to the depth of the stripping cut. Holes usually are loaded with about 100 lb. each of 3x10-in. powder. Two- and 4-in. pumps are used for dewatering.

Operations of the H. A. Siepman Coal Co. and its affiliate, the Lincoln City Coal Co., include one block mine —i.e., Clipper Block—recovering the "Block No. 2" vein, averaging 3 ft. in thickness, at the rate of about 500 tons per day. Overburden thickness ranges from 16 to 30 ft. and includes a thin layer of shale or slate over the coal, with occasional sandstone areas. Consequently, little shooting is done. Stripping is done by a Northwest Model 8 dragline (oil engine) with 65-ft. boom and 1¾-yd. bucket, while loading is done by a Northwest Model 105 shovel with 1¼-yd. dipper. As at all other Siepman operations, coal is hauled by a contractor using 5- to 5½-ton end-dump trucks.

The Siepman bituminous operations include India Heat Wave, recovering the 6th Vein with an average thickness of 5 ft. Average daily output is 600 tons from one pit. Overburden, consisting of slate over the coal followed by gravel and wash, runs up to a maximum thickness of 40 to 45 ft. Stripping is done by a Northwest Model 95 dragline (oil engine) with 75-ft. boom and 2½-yd. bucket, while the coal is loaded by a Lorain 75B shovel with 1½-yd. dipper. Pit width at this, as well as other Siepman operations, usually is 40 to 45 ft. and the coal is loaded the full width with the trucks operating on the bottom. Where necessary, the overburden is drilled ahead under the dragline (usually two holes 4 in. in diameter and 30 ft. deep) with a Bissell horizontal drill. The overburden is shot with King "Detonite."

One pit 4½ miles away from the tipple comprises the Oak Leaf mine, producing about 700 tons per day. The seam is the 5th Vein, averaging 4 ft. in thickness. Average overburden thickness is 20 ft. and the range is 16 to 26. Stripping and loading are done by a Northwest-Murphy diesel dragline with 75-ft. boom and 2½ cu. yd. bucket and a Thew Type O gas shovel with ¾-yd. dipper. The coal at Oak Leaf is overlaid by a hard black slate ranging from 1 to 6 ft. in thickness, which is drilled with a standard pneumatic drill and then shot. Normally, the dragline strips ahead during the loading shift, tearing up as much slate as possible, but leaving what it cannot break loose. At the end of the shift, the loading shovel moves up to the overburden face and the slate is drilled vertically and shot, whereupon it is ripped up by the shovel and cast either into the spoil or up to the toe of the bank, where it can be reached by the dragline.

At the new Siepman "Kingkohl" pit, producing 1,000 tons per day, the 5th Vein, with an average thickness of 5 ft., is being recovered. Overburden thickness ranges from 16 to 30 ft. and usually is made up of the following: 0 to 1½ ft. of slate over the coal; 4 to 6 ft. of limestone; hardpan up to 8 ft. occasionally; and then surface material. Stripping is done by a Model 8 dragline (65-ft. boom, 1¾-yd. bucket), and loading by a Lorain 75B shovel with 1½-yd. dipper. Stripping operations are conducted to recover the limestone, which is sold on the ground for crushing. Consequently, the first operation is taking the overburden off to the lime rock, which then is drilled, using either a standard I-R "Jackhamer" or an I-R air-operated auger. With the latter equipment, holes 12 to 15 ft. deep are drilled under the limestone and loaded with King "Detonite" to break the limestone at the seams. If room is not available for drilling underneath, vertical holes are put in with the "Jackhamer." When the limestone-recovery operation is completed, the slate over the coal, if any, is dug up and the coal finally is loaded in the usual manner.

In the case of the affiliated Lincoln City Coal Co., operating the Lone Eagle mine, the 6th Vein, under 18 to 33 ft. of overburden, is recovered. Output is 700 tons per day. Stripping is done by a Northwest 95 and a Northwest-Murphy diesel machine with 75-ft. booms and 2½-cu.yd. buckets, while the coal is loaded by a Lorain 75A shovel with 1¼-yd. dipper. The overburden is drilled where necessary with "Jackhamer" and air-auger equipment.

Minimum Goal 1,200 Tons

Equipment and methods used by the Sternberg Coal Corporation at its Star Hill No. 1 mine are geared to produce a minimum of 1,200 tons per day with the maximum flexibility in stripping and loading schedules. The company is engaged in recovering tracts of 5th Vein coal up to two miles away from the tipple. Thickness of the coal runs up to 7 ft. However, the practice is not to work coal with an average thickness much less than 3 ft. nor in overburden much over 40 ft. Where average overburden prevails (around 25 ft.), surface sand and clay constitute around 6 to 7 ft., with shales and slates making up the remainder. In heavier overburden, the hard material usually, of course, is thicker.

Stripping is done by a Northwest Model 95 dragline (oil engine) with 75-ft. boom and a 2¾-yd. bucket; also a Northwest Model 80 "Special" shovel with 1¾-cu.yd. manganese-steel dipper. These units may be worked together in one pit or separately in different pits. In this connection, the company attempts to keep a number of pits open, so that at least one is available for stripping and another for loading at all times. If the shovel is working alone, it can strip 20 to 22 ft. of material in a 35-ft.-wide pit. With the dragline and shovel working together, a cut 45 ft. wide can be made in 40-ft. overburden. When the two units are combined, the dragline, working from the bank, first takes off the clay and surface soil. It is followed up by the shovel, which takes up the remaining material, dumping as much as possible in the spoil area and the remainder on the coal. Finally, the dragline, working from the spoil bank, picks up the shovel spoil on the coal and throws it back to complete the operation. Overburden drilling is done with a "Parmanco" horizontal drill.

Loading is accomplished with a Northwest Model 105 gas shovel with 1¼-yd. dipper. First, however, the coal is cleaned off with a LeTourneau "Angledozer" on a Caterpillar 40 diesel tractor, followed by hand shoveling, wire brushes and compressed air. Also, the coal is drilled with a standard air drill and shot with pellet powder. In loading, a narrow berm is left along the bank for a truck roadway until the shovel has gone through the pit. Then this berm is loaded in one operation and the shovel is ready to move to another pit until a new stripping cut can be made. Sternberg pits always are made with two entrances, which facilitates routing the 10- to 12-ton end-dump trucks used. Hauling on the bottom is the practice while the berm is loaded, but not at any other time.

Rated Output 1,500 Tons

Substantially similar conditions prevail at the Star Hill No. 2 operation of the affiliated Boonville Coal Sales Corporation, where the rated output is 1,500 tons per day. Stripping at this operation is done by a new Northwest-Murphy diesel dragline with 80-ft. boom and 2½-cu.yd. bucket, while loading is done by a Model 80 "Special" shovel (Murphy diesel engine) with 1¾-yd. dipper. This shovel also assists in stripping when not loading coal. The general principles of operation are substantially the same as at Star Hill No. 1.

The 5th Vein, averaging 5 ft. in thickness, is stripped by the 20th Century Coal Co., producing about 1,000 tons per day from two pits, each less than half a mile from the tipple. Overburden varies from a minimum of 10 to a maximum of 35 ft. (the stripping limit) and under average conditions carries about 12 to 14 ft. of slate and shales. Stripping is done by a Marion 40A dragline with 80-ft. boom and 3-yd. Page automatic bucket, which can uncover about three acres a month in overburden under 20 ft. The loader is a Lorain 77B with 2½-yd. bucket. Usual width of cut is 40 ft. and a 10- to 12-ft. coal berm generally is carried for the trucks (three 16-ton White cab-over-engine units). Both a standard air drill and a horizontal auger-type drill are used in shooting overburden, the former making vertical holes where the solid material is thin. With the auger drill, three 4-in. holes are drilled ahead under the dragline in a 40-ft. face and are loaded with 40-per cent gelatin in 3x12-in. sticks. The coal is cleaned by a LaPlante-Choate bulldozer on a Caterpillar 30 tractor, followed by shovels and brooms. Main-haulage roads are built of gob, and trucks average ¾ mile per gallon. Pits usually are stripped and loaded alternately. Both gas and electric pumps are used for dewatering.

The 5th Vein, averaging 5 ft., also is recovered by the Winslow Coal Corporation with a capacity of 1000 tons per day. Average thickness of the overburden is 23 ft., with 35 ft. as the maximum attempted. Over the coal as a rule is 18 in. of black slate, an average of 4 ft. of hard shale, 10 to 12 in. of the characteristic No. 5 "steel band," more hard shale and finally surface material. In a 35-ft. bank the hard material will average 20 ft. The operating schedule is based on keeping two or more pits ahead of the one in which loading is being done, thus assuring plenty of reserves for times of good demand.

Stripping is done by a Northwest Model 95 dragline (oil engine) with 75-ft. boom and 2½-yd. Page Class H rock bucket. Loading is done by a Northwest No. 4 shovel with a 1½-yd. dipper. Capacity of the stripping unit under average conditions is about 3 acres per month. Average cut width is 45 ft., running down to 40 ft. under some conditions and up to as much as 60 to 70 ft. at the outcrop. Drilling of overburden is let to a contractor using a well-type drill. Holes are sprung with 30-per-cent gelatin to permit getting the charge below the steel band, and finally are loaded with King "Detonite." Pit-dewatering equipment includes both 3-in. air-cooled engine pumps and 4- and 5-in. water-cooled units, the latter held in reserve for use when the small pumps need helping out.

The coal is shot before loading at Winslow. Drilling is done with a Schramm compressor and an I-R drilling unit. Hole spacing is about 10 ft. and holes are loaded with half a stick of 1¾x8-in. pellet powder. All hauling is done on the coal, using six International and one Ford end-dump trucks built up to 6 tons. These trucks are used at both Winslow and the affiliated Canal Coal Corporation operations. One-way haul is 1½ miles at Winslow and ¾ mile at Canal. An average of 8 miles per gallon of gasoline is obtained.

A double seam is operated at Canal, with the top bench 2 ft. thick separated from the 3½-ft. bottom bench by an 18-in. parting. The two benches are entirely different in character. Overburden conditions are substantially the same as Winslow except that the steel band is absent. Similar equipment is used, although the coal is prepared in a different tipple. In operation, the overburden is taken off down to the top bench, which is loaded. Then, with the dragline working in the pit, the parting is ripped off and spoiled to permit loading the bottom bench. Canal production averages 700 tons per day.

Showing the special stripping shovel digging up the hard material at Star Hill No. 1, which the dragline later will pull back off the coal and spoil.

COAL PREPARATION

+ At Indiana Mines

INDIANA coal preparation exemplifies the trend in the bituminous industry in late years toward a cleaner and more uniform shipped product, new sizes and mixtures for new fuel-burning equipment and techniques, and various auxiliary activities designed to enhance coal's position in the marketplace, such as crushing, tramp-iron removal, dewatering or drying mechanically or by heat, dustless treatment, etc.

As a result of changing ideas among consumers and research and promotion by the operators, a number of full-scale new preparation plants, usually involving mechanical cleaning, have been erected in the State in the past ten years. Mechanical-cleaning facilities also have been added to a number of existing plants, while many others which as yet have not felt this need nevertheless have been impelled to install equipment for dedusting, making additional sizes and breaking down coarse coal in times of slow demand or to meet orders for stoker or screenings, etc.

Shaker Screens Dominate

Indiana operators still rely on the shaker screen for primary separations, and some use this type of equipment, in a higher speed, for rescreening or dedusting. Although some operations five to ten years ago were equipped to ship a fairly wide range of sizes, the average plant generally was a three- or four-track tipple making either lump, egg and screenings, or lump, egg, nut and screenings. Picking usually was limited to lump and egg, and these sizes still are commonly prepared by this method, even at operations equipped with mechanical cleaners. Where mechanical cleaners have not been installed, there has been a tendency to extend picking down to around 2-in.

Picking is done in most plants on the horizontal section of the loading booms, usually of the apron type. High-intensity mercury-vapor lamps have made wide gains in the State in the past two or three years, although other special lighting equipment has been adopted by some operators, as detailed in the article beginning on p. 105. But even picking equipment has been subject to revisions to improve efficiency at a number of operations. The Enos Coal Mining Co., for example, in a tipple-reconstruction program carried out under the direction of the Allen & Garcia Co., has lately installed three shaking-type tables with built-in degradation screens. Degradation is recirculated to the main screens for resizing.

Indiana preparation, in both hand-picking and mechanical-cleaning plants, almost invariably is characterized by provisions for recovering coal values from part of the material taken off the picking tables. In other words, picking usually is conducted to yield two products, one a pure refuse which goes immediately to the bank and the other material containing recoverable coal values—usually in conjunction with pyrites, the most general impurity in the bituminous coal (as distinguished from the "block" type) in the State.

Handling Pickings

Pickings generally are subject to two types of treatment. In one case, the pickings carrying coal are run to a crusher for reduction. This, however, is the less-common practice, although the Glendora, Saxton and Templeton coal companies employ it for making boiler fuel. At the Patoka Coal Co. plant, on the other hand, pickings, if not being treated in a Bradford breaker, as will be detailed later, are crushed and recirculated to the main screen. In mechanical-cleaning plants, the crushed pickings naturally are run to the cleaner or cleaners.

The usual treatment of pickings at Patoka is in accordance with the general practice in Indiana: i.e., they are run to a Bradford breaker, where the coal, being more friable than the sulphur, is broken off and goes through the screen, while the harder refuse retains its size for the most part and is discharged at the end. The result is Bradford-breaker screenings—in many cases a surprisingly good fuel commonly shipped as a separate product. All pickings also go to the breaker at Enos, which produces a 2-in. screenings; at Crown Hill No. 6 mine, Clinton Coal Co.; and at Knox Consolidated No. 1 mine, Knox Consolidated Coal Corporation, where the product commonly is used as boiler fuel. Breaker screenings also is a regular size at the Chieftain No. 20 mine of the Maumee Collieries Co.

In a few instances, reduction in a Bradford breaker is supplemented by cleaning of the coal end before shipment. At Knox's No. 2 mine, as an example, breaker screenings (minus 1½-in.) are run to a hopper from which a Redler elevator takes them up to an air-sand cleaning plant. At the Kings Station mine of the Princeton Mining Co., the breaker product (minus 1½-in.) is washed in a Menzies hydroseparator and then is run over a dewatering screen to remove moisture and minus ¼-in. material. The Standard Coal Co. cleans its 1½-in. breaker screenings on two Deister-Overstrom "Diagonal-Deck" coal-washing tables.

Size Range Widened

In keeping with the trend toward a wider range of sizes, the equivalent of rescreeners has been built into most of the newer plants in the State. At the Bobolink tipple of the Binkley Mining Co., built by McNally-Pittsburg, for example, the feed is separated into plus 6-in., 6x3- and 3x0-in. sizes on the main screen, with a secondary screen taking the minus 3-in. and separating it into 3x2-, 2x1¼ and minus 1¼-in. fractions. And when Maumee built its Chieftain No. 20 tipple it provided seven loading tracks, one of which can be used for box-car shipments through the medium of a Manierre loader.

Where otherwise satisfactory tipples already were in operation, however, expanding the size range meant the addition of rescreening equipment, usually of the vibrating type. At the Submarine No. 2 mine of the Clinton Coal Co., for instance, a 4x6-ft. double-deck Leahy vibrator has been mounted over two truck-loading bins. This vibrator receives 1½-in. screenings from the main tipple and does a scalping job on the top deck, thus making it possible to use a smaller screen, and finishes the separation into 1½x⅜-in. stoker and ⅜-in. carbon on the bottom deck. At the Crown Hill No. 6 mine of the same company, a 4x7-ft. Leahy screen is used for the same purpose. This plant also is equipped with 100-ton lump, egg and nut pockets to serve the truck trade. Four Tyler "Hummer" electric screens are employed at the Staunton mine of the Electric Shovel Coal Corporation for separating at ⅜-in. to make either a 2- or 1½x⅜-in. stoker and a ⅜-in. carbon. These same screens also are used in removing 10-mesh dust in making a dedusted stoker coal. An auxiliary flexible-arm shaker is used at Knox Consolidated No. 2 for making 1¼x¾- or ⅜-in. domestic stoker and ¾- or ⅜-in. carbon.

Sizes and Mixtures Made

At Patoka, the usual screening schedule is 6-in. lump, 6x3 or 6x1½, 3x2 egg, 2x1½ or 2x1¼ nut, 1½x¾ or 1¼x¾ nut, 1½x⅜ or 1¼x⅜ stoker, and ¾x⅜ and ⅜x⅛ stoker, in addition to any desired mixtures. All sizes below 2 in. are run to a rescreening plant where a high-speed shaker (165 strokes per minute) separates it into the various fractions between 2- and ⅜-in. The minus ⅜-in. then is run over three 4x7-ft. Jeffrey-Traylor electric screens equipped with "Tyrod" cloth for dedusting at ⅛ in. The screens are double deck. After the minus ⅜-in. has been dedusted it can be returned to the various bins or mixing conveyors to make processed screenings and the smaller stoker sizes. Dedusting has been found to materially reduce ash and sulphur in the shipped coal. Patoka, incidentally, recently has completed an elaborate study of its coal, and the results are being used in improvements in the preparation plant to substantially better the shipped product.

Rescreening at Kings Station mine is done on both high-speed shaker and vibrating equipment. Sizes are 1¼x¼- and minus ¼-in., and the plant also is arranged so that dedusted screenings, with the percentage of 10-mesh dust adjusted as required, can be produced. The screening equipment is placed over bins arranged for either truck or rail loading. At Saxton, all coal under 3 in. goes to the rescreener, where it is separated into 3x2-, 2x1¼-, 1¼x¾- or ⅜-, and minus ¾- or ⅜-in. sizes. Each size goes to a separate bin, which is arranged to discharge onto a loading belt. Thus, each size may be loaded separately or mixtures of any or all the sizes, in any desired proportions, may be made on the belt. Standard Coal Co. employs two Jeffrey-Traylor screens to separate screenings into 2- or 1½x⅜- and minus ⅜-in.

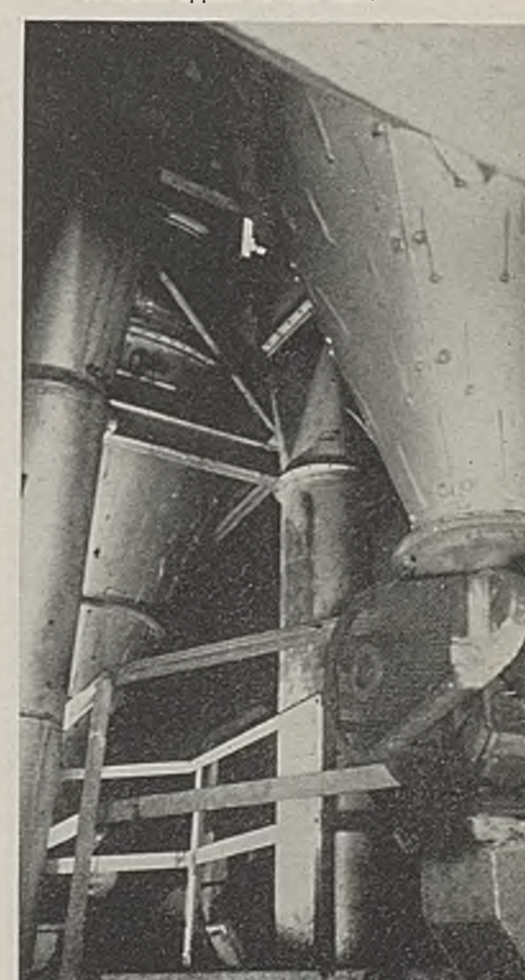
Indiana Dedusting Plants

Dedusting plants in Indiana range from simple one-screen installations to elaborate multi-screen systems in some cases employing water to wash the dust through the cloth. An example of the simpler jobs is the 4x8-ft. Jeffrey-Traylor screen at the Miami No. 10 tipple of the Binkley Mining Co., also equipped with an Ottumwa scraper-line box-car loader. Dedusting is done at 10-mesh at the Glendora No. 27 mine of the Templeton Coal Co., which has installed a double-deck Robins "Gyrex" screen for that purpose. The 2- or 1½x1-in. nut produced on the top deck of the screen may be run to a Jeffrey "Flex-Tooth" crusher if desired. The bottom deck of the screen does the dedusting, after which the fractions over both decks are recombined. At Glendora No. 28 (Glendora Coal Co.), dedusting at 10-mesh is done on two "Gyrex," two Fahy and one high-speed shaker screens in series. A high-speed shaker, placed under and sloping opposite to the main screen, is used at the Old Glory No. 17 tipple of the Maumee Collieries Co. Size of dust removed is variable, depending upon whether the coal is dry or damp and also upon the desires of the customer.

The question of dampness as influencing dedusting efficiency was a major factor in the selection of equipment for Maumee's Chieftain No. 20 300-tons-per-hour rescreening and dedusting plant, designed both for dedusting 1¼- or 1½-in. screenings and producing 1¼- or 1½x⅜-in. stoker nut and ⅜-in.x10-mesh dedusted carbon. Screening equipment consists of two 5x10-ft. "Selectro" vibrators for separating the feed into 1½ or 1¼x⅜-in. and minus ⅜-in. fractions, followed by four additional 5x10-ft. "Selectro" units for the actual 10-mesh dedusting operation. Provisions for adjusting both amplitude and direction of throw, as well as tilt, were the reasons for the selection of these screens by the Maumee management, which felt that these adjustments would make possible an effective commercial separation of dust with a minimum of blinding even when very damp coal was being handled. The plant is arranged so that only part of the screenings need be dedusted, if desired, thus making it possible to load a 1¼-in.x10-mesh product and a ⅜-in. carbon at the same time.

To end permanently variations in screening efficiency arising from fluctuations in the moisture content of the coal as it comes from the pit, the Enos Coal Mining Co. in 1936 adopted the practice of washing the dust through the screen cloth (*Coal Age*, September, 1936, p. 371). Initial dedusting is done at 10-mesh, and this 10-mesh product is further screened to recover the 10x28-mesh fraction. Both rescreening and dedusting are done in a new addition to the Enos preparation plant, which also includes drying facilities. Minus 2- or 1½-in. coal from the main tipple (equipped with two 50-ton bins for storing and loading part of the screenings, if desired, while opera-

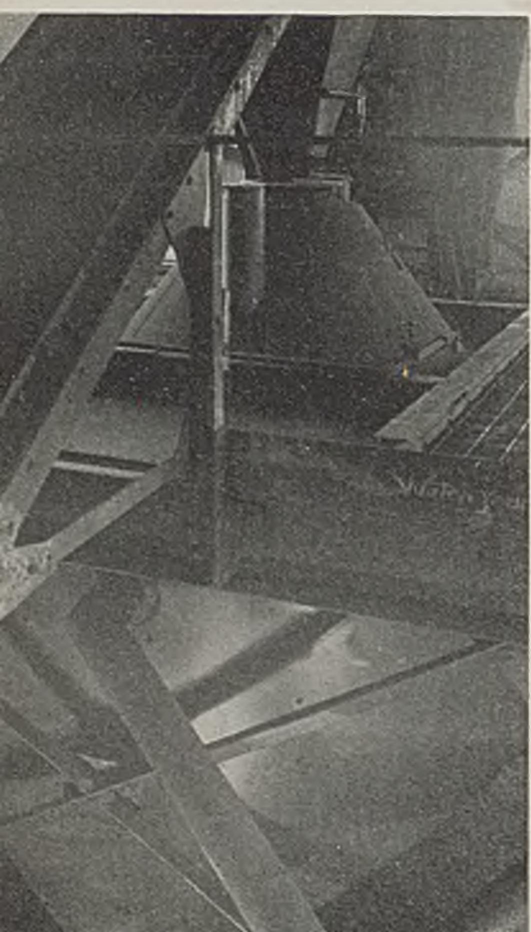
Part of the drying installation at Enos. Drying proper is done while the coal is being pulled up through a tube in a stream of hot air, the coal and air being parted in cyclone separators, the bottoms of which appear in this view.



ting the rescreener) is run over a high-speed shaker screen in the rescreening plant for separation, depending on original size, into 2x1½, 1½x¾- and minus ¾-in. sizes. The latter is split between three 4x8-ft. single-deck Tyler 400 electric screens, where it is separated into ¾x5/16-and minus 5/16-in. sizes. The latter size then goes to additional Tyler screens equipped with "Tyrod" cloth and water sprays for dedusting at 10-mesh.

In winter, the 5/16-in.x10-mesh coal goes to a 4x16-ft. Tyler-Niagara screen equipped with 28-mesh "Ton-Cap" cloth for dewatering and then into a drainage bin feeding the drying equipment. The minus 10-mesh material is run to a Robins "Vibrex" screen, where it is separated into 10x28- and minus 28-mesh fractions, the former going to a storage bin ahead of the dryer and the latter to the sludge pond. In summer, drying is done only on order, with the result that the 5/16-in.x10-mesh dedusted coal goes directly to the loading bin, while the minus 10-mesh material is screened on the Tyler-Niagara unit to recover and dewater the 10x28-mesh fraction. Wet screening at Enos eliminates a considerable percentage of sulphur and ash, which tends to concentrate in the minus 28-mesh fraction.

This continuous centrifugal dryer at Minnehaha also may be used to recover and clean sludge.



In addition, if, as in the summer, the coal is loaded without heat dryin, it is in a more free-draining condition than wet non-dedusted coal directly from the pit and therefore reaches the customer with a lower moisture content. Approximately 70 to 75 per cent of the minus 10-mesh material through the dedusting screens is recovered by the secondary screening at 28-mesh.

Heat Drying Practices

Drying of the "washed" coal in winter, or on order at other times, is accomplished at Enos in two Raymond units supplied with heat by a Skelly stoker. The 5/16-in.x10-mesh size is dried on one shift and the 10x28-mesh on another. Drying is accomplished by pulling the coal upward through a steel tube, or stack, in a current of heated air. The dried coal and air are discharged into cyclone separators, where the coal is collected and the air permitted to escape to the atmosphere. The drying plant is designed to handle 15 tons of coal containing an average of 16 per cent of surface moisture an hour. To secure this moisture figure, dried coal as necessary is mixed with the wet before it is run to the drying units. Inlet temperature is about 1,200 deg. F.; outlet, about 200 deg.

Wet dedusting also has been adopted at the No. 11 mine of the Sunlight Coal Co. for much the same reasons as at Enos. At Sunlight, minus ½-in. coal, at the rate of about 150 tons per hour, is run to two 5x8-ft. single-deck Tyler 400 screens equipped with the necessary water sprays, where a separation is made at 7-mesh. The ½-in.x7-mesh coal over the screens goes to the top deck of a 4x16-ft. Tyler-Niagara screen sloping up from the feed to the discharge and fitted with stainless-steel "Ton-Cap" cloth. The top deck dewaters the coarse size. Minus 7-mesh material from the two electric screens goes onto the bottom deck of the Tyler-Niagara unit, where the 7x28-mesh material is recovered and dewatered to approximately 20 per cent surface moisture. Minus 28-mesh material through the bottom deck of the Niagara screen goes to the sludge pond.

Few Indiana tipples are without crushing equipment, and in many cases provision is made for breaking down the entire product, if desired, to screenings. Crushers frequently are supplemented by auxiliary screening installations for separating out oversize or for other purposes. At Bobolink, for instance, a crusher is installed at the end of the mixing conveyor for breaking down any or all the lump, egg and nut. The crusher product may be returned to the tipple and run over a Tyler-Niagara screen to remove the oversize, which may be loaded or returned to the main screen for resizing. At Binkley's Miami No. 10 mine, a small Jeffrey crusher breaks down coarse-coal degradation to screenings. Size reduction at the Dresser mine, Walter Bledsoe & Co., is done in a Bradford breaker, which is arranged to take, when desired, all coal over 1¼-in. for reduction to that size and combination with the natural 1¼-in. screenings on a belt to the Dresser power plant. This belt is equipped with a Merrick "Weightometer."

Crushing and breaking equipment at Enos includes a McNally-Norton pick breaker mounted at the end of the main shaker screen for reducing 6-in. lump when desired. In addition, a Jeffrey 36x36-in. single-roll crusher is employed for breaking any or all prepared sizes, usually down to nominally 2 in. The crusher product can be returned to the main screen for resizing, meaning usually that the most of it winds up in the rescreener, or it can be passed over a Tyler-Niagara screen for taking out oversize material (plus 2-in.). This oversize may be returned to the main screen or, if 3x2-in. coal is in demand, it may be run in with that size to augment the tonnage. A needle-type breaker is used for reducing lump at the No. 6 mine, Jackson Hill Coal & Coke Co.

Plus 6-In. Size Broken

Knox Consolidated Nos. 1 and 2 mines seldom ship lump and therefore all coal over 6 in. normally is broken down with sledges before it goes onto the screens at these properties. In addition, No. 1 is equipped with a Webster crusher for breaking all prepared sizes down to 1½- or 1¼-in. screenings. At No. 2, in addition to other breaking equipment, a Jeffrey Series "N" 30x30-in. single-roll crusher has been reequipped with special segments with short pyramidal teeth, the maw restricted, an extended shoe installed, etc., for crushing 2¼x1¼-in. washed nut in making commercial stoker (nominally minus 1¼ in.). One test after rebuilding showed 1.4 per cent of plus 1¼-in. material in the broken product, 80.9 per cent of 1x⅜-, 11.9 per cent of ⅜x⅛- and 5.8 per cent of minus ⅛-in.

Chieftain No. 20 is another operation where lump shipments are infrequent. In this case, the lump first is picked and then is run through a Link-Belt double-roll crusher, after which the crushed material is picked on a conveyor belt and returned to the main screen. Egg, when desired, is broken down in a Gruendler ring mill at the end of the egg boom and is discharged directly to the car. At Patoka, a Link-Belt 48x48 double-roll crusher is set at the end of the mixing conveyor, where it can receive all coal down to 1½ in. in size, breaking to 2 in. and discharging directly to the car. A Link-Belt double-roll crusher for all coal over 1¼ in. is installed at the Kings Station mine, while Saxton uses a Jeffrey single-roll unit for reducing lump and egg to screenings or nut sizes.

The necessity for two types of preparation in summer and winter was reflected at the Staunton mine in the installation of a separate picking and crushing section. In summer, the mine-run, instead of going directly to the main screen in the tipple, is bypassed to an elevating-type apron conveyor. Picking space is provided on the upper horizontal run of this conveyor, and the coal, after picking, is screened into plus and minus 6-in. fractions. The minus 6-in. is returned to the main conveyor to the tipple, while the plus 6-in. is discharged into a 36x54-in. Jeffrey single-roll crusher, adjustable to break to 10- down to 2-in. The crushed material joins the natural minus 6-in. coal on the way to the main tipple, where it is screened and then goes through the normal picking, rescreening, dedusting and loading cycle. As Staunton mines the Brazil Block coal, about half of the average daily output of 1,500 tons is 6-in. block.

Magnetic Equipment Gains

Magnetic equipment for the removal of tramp iron has made substantial gains in Indiana, as elsewhere, particularly as a result of the rise in the use of domestic and commercial stokers. Among the plants preparing coal mainly by screening and hand-picking, Knox Consolidated No. 2, for example, has installed a Central Electric Repair Co. chute-type magnet for taking iron out of its domestic-stoker product. All screenings at the Glendora Nos. 27 and 28 mines pass over Dings magnetic pulleys. The same practice is followed at Kings Station, which also has equipped one of its apron-type booms with a magnet developed at the mine (*Coal Age,* October, 1938, p. 70). A suspended-type magnet is installed over the car-loading belt following the rescreener bins at Saxton, so that it can function on all sizes from 3-in. down.

Mechanical - cleaning installations in Indiana include both the straight wet, straight dry and combination types. The Black-Hawk Coal Corporation mine, reopened in 1936, was equipped with a Jeffrey two-compartment diaphragm jig for cleaning 4x1¼- or 4x$\frac{3}{16}$-in. coal in February, 1938. Rated capacity of the washer is 130 tons per hour, but it has been operated at 200 tons. The principal impurity removed is sulphur. Minus $\frac{3}{16}$-in. material is screened out of the washer feed and bypassed to simplify water-clarification and sludge-disposal problems.

In the summer at Black-Hawk, the preparation schedule usually includes an 8-in. lump and an 8x4-in. egg. Either or both, however, may be crushed and run through the washer. Standard preparation, on the other hand, usually contemplates the production of 6-in. lump, 6x4-in. egg, 4x1¼-in. washed nut, and one or more of the following: 1¼-in. raw screenings, 1¼-in.x10-mesh dedusted screenings, 1¼x$\frac{3}{16}$-in. washed or raw stoker, modified screenings (part of the minus $\frac{3}{16}$-in. material removed) and $\frac{3}{16}$-in. raw carbon.

Crusher Teeth Tipped

Both pure refuse and material containing recoverable coal is made in picking lump and egg. The latter goes to a single-roll crusher, also used for breaking down lump and egg, and from there to the washer. The crusher teeth are tipped with "Stoodlite" once a week to keep them in the proper shape and thus preserve size realization. By running lump and egg through the crusher and combining it with the natural minus 4-in. material, it is possible to clean a large part of the mine output by operating the washing unit at greater than its normal capacity.

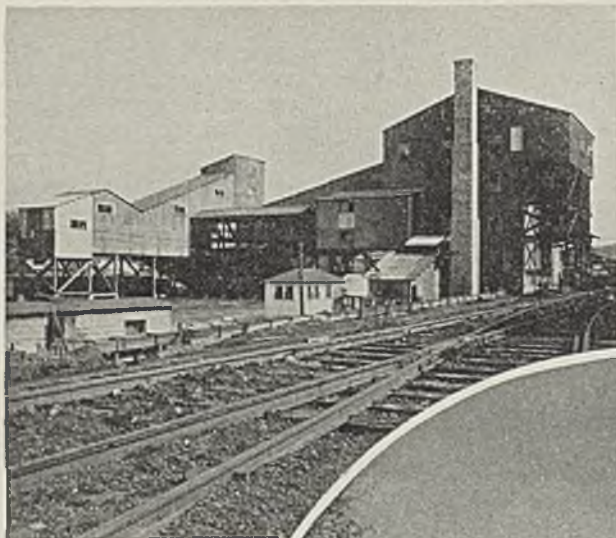
Before entering the washer, the coal passes over a 4x6-ft. C. C. Wright vibrator, which removes the minus $\frac{3}{16}$-in. material. However, this screen acts more in a secondary capacity, as two similar vibrators in the tipple normally remove the fines, either in preparing the coal for washing, making a raw 1¼x$\frac{3}{16}$-in. stoker or making a modified screenings by operating only one of the two vibrators and thus taking out only that proportion of the fines. These vibrators also may be used for dedusting at 10-mesh when desired. Upon leaving the washer, the cleaned coal passes over a Wright classifying and dewatering screen, in the course of which it is separated into nut and stoker or, if only nut is being washed, is dewatered. The dewatering screen is arranged to remove any minus $\frac{3}{16}$-in. material which remains in the coal, which is run to a Jeffrey settling tank and eventually to the refuse car.

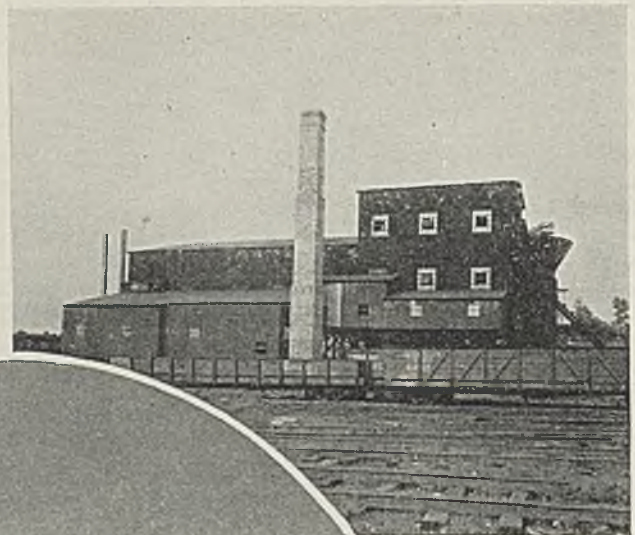
All coal under 3 in. is mechanically cleaned at the Buckskin Coal Corporation's plant, which normally produces either 6x3-in., 3x1½ and minus 1½-in. or 6x3-, 3x1¼, 1¼x¾ and minus ¾-in. sizes. Minus 3-in. coal, along with pickings broken down in a Jeffrey 24x24 single-roll crusher, first go to a Menzies hydroseparator. The washed coal flows with the water onto a dewatering and classifying screen, where, among other operations, the minus ⅜-in. material is taken off for further preparation on four Deister-Overstrom "Diagonal-Deck" coal-washing tables. Wedge wire in the bottom deck of the classifying screen carrying the minus ⅜-in. coal unloads most of the water and thus prevents flooding the tables, which are followed by a dewatering screen and an elevator to a Carpenter centrifugal dryer. All water flows to a sludge tank from which the pumps feeding the hydroseparator get their water. The dryer reduces the surface moisture of the minus ⅜-in. material to around 7 per cent or less, and the dried product then is combined with coal from the classifying screen to make 1¼- or ¾-in. screenings.

Air Tables Installed

Air tables are employed at the Ayrshire mine of the Electric Shovel Coal Corporation for cleaning all sizes from 3-in. down. At this operation, minus 1¼-in. material in the mine-run may be unloaded in the chute to the main screens and run over vibrators for dedusting at 10-mesh in making stoker. The main screens separate the feed into 6-in. lump, 6x3-in. egg, 3x2-in. nut and 2-in. screenings. Lump and egg are hand-picked while the 3x2 is cleaned on an air table. Jeffrey single-roll and American Pulverizer ring-mill crushers are installed—the latter for 3x2 only—for breaking down all sizes above 2-in. The crusher product may be run to an Arms screen for separation into plus and minus 1¼-in. fractions, the former going back to the main screens and the latter, along with the natural screenings, to two Robt. Holmes vibrators for dedusting at 10-mesh. Screenings, of course, may be bypassed and loaded without dedusting when desired.

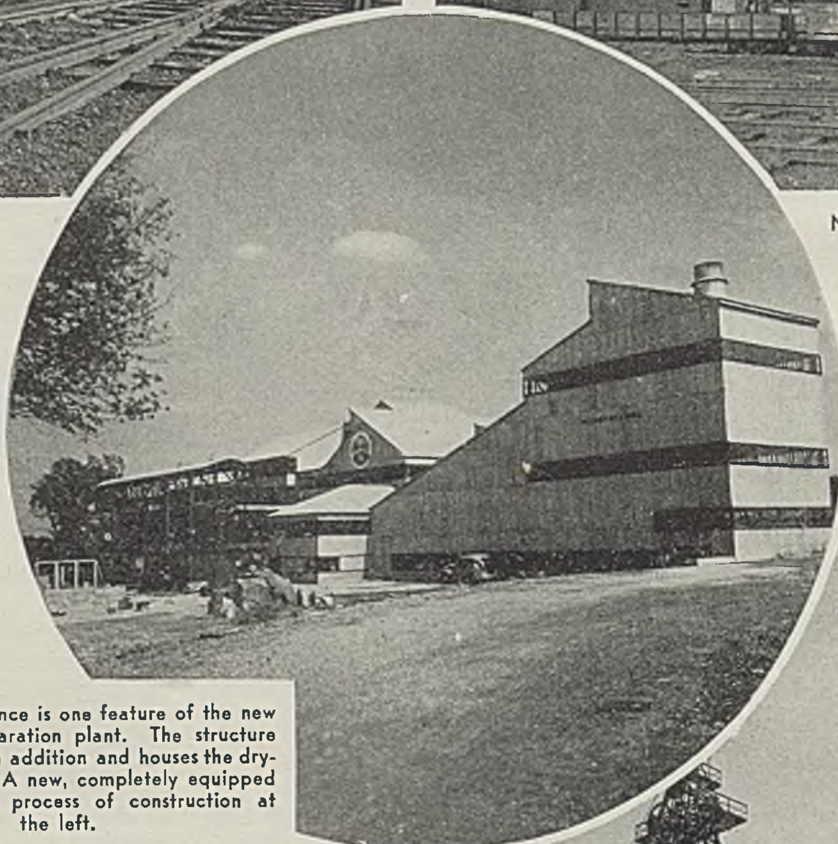
Five Arms air tables are used in producing 2x1¼-, 1¼x¾-, ¾x$\frac{3}{16}$- and minus $\frac{3}{16}$-in. sizes Feed to the tables consists of part of the 2-in. raw screenings made in the main tipple



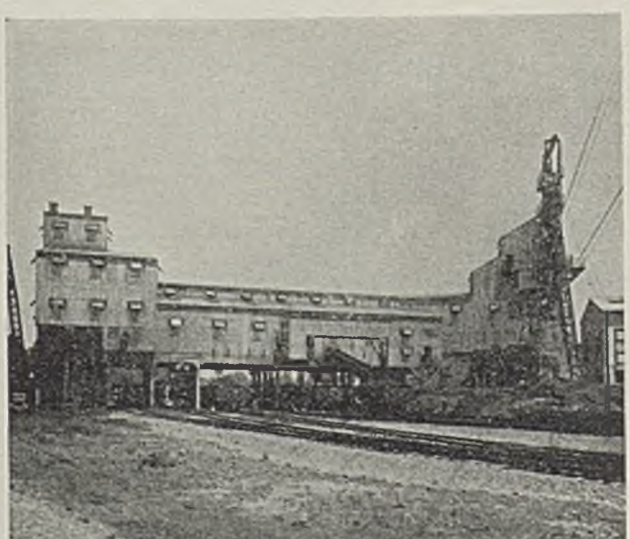


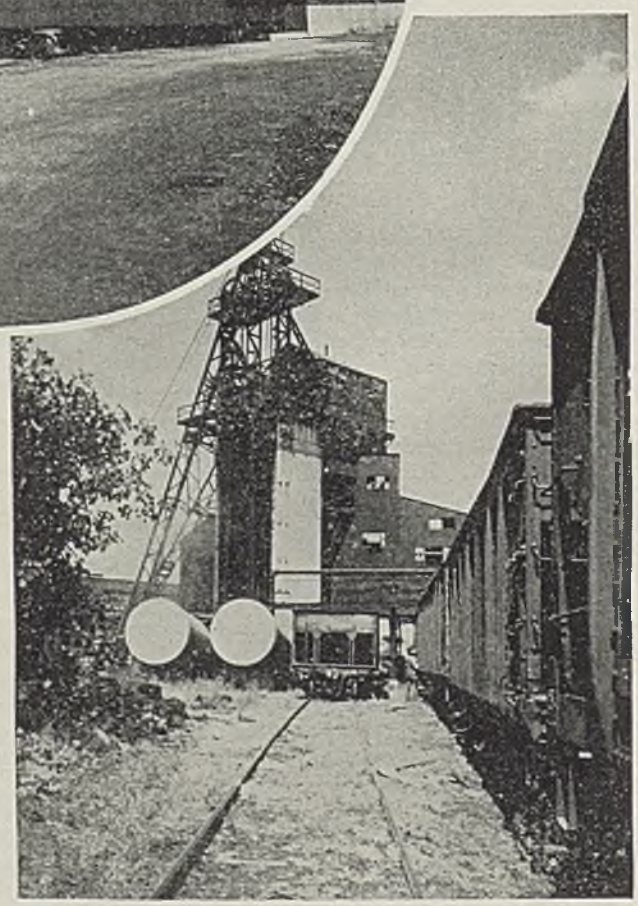
Mechanical cleaning and heat drying feature the Friar Tuck preparation plant

New Hope coal is prepared in this mechanical preparation plant with heat-drying addition



Modern appearance is one feature of the new Minnehaha preparation plant. The structure at the right is an addition and houses the drying equipment. A new, completely equipped laboratory is in process of construction at the left.





All coal is washed in this preparation plant at Talleydale mine.

Both washing and dry cleaning are done at Knox Consolidated No. 2.

plus a Bradford-breaker product. This Bradford-breaker product consists of pickings; lump, egg and 3x2-in. degradation; etc., from which large sulphur and rock are eliminated in the course of a reduction to 2 in. The breaker discharges into a bin which also receives the natural screenings and feeds the air tables. Incidentally, the introduction of the breaker product, by providing increased surface over which to spread moisture carried by the natural screenings, goes far toward smoothing out moisture fluctuations in the table feed and this improves their operation.

Screens ahead of the tables separate the feed into 2x1$\frac{1}{4}$-, 1$\frac{1}{4}$x1-, 1x$\frac{3}{4}$-, $\frac{3}{4}$x$\frac{3}{8}$-in. and $\frac{3}{8}$-in.x10-mesh sizes, with the 10-mesh going to a storage bin. Each size is cleaned on a separate table and then all are recombined and rescreened into 2x1$\frac{1}{4}$-, 1$\frac{1}{4}$x$\frac{3}{4}$-, $\frac{3}{4}$x$\frac{5}{16}$- and minus $\frac{5}{16}$-in. sizes. The latter is run to the 10-mesh dust bin primarily as a means of improving the flowing characteristics of this product.

In Modernistic Class

One of the latest Indiana mechanical-cleaning plants, that of the Hickory Grove Coal Mining Corporation, falls into the "modernistic" class, in which outside appearance is dressed up to appeal to the eye while the interior is arranged for convenient access to equipment, coolness, light, ventilation, etc. Fireproof construction and provisions for low maintenance of structure and equipment are other design features of the Minnehaha plant, designed by Jeffrey and erected by Hickory Grove.

Seven primary sizes may be loaded at one time at Minnehaha, as follows: 6-in. lump, 6x4-in. egg, 4x2-in. egg, 2x1$\frac{1}{2}$-in. nut, 1$\frac{1}{2}$x1-in. nut, 1x$\frac{3}{8}$-in. stoker and $\frac{3}{8}$-in. (nominally $\frac{3}{8}$-in.x35-mesh) carbon. The five largest sizes are loaded over booms equipped with diversion chutes, while the two smaller sizes are brought to the outside of the tipple by belts and then are loaded through bifurcated chutes, to permit car changing without stoppage. Bringing the two smallest sizes outside places all loading operations under the eye of the plant operator in the control room facing the loading bay. Equipment is provided for making practically any desired mixture, either straight run-of-size or with sizes proportioned by varying gate openings, on practically any track.

Coal from the pit is dumped into a 200-ton hopper from which it is moved out onto a beaded-apron conveyor on a 27-deg. pitch by a plate feeder. Feeder speed is adjustable at will from the operator's quarters in the plant. On the main screen, mine-run is separated into 6-in. lump, 6x4-in. egg and a minus 4-in. resultant. The latter goes to the washing equipment, while the lump and egg are hand-picked on two shaking tables equipped with degradation screens. Picking yields two products, one a pure refuse and the other a material containing recoverable coal. The latter is run to a single-roll crusher, which also receives the degradation from the tables. By taking out the degradation screens, lump or egg or both also can be run to this crusher, the product of which (nominally minus 4 in. in size) is returned to the main screen.

Wash With Baum Jigs

The Minnehaha washer is a three-compartment Jeffrey Baum jig with a capacity of 200 tons per hour. It receives all the minus 4-in. material made on the main screen directly through a launder, and is followed by a classifying and dewatering screen separating the washed coal into the following sizes: 4x2, 2x1$\frac{1}{2}$, 1$\frac{1}{2}$x1, 1x$\frac{5}{16}$, $\frac{5}{16}$x$\frac{1}{8}$ and minus $\frac{1}{8}$. The three largest sizes go directly to a multi-compartment distributing conveyor, which carries them to their respective loading booms, or to the boom equipment on which a mixture or mixtures are being loaded. Supplementing the above facilities a "Flex-Tooth" crusher has been installed for breaking all sizes from 4 down to 1 in. down to as low as $\frac{3}{4}$ in. or any other size to which the crusher is set, which means, if the other crusher is operating on lump and egg, that the entire plant output may be reduced to screenings.

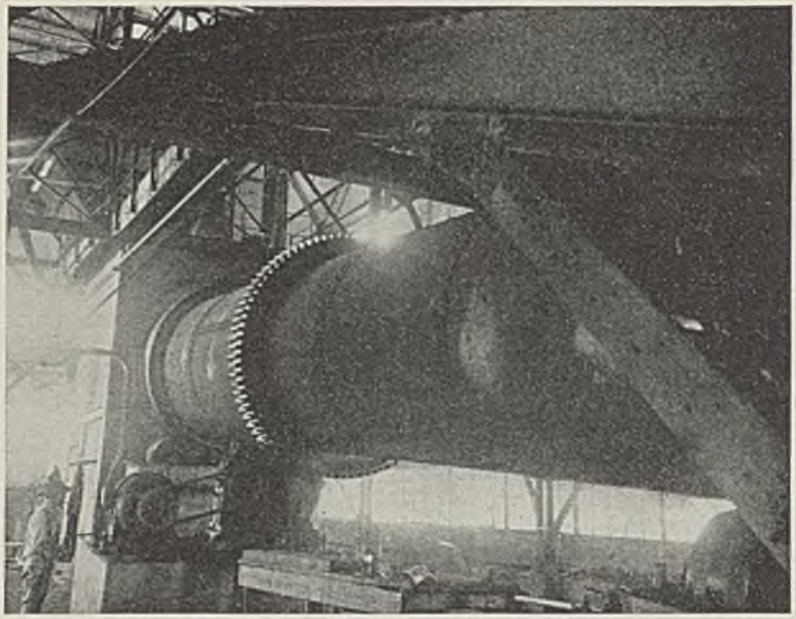
The 1x$\frac{5}{16}$- and $\frac{5}{16}$x$\frac{1}{8}$-in. sizes from the classifying screens may be sent to the Minnehaha drying plant or combined and conveyed without further treatment to a Jeffrey-Traylor vibrator for separation into 1x$\frac{3}{8}$- and minus $\frac{3}{8}$-in. sizes for loading or mixing. Minus $\frac{1}{8}$-in. coal is run to a Jeffrey fine coal recovery plant, where, primarily by hydraulic classification, it is separated into $\frac{1}{8}$-in.x35-mesh and minus 35-mesh fractions. The former is recovered and run to a storage bin, from which, if desired, it can be combined with the $\frac{5}{16}$x$\frac{1}{8}$-in. size, thus increasing recovery. Minus 35-mesh material removed from the settling tank by the sludge conveyor is pumped to the slurry pond, although part of it may be reclaimed as outlined below.

Facilities for both mechanical and heat drying are provided in the drying addition to the Minnehaha plant. Equipment includes a Howe continuous centrifugal dryer and a No. 5 Christie heat dryer supplied with heat by a "Firite" stoker. Temperature of the air to the Christie unit normally is about 1,200 deg. F.; outlet temperature is about 300 deg. The drying plant is arranged so that 1x$\frac{5}{16}$-in. coal can be run to the Christie unit and $\frac{5}{16}$-in.x35-mesh to the Howe. However, the entire minus 1-in. product may be sent to the heat dryer or it may be left divided to permit running the minus $\frac{5}{16}$-in. material through the Howe unit first. When the entire product is being passed through the heat dryer, the 1x$\frac{5}{16}$-in. size usually reaches it carrying about 8 per cent of surface moisture, with the Howe product carrying less than 6 per cent, as compared to 16 to 18 per cent as it enters the machine. The whole is dried in the Christie to less than 3 per cent surface moisture and is returned to the tipple for supplementary screening and loading, as outlined above.

Recovering Minus 35-Mesh

The Howe unit has been used for recovering and cleaning minus 35-mesh material otherwise pumped to the sludge pond. This size, of course, carries some material up to about $\frac{1}{8}$ in. in size. When reclamation is practiced, slurry from the settling tank is pumped into the centrifuge along with the product normally dewatered. Slurry so handled varies from 20 to 25 tons per hour, of which around 5 to 7 tons per hour can be reclaimed in the dryer with an ash, according to one test, of 7.56 per cent as a result of whirling out the clay and other very fine impurities with the water.

In building the Minnehaha plant, a concrete structure (reinforced columns, beams and floor slab) was installed over the loading tracks, as investigation showed the cost to be about the same as if steel columns, beams and a 5-in. concrete floor were used, while the resulting structure would be more substantial and have a neater appearance. All heavy equipment, such as the washer, fine-coal recovery plant, etc., are located on the ground or on short stub columns, these measures, along with the concrete structure, materially reducing vibration and sway. The conveyor system from the heat-drying plant is entirely inclosed, with vents to the atmosphere, to prevent the escape of dust and fumes into the plant at all times, as well as moisture in the winter time, with resultant condensa-



Coal from 1-in. down may be dried in this kiln-type stoker-fired unit at Minnehaha.

tion on the walls and equipment.

Both wet- and dry-cleaning equipment has been installed at the Wick mine of the Ingle Coal Co. for treating coal smaller than 4 in. Facilities also include two Tyler 400 electric screens for dedusting screenings at 10-mesh. Minus 4-in. coal usually is run to a Menzies hydroseparator and then is separated into 4x2, 2x1¼, 1¼x¾ and minus ¾ sizes on a dewatering and classifying screen. Feed to the washer includes pickings, which are broken down to minus 1¼-in. in a single-roll crusher. Minus ¾-in. coal can, however, be run over a "Ro-Sieve" screen for separation into ¾x⅜- and minus ⅜-in. fractions for cleaning in two Stump Air-Flow units.

A Morrow-Prins washer recently was installed at Knox Consolidated No. 2 mine to improve the combustion characteristics of the plant's 2½x1¼-in. nut, primarily by removing pieces of pyritic material that tended to form nuclei and clinker in the fuel bed. Also, in addition to an accompanying ash reduction, removing pyrites and other hard material facilitates crushing this washed nut in making a commercial-stoker coal. A detailed description of this installation appeared in the August, 1938, issue of *Coal Age*, p. 31.

Washing of all coal under 3 in. is the practice in the New Hope preparation plant of the Linton-Summit Coal Co., designed and built by McNally-Pittsburg. At this plant, 6-in. lump and 6x3-in. egg are handpicked and material containing coal is sent to a jaw crusher for reduction and return to the mine-run feed. The jaw crusher was adopted because of the extremely hard nature of the refuse material, which made it difficult to reduce in other types of breaking equipment. Washing is done in a five-compartment McNally-Norton washer with automatic reject control. After washing, the coal is dewatered and separated into 3x2-, 2x1¼, 1¼x¾- and minus ¾-in. sizes on a classifying and dewatering screen. The latter size is further dewatered on high-speed shakers fitted with wedge-wire sieves, the material through the screens going to a settling cone with the water.

In summer, barring specific instructions from a customer, the dewatered minus ¾-in. coal is combined with the 1¼x¾-in. fraction to make a 1¼-in. screenings, which can be loaded directly or mixed with other sizes. A crusher between the strands of the mixing conveyor can be used to break down lump and egg, the product going either to the mixing conveyor and the car or by belt back to the main screen for recirculation. In winter, the minus ¾-in. coal is dried in an addition to the original plant, comprising a "D-L-O" heat dryer and auxiliary equipment. Inlet temperature is 900 to 1,050 deg., and the dried coal is returned to the main plant for recombination with the dewatered 1¼x¾-in. size.

Washing at Two Gravities

Two washing gravities are employed at the Linton Supreme plant of the Maumee Collieries Co. (September, 1938, *Coal Age*, p. 29), where changes in gravity are accompanied by changes in the size of the feed to the cleaning unit. This arises from the fact that two mines feed the same plant, one recovering the Indiana Fourth Vein and the other a rider coal overlying part of the No. 4 territory. The two coals are prepared on separate days or separate shifts. The plant is equipped to ship seven primary sizes simultaneously, with box-car loading equipment in addition. However, lump seldom is made at the plant and consequently the usual list is six grades when preparing No. 4 coal. When preparing rider coal, on the other hand, only egg and screenings are shipped as a rule and the entire product is washed, as compared with only material under 4 in. in the case of the No. 4 product.

Under the above schedule, raw mine-run from both seams first is run through a Gruendler 24x36-in. crusher adjustable to between 2 and 12 in. In the case of rider coal, the crusher reduces it to 6-in., after which it goes directly to the washer for cleaning at a gravity of 1.50 When No. 4 coal is being prepared, however, the crusher discharges onto two shaker screens for making either lump, furnace lump and a minus 4-in. resultant, or furnace lump and resultant only. The large coal is handpicked, while the 4-in. resultant goes to the washer for cleaning at a gravity of 1.45. This washer also receives pickings containing recoverable coal, which are broken down in a 20x14-in. Gruendler ring mill.

Washing is done in a McNally-Norton five-compartment automatic washer. The washer is followed by a dewatering and classifying screen separating the coal into plus 2-, 2x 1½- or 1¼-, 1½-or 1¼x¾-, ¾x⅜- and minus ⅜-in. fractions. The latter flows with the water to high-speed auxiliary dewatering screens fitted with ½-mm. wedge-wire sieves. If rider coal is being shipped, all the fractions are combined to make egg and screenings. If No. 4 is being prepared, the various sizes may be loaded separately (after supplementary treatment of the minus ⅜) or in combinations. Two additional Gruendler crushers (one ring and one single-roll) follow the dewatering and sizing screen for making stoker coal from the 2x1½- or 1¼-, or 1½- or 1¼x¾-in. sizes.

Minus ⅜-in. coal off the wedge-wire screens may be heat-dried in a Christie unit supplied with heat by two "Firite" stokers. This dryer also will handle minus ¾-in. coal, but this is not the usual practice. Inlet temperature usually is 1,200 deg. F.; outlet, 200 deg. The plant is designed to remove all surface moisture from the ⅜-in. material so that when it is mixed with the 1¼x⅜- or ¾x⅜-in. coal from the dewatering screen the resultant average moisture will be low enough to obviate freezing. Dried coal is conveyed to a 25-ton storage bin, which permits running the dryer empty in case of a stoppage in coal flow—a guard against the possibility of fire—and also provides a reserve of minus ⅜-in. coal at all times for mixing to make screenings.

The Linton Supreme plant is the third welded installation to be put in service by Maumee, the first being Chieftain No. 20 and the second Old Glory No. 17. Both the earlier installations were considerably simpler, inasmuch as they did not embody washing and drying equipment. Welding at Linton Supreme was extended to all elements, structure as well as equipment, with the exception of equipment purchased as a unit, such as the washer.

Pioneers in Washing Plant

Among the pioneering developments of the Sherwood stripping organization was the first use of washing equipment at a strip mine in Indiana: viz., Elmore jigs in 1919. Carrying on along this line, the first Link-Belt Simon-Carves washing equipment to go in operation at a mine in the United States was installed at the Friar Tuck mine of the Sherwood-Templeton Coal Co. in 1928 (*Coal Age,* April 1929, p. 221). Primary sizes produced at Friar Tuck are: 6-in. lump, 6x4-in. egg, 4x2-in. nut, 2x1¼-in. nut and 1¼-in. screenings. Lump and egg are hand-picked and all coal under 4 in. is washed in two Link-Belt Simon-Carves washers with an aggregate capacity of 400 tons per hour. Plant reject runs 23 to 24 per cent.

Washed coal passes over a dewatering and classifying screen, where it is separated into 4x2, 2x1¼, 1¼x¾ and minus ¾ sizes. The latter goes to wedge-wire dewatering screens, where the moisture is reduced to 8 to 9 per cent. The 1¼x¾-in. size is run onto a 3x6-ft. "Plat-O" vibrator, where the surface moisture is further reduced to around 3 to 4 per cent. In summer, the two sizes then are mixed to make screenings for shipment.

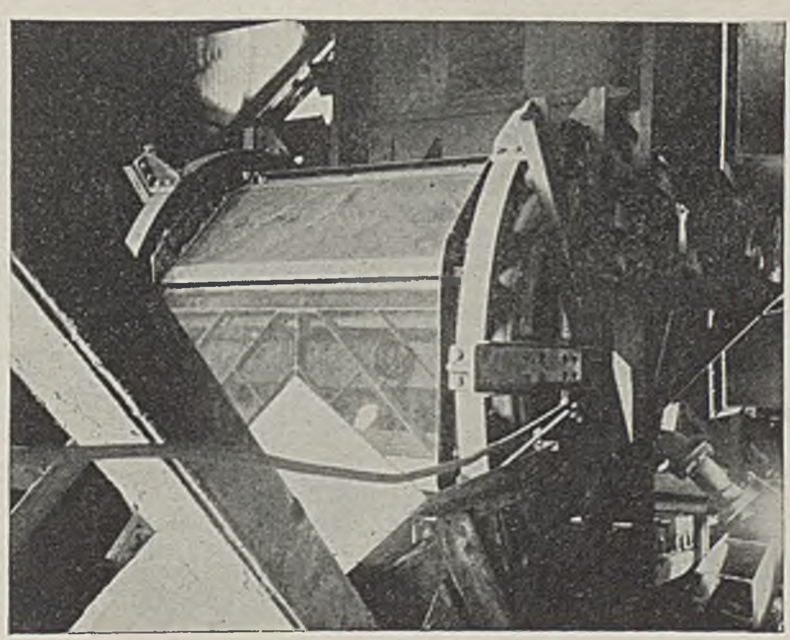
Crushing facilities at Friar Tuck permit breaking all coal down to minus ¾ in. Primary crushing is done in a Link-Belt double-roll unit which can receive all sizes down to ¾ in., breaking to nominally 1¼ in. or other figure to which the crusher may be set. Usually, the limit is 1¼. Then if the coal is to be further reduced the crushed product is run over a screen to take out all material larger than ¾ in. This overscreen material is passed through a second double-roll crusher for reduction to nominally ¾ in. and the crusher product is discharged onto an Allis-Chalmers "Low-Head" vibrator, where it is separated into plus and minus ⅛-in. sizes. The large coal then is run over two Link-Belt vibrators to separate out any plus ¾-in. coal, which is returned to the crusher. Equipment also was being installed at the time this article was prepared for making stoker from coal from the classifying screen or from the crushing equipment.

Friar Tuck also is equipped with heat-drying equipment for dewatering the minus ¾-in. product from the wedge-wire screens in the winter time. The drying equipment is a D-L-O unit, in fact the first D-L-O unit ever developed for coal drying (*Coal Age,* January, 1933, p. 7). This resulted from a search for a cheaper and more reliable means of preventing freezing of washed coal in the winter time, formerly accomplished at the Sherwood mines by the use of calcium chloride—another pioneering step by this organization. The D-L-O unit went into operation in 1931 after being developed at the Friar Tuck mine. It is operated at an inlet temperature of 600 to 800 deg. F., with the usual figure as 700. Heat is supplied by an Illinois chain-grate stoker. The goal is a ¾-in. product sufficiently dry so that when it is mixed with the 1¼x¾-in. size from the "Plat-O" dewatering vibrator the resultant average moisture of the mixture will be close to 6 per cent.

Fines through the wedge-wire sieves noted above are pumped, along with similar material from the New Hope plant, to the cleaning plant of the Antioch Power Co., another Sherwood company. The pumping medium is a "Hydro-seal" unit. The Antioch cleaning plant consists of two 7½x16-ft. Deister "Plat-O" coal-washing tables with a capacity of approximately 20 tons each per hour of nominally minus ⅛-in. material. Before this material is fed to the tables, it is passed over a section of ½-mm. wedge wire to eliminate the extreme fines, as well as much of the water containing clay, etc. The tables reduce the ash content of the feed from around 25 to 30 per cent to around 12 per cent as an average, with 15 per cent as a maximum. Cleaning of the slurry, which is used as a boiler fuel, resulted in a reduction of two-thirds in fuel consumption and also permitted the company to take one boiler off the line.

Washing at the Allendale plant of the Central Indiana Coal Co., another Sherwood company, where the reject averages around 25 per cent, is done in two Elmore jigs (4x2-in. coal) and one Link-Belt Simon-Carves washer (2x0). Otherwise, preparation practices are substantially the same as at Friar Tuck, except that a Bradford breaker is used for breaking down prepared

Part of the Friar Tuck heat dryer, the first such unit of this type to be installed in a coal-preparation plant.



coal over 4 in. in size and heat is supplied to the D-L-O dryer by a Firite stoker.

Ships No Lump Coal

Lump is not shipped from the Talleydale plant of the Snow Hill Coal Corporation, designed and built by the Allen & Garcia Co., and consequently all material over 6 in. is broken down. To this end, mine-run coal is dumped onto a shaker screen, where it is separated into plus and minus 6-in. sizes, the latter going to a classifying screen ahead of the mechanical-cleaning units. Originally, the 6-in. lump was run into a Bradford breaker, also receiving coarse-coal-washer refuse, and the mixture was broken to minus 1¼ in. To salvage some of the size value of the lump, however, a partition was put in the breaker, dividing it into two parts, one with a 1¼-in. screen, which still receives the refuse, and the other with a 6-in. screen, receiving the lump.

All 6-in. material, whether natural or made in the Bradford breaker, is separated into 6x3-, 3x1¼-, 1¼x¾-, ¾x⅜- and minus ⅜-in. fractions on the classifying screen. Then, on the basis of the original operating schedule, these sizes were routed as follows: 6x3, No. 1 Vissac jig; 3x1¼, No. 2 jig; 1¼x¾, No. 3 jig; ¾x⅜, No. 4 jig; and minus ⅜, two Algar dedusters for removal of minus 48-mesh material and then to four Stump "Air-Flow" cleaners. Refuse from the Nos. 1 and 2 jigs goes to one section of the Bradford breaker for reduction to minus 1¼ in., and then is combined with Nos. 3 and 4 jigs refuse for treatment in another Vissac jig (No. 7). This jig is primarily for the recovery of pyrites, which is shipped as far as orders are available. The coal end from No. 7 jig goes to No. 6 jig, which makes a final refuse and another coal end. This coal end in turn is screened at $\frac{3}{16}$ in., the overscreen material going to an auxiliary shaker screen for separation into 1¼x¾-, ¾x⅜- and minus ⅜-in. sizes. The larger sizes go to Nos. 3 and 4 jigs, respectively, for retreatment, while the minus ⅜ goes to still another Vissac jig (No. 5). This No. 5 jig also receives middlings from the "Air-Flow" cleaners and slurry from the settling tank, consisting of minus $\frac{3}{16}$-in. material from No. 6 jig and minus ¼- and ⅜-in. degradation from the dewatering launders following Nos. 1 to 4 jigs. Clean coal from No. 5 jig is dewatered on a Symonds screen, where it can be combined with the ⅜-in. product from the air cleaners. Reject from No. 5 jig goes to the refuse. Thus, if minus 48-mesh dust is excluded, refuse is made at only three points in the plant: namely, Nos. 5 and 6 jigs, and the air cleaners. A mixing conveyor permits shipment of mixtures of any two or more sizes, while refuse is handled by an American Steel & Wire Co. two-bucket reversible, or jib-back, aerial tramway with an average capacity of 90 tons per hour.

Preparation at the No. 11 plant of the Sunlight Coal Co. is based on hand-picking 6-in. lump, 6x4-in. egg and 4x2-in. nut; washing 2x½-in. coal; and water-dedusting minus ½-in. material as outlined earlier in this article. Washing is done in a McNally-Norton automatic washer, and its feed is separated from 2-in. raw screenings by Morrison vibrators. Washed coal is separated into 2x¾- and ¾x½-in. fractions on a classifying and dewatering screen and when screenings are being made are combined with the minus ½-in. coal after wet dedusting. A Bradford breaker is installed to break down pickings or pickings and oversized coal and the breaker product is returned to the plant feed. In addition, an American Pulverizer ring mill is installed for crushing all sizes down to ¾ in. to that limit when desired. A mixing conveyor rounds out the No. 11 facilities.

Dustless Coal Treatment

Indiana operators generally use petroleum products as a means of allaying dust in handling coal. The Enos Coal Mining Co., however, is prepared to apply several treatments, including a chemical combination developed especially for its use. And the Maumee Collieries Co. has installed the Dustlix process at its Old Glory No. 17 and Chieftain No. 20 plants. Hot oil, however, is the favored treatment among Indiana producers, with Viking heating and spraying equipment for raising the oil temperature and applying it. Companies using hot oil include the Hickory Grove Coal Mining Corporation, Ingle Coal Co., Knox Consolidated Coal Corporation, Central Indiana Coal Co., Glendora Coal Co., Maumee Collieries Co. (Waxolizing process, Linton Supreme preparation plant), Princeton Mining Co., Sherwood-Templeton Coal Co. and the Templeton Coal Co. The Snow Hill Coal Corporation, on the other hand, has installed the Piggott (Brown-Fayro) high-pressure system for spraying cold oil.

In the majority of cases, the treatment systems are designed to include all sizes, although some omit lump and others are confined only to the smaller screened sizes and screenings or stoker. The trend, as in other fields, is toward heavier oils or waxes, with some preparation men, as at Glendora No. 28, considering the use of 600-second petroleum products. One operation in the State, Ayrshire, is equipped to treat its coal with "Procite" to improve combustion characteristics.

Another Electric Shovel operation, Staunton, furnishes an example of the use of a petroleum product to arrest the evaporation of moisture and thus prevent degradation of the coal in handling and storage. Staunton strips the Brazil Block coal, running 51 per cent of 6-in. block. The coal has a high ash fusion and is low in sulphur and ash but at the same time has a high moisture content, the evaporation of which results in disintegration of the lumps.

Paraffin Coat Applied

In investigating the problem of checking moisture escape, particularly in summer, it was decided that possibly the coal might be covered with a sealing coat and at the same time rendered dustless if a paraffin-base petroleum product of the right pour and viscosity could be found. As a result, the plant now uses a product, supplied by the Coal Processing Co., with a 90- to 100-deg. F. pour and a 200-second viscosity. The treating material is brought up to and maintained at the proper temperature by a Viking dual heating and circulating system.

Since experience has demonstrated the importance of closely controlling conditions at the point of application, thermometers and pressure gages are mounted in the tipple to assist in keeping temperature at close to 165 deg. F. and pressure at 135 to 140 lb. per square inch at the nozzles. All treating points are inclosed to prevent the escape of the treating fluid, and the coal either is sprayed in inclosures while falling through the air or, in the case of egg and lump on the main screen, from above, below and both sides through the medium of a special hood (see p. 114). Elimination of waste in this manner makes it possible to treat all sizes with an average of 0.68 gal. per ton. A major result has been a reduction of as much as 10 per cent in the production of material smaller than 1¼ in. from breakage in loading and subsequent handling.

TIPPLE ELECTRIFICATION

+ At Indiana Coal Mines

CONNECTED motor horsepower in some of the larger preparation plants of Indiana totals close to 1,000 and in one instance, at a strip mine using electric shovels, the plant uses 50 per cent of the total electric power requirements. At two other mines, one a strip operation and the other underground, the preparation plants use 25 per cent of the total kilowatt-hours purchased. Electrical construction in some of the newer plants embodies the latest ideas for safety and low maintenance. Picking-table illumination has been materially improved and several types of the newer lighting units are in use.

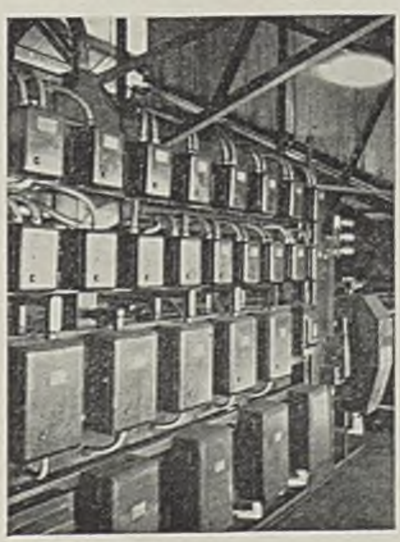
With the exception of four mines where direct current only is available and two plants where 220 volt a.c. is used, motors in the tipples and preparation plants in Indiana covered in the *Coal Age* survey operate on 440 volts. There are, however, a few 2,300-volt motors in sizes of 75 hp. and larger. Talleydale plant of the Snow Hill Coal Corporation has a 75-hp. 2,300-volt wound-rotor motor on a Bradford breaker, a 75-hp. 2,300-volt motor driving a blower, and two 125-hp. 2,300-volt synchronous motors driving circulating pumps. All other motors in the plant (58 in number) operate on 440 volts. Talleydale equipment includes seven Vissac jigs, four Stump "Air-Flow" cleaners and two Algar dedusters, and the 62 motors total 959 connected-horsepower. Fifty-four of the 62 motors in the plant are the inclosed, fan-cooled, ball-bearing type. Kings Station mine of the Princeton Mining Co. has one 2,300-volt motor on a crusher and it is one of a few plants where all other motors are 220-volt units.

The strip-mine preparation plant of the Enos Coal Mining Co. contains 64 motors with full-load ratings totaling 900 hp. Indiana's largest preparation-plant motor is a 200-hp. unit on a crusher at the Sunlight Coal Co. Multiple V-belt drive connections are standard practice in the State. Exceptions are a few gear reducers on special duties and some flat belts. Individual pushbutton control for each motor is the common practice in Indiana preparation plants. At the Chieftain No. 20 plant of the Maumee Collieries Co. the operation of the thermal relay in the control of any one motor causes a shutdown of all motors driving equipment feeding coal to that point.

In a new Jeffrey 300-tons-per-hour plant at the Minnehaha mine of the Hickory Grove Coal Mining Corporation the electrical system is a combination of design by factory engineers and installation by the electrical department of the coal company. The plant with its washing and drying equipment contains 30 440-volt

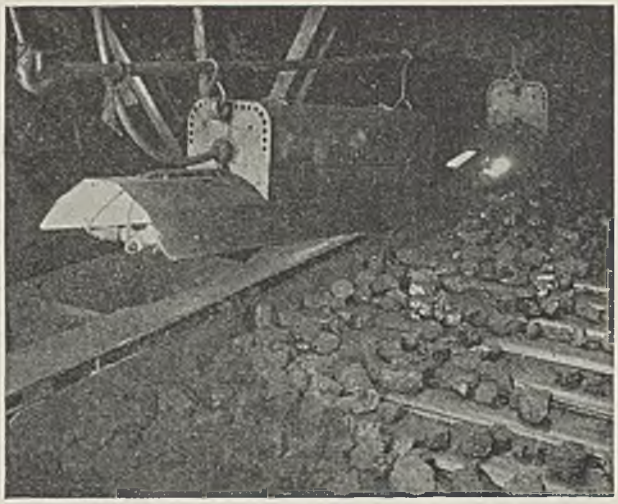
Twenty-seven interlocked pushbutton stations control the new Minnehaha plant.

Magnetic switches with thermal overload relays at Minnehaha. No fuses are used.



Right: square duct protects wire groups between rigid and flexible conduits.

Six high-intensity mercury lamps over two picking tables illuminate the coal to 160 foot-candles at Knox Consolidated No. 2 mine, Knox Consolidated Coal Corporation.



Two tube-type mercury lamps over this table in the Chieftain No. 20 preparation plant, Maumee Collieries Co., illuminate the coal to 100 to 160 foot-candles.

motors, the largest a 100-hp. unit on the crusher. The connected horsepower is 511. In the plant, dryer not included, there are 27 principal motors, and on a sloping bench-type control board, in a room overlooking the booms and main equipment in the tipple, are a corresponding number of General Electric pushbutton stations above each of which are two indicating lamps, both in parallel, so if one lamp burns out there is still an indication that there is power on the motor.

The buttons are in position sequence and to put the plant in operation, therefore, the starting buttons are pushed "down the line" one after the other. Interlocks prevent the actual starting of any item of equipment until the unit ahead (in coal flow) is in motion. Besides the start and stop buttons each pushbutton station has a pair of transfer buttons. Normally the sequence button of the pair is kept in the depressed position. Pushing the other button, which throws out the sequence button, cuts that motor unit out of the sequence. Thus if all "out-of-sequence" buttons are depressed, any motor in the plant can be stopped or started without regard for the operating condition of any other. If any unit stops during normal operation, all previous units (in the coal flow) stop immediately.

Motor-Control Set-ups

At each motor there is a quick-make-and-break safety-type knife switch and a stop button. This button acts with the main control board to stop the motor and all other motors feeding coal toward that point. No fuses are used in power or control circuits of the plant. Thermal overload protection is afforded by the individual magnetic starting switches. On the incoming 440-volt oil-switch panel there is an ammeter and six ground detector lamps. Two 220-volt carbon lamps are in series. The three pairs are each connected from a line wire to ground. Dimming of a pair of lamps indicates a ground on the phase wire to which they are connected.

Except for short pieces of flexible conduit at motors and between "Square Ducts" and magnetic starters, the Minnehaha plant wiring, including lighting circuits, is in rigid conduit. The "Square Duct" serves admirably to inclose the wiring back of the control panels. Wire sizes in every case are at least 50 per cent greater than the size called for by the Underwriters to carry the full-load motor current. This was done with the idea that later on in some cases larger motors might be found necessary. Already one change was made which required a larger motor, but it was not necessary to revise the

Table 1—Motor Test Data, Minnehaha Preparation Plant

	Horsepower			Watts	Amperes		Volt-Am-peres	Power Factor †	Rated Speed
	Rated	Actual * Input	Actual * Output	Input	Rated	Actual			
Stoker belt conveyor	2	1.2	0.7	920	2.9	2.0	1,524	0.61	Gearmotor
Slack belt conveyor	2	0.8	0.4	600	2.9	1.7	1,255	0.48	Gearmotor
Pea boom, No. 5 conveyor	3	2.9	2.2	2,180	4.8	4.2	3,200	0.68	1,200
Stoker nut boom, No. 4 conveyor	3	3.1	2.3	2,300	4.8	4.2	3,200	0.72	1,200
Nut boom, No. 3 conveyor	3	3.0	2.2	2,240	4.8	4.1	3,080	0.73	1,200
Lump boom	5	2.9	2.0	2,200	7.5	4.6	3,500	0.63	1,200
Egg boom	5	2.2	1.3	1,600	7.3	4.2	3,150	0.51	1,200
Bone-coal conveyor	5	1.7	0.8	1,240	7.5	3.1	2,380	0.52	1,200
Refuse conveyor	5	2.5	1.8	1,880	7.5	4.2	3,160	0.59	1,200
Fine-coal rescreen	5	4.2	3.3	3,120	7.5	5.5	4,180	0.75	1,200
Fine-coal hopper	3	0.9	0.4	700	4.2	1.9	1,425	0.49	Gearmotor
Lump table	7.5	3.2	1.3	2,360	12.1	6.5	4,630	0.51	900
Egg table	7.5	3.2	1.3	2,340	9.8	6.1	4,680	0.50	900
Jig refuse and table refuse	7.5	7.7	6.5	5,760	10.8	9.3	7,100	0.81	1,200
Crushed-coal elevator	7.5	1.9	0.8	1,440	9.4	4.0	2,348	0.61	1,200
Lake pump	7.5	8.8	7.6	6,580	10.0	11.0	8,382	0.78	1,200
Sludge pump	7.5	5.9	4.2	4,420	10.0	6.9	5,250	0.84	1,200
Three-compartment conveyor	15	11.8	9.0	8,800	20.5	15.0	11,400	0.77	1,200
Fine-coal conveyor	15	10.6	8.0	7,920	18.3	14.5	11,000	0.72	1,200
Jig	15	3.9	2.3	2,920	19.0	7.0	5,330	0.55	1,200
Feeder	10	6.1	4.5	4,560	......	11.0	8,480	0.54	....
Air compressor	40	33.9	27.0	25,280	51.0	36.5	27,800	0.91	3,600
Shaker	20	3.7	2.0	2,760	......	8.8	6,700	0.41	695
Dewatering screen	20	13.0	9.0	9,720	27.0	19.5	14,870	0.65	900
Circulating pump	40	48.0	40.0	35,840	50.5	55.0	41,900	0.86	1,200
Crusher, small	30	9.7	5.5	7,200	38.1	26.5	20,400	0.36	900
Mine-run conveyor	40	31.5	24.0	23,440	49.2	39.0	29,700	0.79	900
Centrifuge:	50	......	......	......	......	......	......	......	....
¾ x 0 plus ⅜-in. slurry:	......	44.0	38.5	32,800	63.0	54.0	41,100	0.80	....
¾ x 0 plus 10 per cent 1-in. plus ⅜-in. slurry:	......	51.5	45.0	38,400	63.0	60.0	45,600	0.84	....
Gate full open:	......	102.0	86.0	75,600	63.0	135.0	103,000	0.74	....
Dryer exhaust fan	30	26.7	23.5	19,840	38.0	31.0	23,600	0.84	....
Crusher, large	100‡	......	......	......	......	......	......	......	1,200

* Horsepower output was calculated from motor input and rated efficiency. † Over-all power factor of the whole preparation plant is 0.80. ‡ Large crusher was added after test was made.

electrical circuit. At the Linton Supreme mine of the Maumee Collieries Co. "Square Duct" in 4- and 6-in. sizes is used for the main runs of wiring from control board to motor groups. All motor and light wiring in the preparation plant at Enos consists of BX cable.

From the standpoint of picking-table lighting, at least 75 per cent of the companies which do considerable hand picking have installed some form of new lighting in place of the old method of small to medium lamps without reflectors. High-intensity mercury vapor lamps, A. C. Cooper-Hewitt long-tube mercury lamps, 200-watt Mazda units with day-blue cover glasses and Mazda "Skylight" units all are represented in the modern installations. In general, excellent results are being obtained from the high-intensity mercury vapor lamps which are used at seven of the plants visited by *Coal Age*. In some cases, however, the results fall short of the possibilities because not enough lamps are used.

Heights Affect Intensity

Where lamps are hung low (30 in.) the intensity of illumination is high, but is spotty unless the lamps are about that distance apart. If the lamps are hung high (6 ft.) which is necessary if sledges are used for breaking coal or refuse on the table, the distribution is likely to be uniform but the intensity of illumination too low. One fault voiced by mining company engineers, and no type of inclosed unit escaped this criticism, was that the so-called dustproof units are far from dust-tight. Apparently only vaporproof units with gasketed flanged covers having a generous number of bolts or clamps will keep out the fine coal dust. Unless the joints can actually withstand a pressure, heating and cooling of the air in the unit will cause a breathing which will carry in dust.

Measurements were made of the relative intensities of illumination at coal level above the picking table at several mines. These tests were made with a Weston Model 650 "Photronic" exposure meter. Although the meter is calibrated in foot-candles and was checked for accuracy with another meter of the same type, the readings mentioned in the following paragraphs are set forth only as approximations for comparison.

The installations of 200-watt incandescent lamps in bowl reflectors, some with day-blue cover glasses, illuminate the picking-table surfaces directly under the units to intensities of 28 to 50 foot-candles. High-intensity mercury-vapor lamps of 250-watts capacity provided 160 foot-candles and those of 400-watts capacity, 170 foot-candles. A.C. Cooper-Hewitt lamps provided 100 to 160 foot-candles. These readings on the four types were made on installations where the mounting height is 26 to 36 in. above the table. Dust was wiped from the bottom of the cover glass, if the unit had one, but in no case was the unit disassembled and cleaned on the inside.

Kings Station preparation plant has eleven 400-watt high-intensity Westinghouse lamps in use over picking surfaces of the Marcus shaker unit and several apron conveyors. Mounting heights range from 28 in. to 56 in., depending on the individual wishes of the men at the various stations, except that the higher units are so mounted because sledges are used by those pickers. Only the use of wire-mesh screen guards below the cover glasses allows a mounting as low as 56 in. where sledges are used. Intensities measured under the Kings Station mercury lamps ranged from 40 to 170 f.c. Apparently this 400-watt unit spreads the light over a larger area than does the typical 250-watt unit. At this plant under the mercury lamps the sulphur (pyrites) stands out in extreme contrast to the coal.

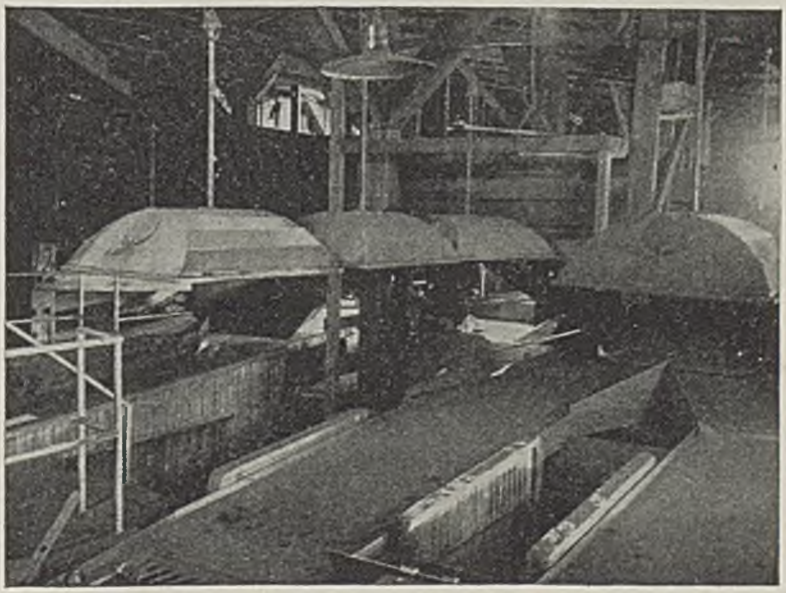
Three General Electric A.C. Cooper-Hewitt lamps, three Westinghouse 250-watt high-intensity mercury vapor lamps and one 200-watt incandescent reflector unit are used over picking tables in the Chieftain No. 20 plant. Foot-candle intensities under the Cooper-Hewitt units are 100 at one end of the tube and 160 at the other. The center of the sloping tube is 29 in. above the table. Because the adjacent tube ends of the two lamps are not over 15 in. apart, the picking table thus served has a fairly uniform illumination.

Unusual Illumination Features

Illumination of picking tables at Enos has two unusual features. To the skylights in the plant roof shades have been applied to stop a large part of the natural light. Illumination for the tables is furnished by Benjamin "Skylight" units each consisting of an enameled steel box containing two 200-watt daylight Mazda lamps and having the 24x36-in. bottom area covered with a diffusing glass. These illuminate the tables to intensities of 28 to 50 foot-candles.

Three tables, each of a different size, are equipped with these Skylight units. One has six, another four and the third has two. Edges of the units are only 8 in. apart and therefore practically the whole table surface is blanketed with a highly diffused non-glare light. Plant officials report that mercury lamps were tried, but for some peculiar reason their light appeared to deaden the coal and reduce the contrast between the coal and slate as compared to the incandescent light. A similar conclusion was arrived at by officials of the Templeton interests after experiments with mercury lamps at Glendora Nos. 27 and 28 mines. Single 200-watt incandescent units were installed at those mines. At Glendora, as at Enos, slate is the major item.

Three "Skylight" Mazda units over each wing of this table at Enos supply 28 to 50 foot-candles of diffused light.



POWER GENERATION

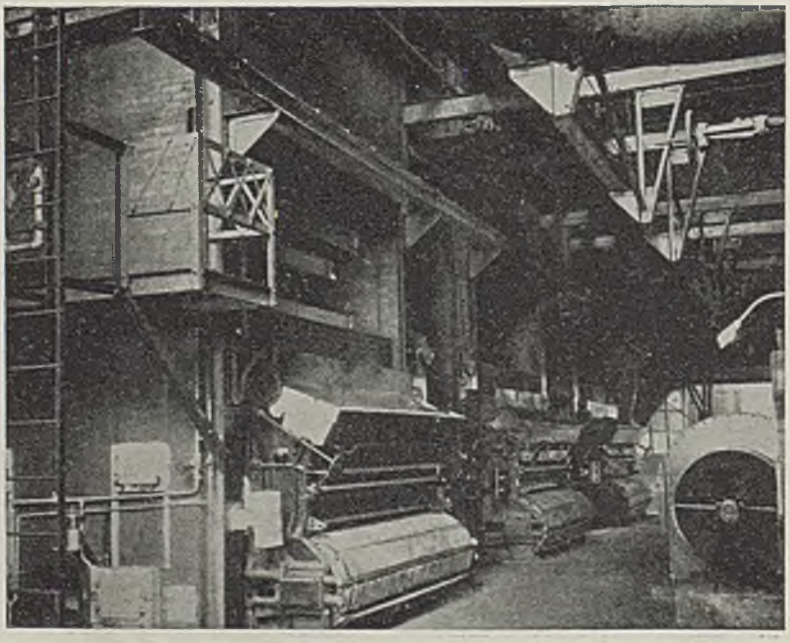
+ At Indiana Coal Mines

ELECTRIC POWER for a number of Indiana mines originates wholly or in part in generating plants at the mines or from a plant near by operated by an affiliated company. In practically every case covered in the *Coal Age* survey, the plants have special equipment to prepare or handle fuel which otherwise would have little, if any, market value.

An outstanding power-generation development in the State was the construction about four years ago of the generating plant of the Antioch Power Co., an affiliate of the Sherwood stripping interests. Located about 1,000 ft. from the Friar Tuck mine of the Sherwood-Templeton Coal Co. and the New Hope mine of the Linton-Summit Coal Co., this plant serves a total of five deep and strip mines, in addition to the city of Linton. Total power generated per month averages about 1,400,000 kw.-hr.

Fuel for the plant, designed by C. M. Garland & Co., is nominally minus $\frac{1}{8}$-in. slurry pumped from the Friar Tuck and New Hope washeries to a cleaning installation at the power plant. Before the fuel enters the cleaner, equipped with two coal-washing tables (see article beginning on p. 96), it is run over $\frac{1}{2}$-mm. wedge wire, thus making the final feed to the tables nominally $\frac{1}{8}$ in.x$\frac{1}{2}$ mm. The cleaned fuel runs into drainage hoppers, from which it is removed to ground storage for still further drainage by a clamshell. The same clamshell finally picks up the fuel and deposits it in an elevated concrete silo. From this storage the fuel flows by gravity into a weigh larry which drops it into the hoppers of Combustion Engineering Co. traveling grates having 170 sq.ft. of effective grate surface.

Traveling grates burn the $\frac{1}{8}$-in.x$\frac{1}{2}$-mm. fuel at Antioch.



Steam at 190 lb. pressure is generated by three 500-hp. Babcock & Wilcox Stirling boilers. Natural draft is furnished by a 215-ft. concrete stack and forced draft is supplied by manually controlled blowers. Equipment includes Copes feed-water regulators, Diamond soot blowers of the type without valve in head, and a steam-jet ash conveyor. Ignition and combustion arches are Detrick and the rear arch is American.

Out of the deep-well water used as boiler feed, 58 gr. of sodium-bicarbonate per gallon is removed by two Griscom-Russel evaporators with a combined capacity of 10,000 lb. per hour. A feed-water heater serves also as a condenser for the vapor from the evaporator. Steam from the evaporator and from the auxiliaries goes to the feed-water heater, with any excess to the condensers of the main generators, this in order to conserve feed water. Feed-pump equipment consists of two turbine-driven 3-stage centrifugals and one motor-driven pump of the same type. The electric pump is used under heavy load conditions.

Three 2,300-volt turbo-generator units with surface condensers constitute the engine-room equipment. One is a General Electric 500-kw. 1,800-r.p.m. unit, another a General Electric 2,000-kw. 3,600-r.p.m. unit, and the third an Allis-Chalmers 3,200-kw. 3,600-r.p.m. machine. The brick building housing generators and boilers is 90x100 ft. Circulating water for the surface condensers is cooled in a spray pond. It is well water that is treated in the pond to reduce the deposit of carbonate scale in the condenser tubes. To prevent growth of algae in the pond the water is chlorinated.

Four years ago a 2,300-volt a.c. plant was built under C. M. Garland at Kings Station mine of the Princeton Mining Co., previously operated with purchased power. Fuel consists principally of ¼x0-in. carbon which is pulverized in unit machines for each boiler. One turbine (General Electric 1,000-kw., 3,600 r.p.m.) is a mixed-pressure unit which utilizes the exhaust from a steam coal hoist. Other generating equipment consists of a high-pressure turbine otherwise the same as the low-pressure unit; one General Electric 2,000-kw. 3,600-r.p.m. unit, and an Allis-Chalmers 3,000-kw. 1,800-r.p.m. machine. Surface condensers are used on all generating units and the circulating water is cooled in a spray pond. Water supply comes from three sources: a deep well, surface water and creek water. For boiler feed the water is given the hot-process-lime and soda-ash treatment.

Steam at 160 lb. and 125 deg. F. superheat is generated in four Babcock & Wilcox straight-tube boilers. Three are 500-hp. Two of them are equipped with Strong-Scott impact pulverizers and one with a Whiting roller pulverizer. The fourth boiler is a 665-hp. unit with a Kennedy-Van Saun ball-type mill. All have water walls and air-cooled furnaces. Water feed level is governed automatically but the combustion control is manual. Feed pumps are steam-driven reciprocating units and the feed-water heater is of the open type.

Natural draft is supplied by two concrete stacks each lined to a height of 50 ft. One is 168 ft. high by 6 ft. in diameter and the other 175x7 ft. Load on the plant aggregates 1,500 kw., 15-minute average maximum demand, and the yearly output is 5,500,000 kw.-hr. All of this power is used by the Kings Station operation and none is stepped to higher than 2,300 volts for transmission to the boreholes feeding substations.

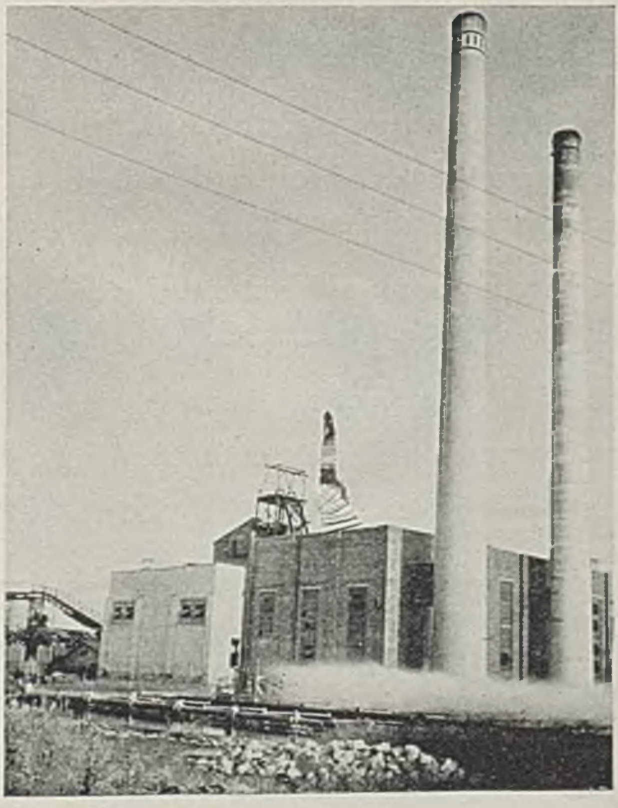
Knox Consolidated No. 1 mine of the Knox Consolidated Coal Corporation is another to be equipped with an a.c. generating plant. There, table refuse is prepared in a Bradford breaker and the six 308-hp. water-tube boilers with shaking grates are hand-fired. Generating equipment consists of 1,600-kw. and 500-kw. turbine units and an engine-generator. Hoisting is by steam. At present a line is being built from No. 1 mine to No. 2 so that the plant can supply part of the No. 2 power requirements, heretofore purchased.

Pneumatic spreader-type Iron Fireman stokers recently were installed to replace hand-firing of five 150-hp. h.r.t. boilers at the Black Hawk mine of the Black Hawk Coal Corporation. Steam is used primarily for hoisting, with d.c. generation during the working shift only. Both day and night, a.c. is purchased for an inside d.c. substation and for small motors and lighting.

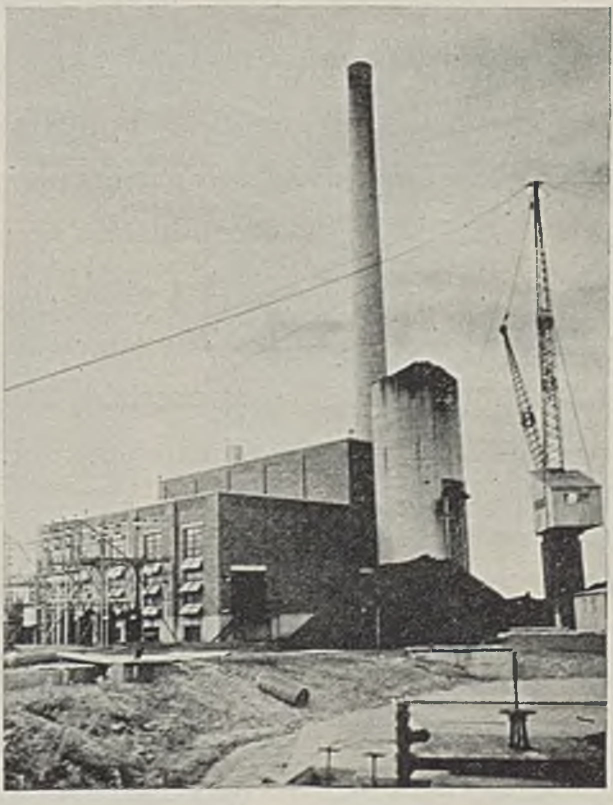
Crown Hill No. 6 mine of the Clinton Coal Co. is another shaft operation with a steam hoist and generating only a part of its power. D.c. is generated for the underground requirements within a half mile of the shaft bottom and a.c. is purchased for an inside d.c. substation 4,000 ft. from the bottom. A Bradford breaker crushes table pickings which are supplemented at times by some fines from the screening plant to supply the plant, equipped with six hand-fired 125-hp. h.r.t. boilers. At Submarine No. 2 mine of the same company, the entire power requirements of the mine during working days, all d.c., is generated. The power house also contains a 300-kw. 275-volt synchronous converter which is operated by purchased power to supply the plant and mine requirement when the mine is shut down for periods of several weeks or a month or more.

D.c. power only is used at the No. 6 mine of the Jackson Hill Coal & Coke Co. and all of it is generated in a hand-fired plant which also supplies steam for hoisting and the ventilating fan. The steaming equipment consists of six 150-hp. h.r.t. boilers with shaking grates and the fuel is principally crushed waste coal from the picking tables. A 200-kw. generator is direct driven by a 16x20-in. Chuse engine and a 150-kw. unit by a 12x16-in. Chandler & Taylor engine.

Kings Station power plant burns pulverized coal. Boiler and turbine rooms (left) are in separate buildings.



Antioch plant fuel is fine coal pumped and flumed from two preparation plants 1,000 ft. distant.



HAZARD

MINING MACHINE CABLE

Hazacord Twin Flat Mining Machine Cable (All-rubber Construction), consists of two tinned, flexible, copper conductors, individually insulated with high grade rubber compound and covered with a single braid. The two conductors are then laid parallel and covered overall with an outer jacket made of exceedingly tough rubber, reinforced with seine twine. The smooth finish of this jacket excludes moisture and dirt, is not appreciably affected by oil, grease or acid, and is practically proof against wear and tear. Hazacord cable is economical by reason of its long life and uninterrupted service.

HAZARD INSULATED WIRE WORKS

DIVISION OF THE OKONITE CO.

WORKS: WILKES-BARRE, PENNSYLVANIA

New York Chicago Philadelphia Atlanta Pittsburgh Buffalo Boston Detroit
Seattle Dallas Washington San Francisco St. Louis Los Angeles

OPERATING IDEAS

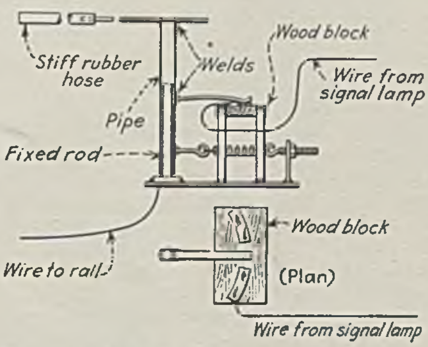
From Production, Electrical and Mechanical Men

Cars Actuate Blinker Lights At Saxton-Mine Curves

Cars passing by and bumping a piece of rubber hose flash traffic signals on and off at curves in the Saxton mine of the Saxton Coal Mining Co., Terre Haute, Ind. A blinking red light seen ahead near a curve means that a trip is approaching the curve from the opposite direction. At some curves two sets of signals are installed so as to warn traffic approaching the curve from either direction.

As indicated in the illustrations, cars bump the rubber hose and cause the supporting arm to rotate about 30 deg. against the action of a straightening spring fastened to a short arm projecting from the back end of the bearing-mounted column pipe. As the pipe rotates it carries a contact arm over onto a segment. The arm is grounded to the rail return by way of the steel frame of the device and the segment is the terminal of a return wire from the signal lamp.

In the plan view of the wood block on which the segments are mounted, only one segment is shown connected to a wire. Which one of the two is to be connected depends on which side of the track the device is mounted and also upon the direction of the traffic that is sending out the warning. The principal reason for using a length of hose projecting beyond the end of the arm is so that it can buckle and thus avert damage to the device in case a car should be stopped and then backed up from a position with the arm rotated at an angle. The column pipe, which works over the fixed rod, is kept well oiled and thus the pipe and its arms vibrate back and forth and the signal is blinked several times by each car that passes. A scrapped hydraulic hose from a loading machine is serving as the arm extension of the automatic contactor shown in the illustration.



Excepting the hose and wood block, the parts are steel and were assembled by arc-welding.

Passing cars bumping the hosearm cause a light to blink around the curve ahead. The rail showing prominently in the center is just an extra lying along the rib. The track rail is at the extreme left.

Padlocks and Interlocks Used on Oil Switches

Padlocks and interlocks are safety features of portable oil switches used in 4,000-volt strip-pit cables at Ayrshire mine of the Electric Shovel Coal Corporation, Oakland City, Ind. Oil switches are built into a wooden connector box which two men can carry. Sometimes this box is set down in the pit and at other times on top of the bank. As used in feeding a strip shovel it is 750 ft. by cable from the shovel and 350 ft. by cable from the cutout on the end of the lateral pole line.

Portable interlocked oil switch serving the stripping shovel at Ayrshire.

As indicated in the illustration showing the door open, the oil switch is mounted in the center and is operated by an insulated handle projecting out through a slot. "On" and "Off" positions are marked plainly on white backgrounds at the ends of the slot. The door closest to the observer is mechanically inter-

Covers opened to show safety features of switch.

Here the "conductor" is in the center of a series of insulators.

locked so it cannot be opened unless the oil-switch operating handle has been moved to the "Off" position. This door covers the Miller connectors on the power end—that is, to the cable from the pole line—and consequently these connectors are not accessible unless the oil switch has first been opened. This door, and that of the load end also, are individually padlocked. The chief electrician has keys to both ends. The shovel crew has a key to the load end and in that end is an emergency key to the door of the power end.

The connectors of leads from the oil switch are male on the power end and female on the load end and thus the cables cannot be interchanged. Ground-wire connectors of the oil-switch terminals are female on the power end and male on the load end and thus cannot be interchanged with a phase conductor. Showing above the oil switch in the illustration is a box containing rubber gloves, and on the inside of the door on the power end a sign reads: "Always Use Rubber Gloves to Handle Cable Connections."

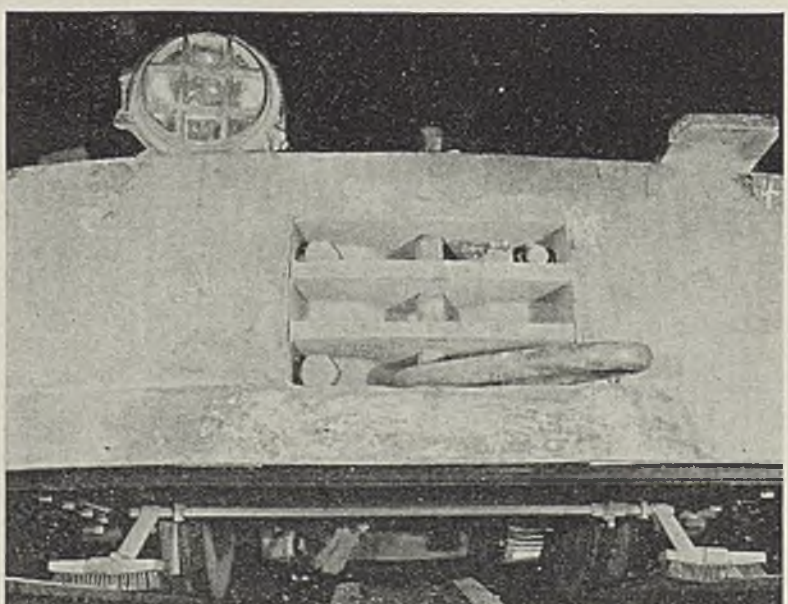
In another illustration Harry Greisemer, chief electrician, who developed the portable oil switch, demonstrates the precautions taken when making 4,000-volt cable connections to the end of the lateral line. The "hot hook" is attached to a petticoat insulator on the wooden stick and the top of the table on which he stands is separated from the base section by four insulators of the same type.

Brushes on Locomotive Clean Track Rails

A 13-ton locomotive has been fitted with brushes to sweep the sand from the rails and thus present a clean surface for the trip of cars being pulled at the New Hope mine of the Linton-Summit Coal Co., Linton, Ind. William Cunningham, general superintendent, originated the idea. The illustration shows the brushes in operating position. They are controlled by a lever in the cab and are lowered to sweep the rail only while sand is being applied. For this first experimental installation scrub brushes with stiff fiber bristles are used.

That the additional friction with sand on the rails amounts to a consideration of practical importance is illustrated by instances in steam railroading, mostly in days gone by, where a train of a certain number of cars could be pulled over a short stiff grade only if members of the crew walked on each side and swept the locomotive sand from the rails. In mine transportation the saving of a large percentage of the wear on car wheels and the better electrical contact for the locomotive next along, are other practical advantages of sweeping sand from the rail after it has served its purpose of increasing adhesion for the pulling locomotive.

Worms-eye view of a 13-ton locomotive with desanding brushes



Hoosier Sparks

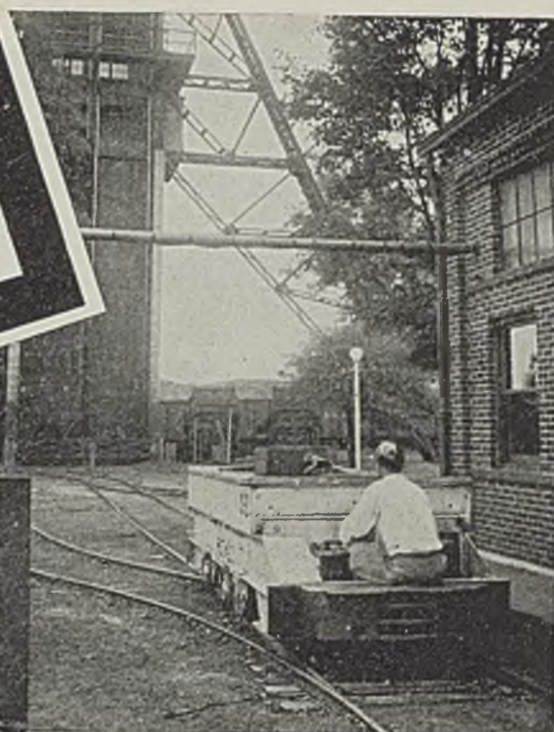
• Indiana coal men—operating, electrical, mechanical and safety—are as receptive to cost-cutting, time-saving or safety-promoting ideas as any of their brothers in other producing fields of the country. The items in the Operating Ideas section of this issue —the 18th Model Mining Number of Coal Age—amply support this statement and warrant your attention. While this month's material was supplied by Indiana, next month we resume publication of material from all over the country. Perhaps you have an idea for increasing efficiency or promoting safe operation in your system. If so, here is the place for it. So send it in, with a sketch or photograph if it will help to make it clearer. For each acceptable idea submitted, Coal Age pays $5 or more.

Loader Efficiency Increased By Improved Design

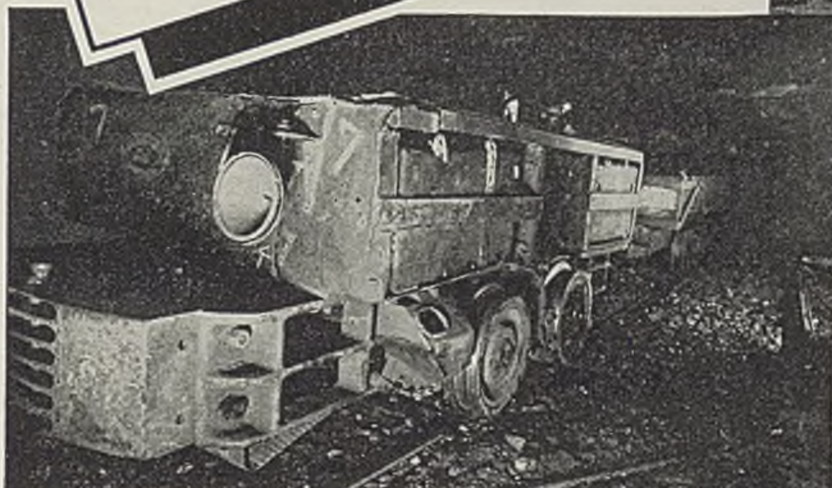
Mobile loading machines of the 5BU type in use at the Standard mine of the Standard Coal Co., Wheatland, Ind., now bear only a nominal resemblance to the original machines, as a result of a program of reconstruction to increase their capacity and reduce maintenance. One measure taken to increase capacity was the elimination of the deep-curved hopper in favor of a flat hopper. With the flat type, chunks do not hang in the hopper and keep rolling over and over, but instead go right on out, thus increasing the ability of the rear conveyor to handle the feed from the front conveyor. A roller hold-down on each side at the rear of the hopper keeps the conveyor chains in position.

On the front end of the machine, a 7BU drive and a center-chain conveyor were installed on the loading head, in the

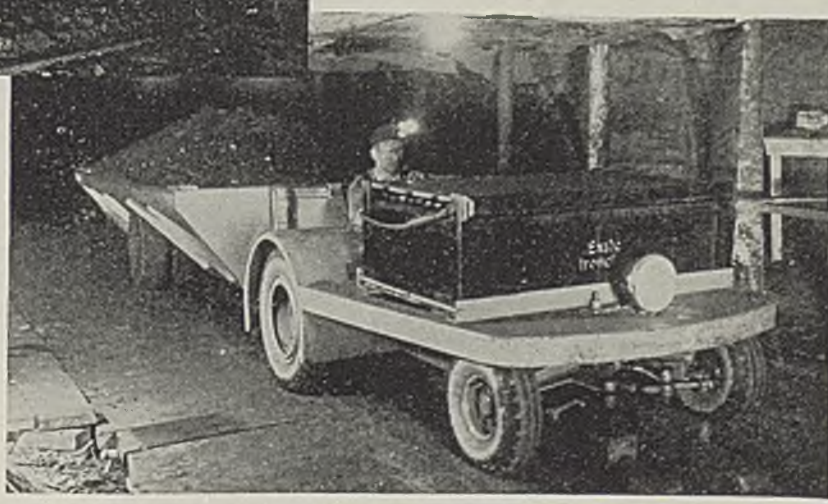
Exide-Ironclad Batteries help speed up coal production in the mines of Indiana . . . .



Exide-Ironclads are used for surface locomotive haulage at the Dresser mine of Walter Bledsoe & Company.



All 13 of the storage battery locomotives at Jackson Hill Coal & Coke Co. are Exide-equipped for speedy, low-cost haulage.



The newest installation of underground rubber-tired tractor haulage at Wick mine of Ingle Coal Company is powered by Exide-Ironclads.

INDIANA'S deep mines are highly mechanized, more than 60% of their output being produced by mechanical loading. Exide-Ironclad Batteries are playing an important part in many of these operations, by bringing increased dependability, speed and power to the underground haulage service.

Exide-Ironclads have the high power ability needed to move heavy loads up steep grades. They maintain a good voltage all day long, providing good haulage speed hour after hour. They are dependable, trouble-free, long-lasting. These are the qualities that have made Exide-Ironclads the most widely used batteries in underground haulage service today.

Why not write for free booklet, "The Storage Battery Locomotive for Underground Haulage"?

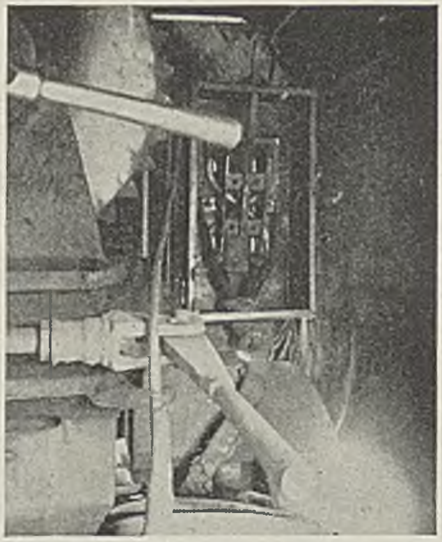
THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia
The World's Largest Manufacturers of Storage Batteries for Every Purpose
Exide Batteries of Canada, Limited, Toronto

To mark the fiftieth anniversary of Exide Batteries, a handsome souvenir booklet has been prepared, illustrating the essential part these batteries play in daily life. Write, and we will gladly send you a free copy.

FIFTY YEARS OF ACHIEVEMENT 1888 1938

Exide
IRONCLAD BATTERIES
With Exide MIPOR Separators
"MIPOR" Reg. U. S. Pat. Off.

Loader improvements include flat hopper, new drive on front end, springs on swing-jack ropes, etc.



Loading-shovel rocker switch saves time and maintenance.

course of which the speed of the gathering arms was increased about 12 r.p.m. to a total of 54 to 56 r.p.m., with a consequent increase in loading capacity. Another step was to take part of the bend out of the rear conveyor so that cars would strike the bumper instead of the conveyor itself.

In the old days, swing-jack ropes used to last about a week at the most. To reduce this breakage, the first jack-rope springs were installed last summer, and to date no rope breakage has been experienced on machines so equipped. In installing the springs, an ear was welded on the cylinder housing. An eyebolt, to which the rope was attached, was run through a hole in this ear and then through the spring.

The resistance has been moved around behind the controller so that it cannot be struck in moving back. Consequently, one resistance has been in service three years without any trouble.

All major parts have been welded solidly to the frame, such as the lower half of the transmission case, front clutch housing, etc., in addition to a liberal use of hard-surfacing where required and other measures taken to reduce maintenance. One result of the improvement campaign has been a reduction in the per cent of shift time due to breakdowns of from 28 to 11 per cent.

Reversing "Cats" Facilitated By Rocker-Type Switch

Time-saving convenience to the operator and elimination of the danger of causing a flash-over in generator and motor are features of an improvement to the two 11-year-old Marion 37 2½-yd. 440-volt (a.c.) loading shovels at the Ayrshire mine of the Electric Shovel Coal Corporation, Oakland City, Ind. Harry Greisemer, chief electrician at the mine, gathered this improvement.

On this type of loader the d.c. hoist motor of the Ward Leonard system serves also to drive the "cats" when moving. This motor is not reversed for its normal duty of hoisting but needs to be reversed for backing a "cat." This reversal is accomplished by reversing the series field of the motor and in the original arrangement this was done by an ordinary double-pole double-throw 440-volt knife switch mounted in a steel box back of the operator and out of his reach when at the other controls. He had to take a few steps to get to the switch if he operated it himself, and if he had a helper stationed to operate the switch for him there was a chance that the helper would throw the switch when power was on the hoist motor.

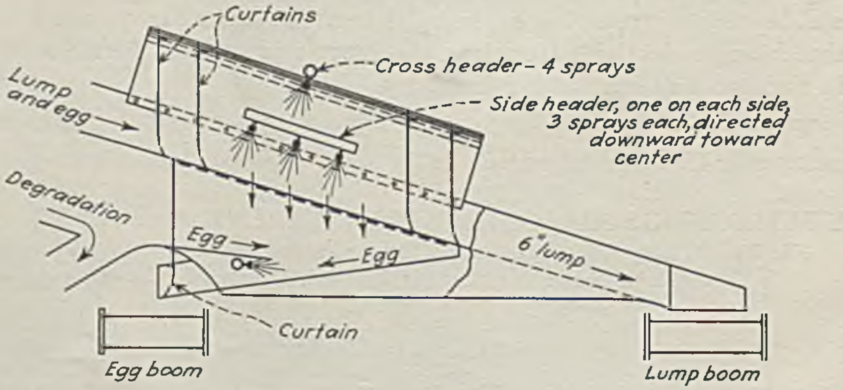
With the plain double-throw switch arrangement the first action opened the circuit, which, in case of heavy load, would cause an inductive kick sufficient to flash the brushes and commutators. In the improved layout, shown in the illustration, a rocking-type double-throw switch was substituted and the contacts of one end are not broken until after the contacts at the other end are established. Instead of the field circuit being opened momentarily the fields are short-circuited during the change, but this cutting out of the field has no serious effect. A control rod from this rocking switch extends to a lever directly above the operator's head. Now he can make the reversals without leaving his seat and with no chance of opening the field circuit.

Treating Results Improved By Special Hood

Thorough dustless treatment of lump and egg sizes on the main shaker screen with the minimum quantity of the paraffin-base treating fluid employed were the objectives in the design of a special hood at the Staunton (Ind.) preparation plant of the Electric Shovel Coal Corporation. Spraying is done from underneath as well as from the top and both sides.

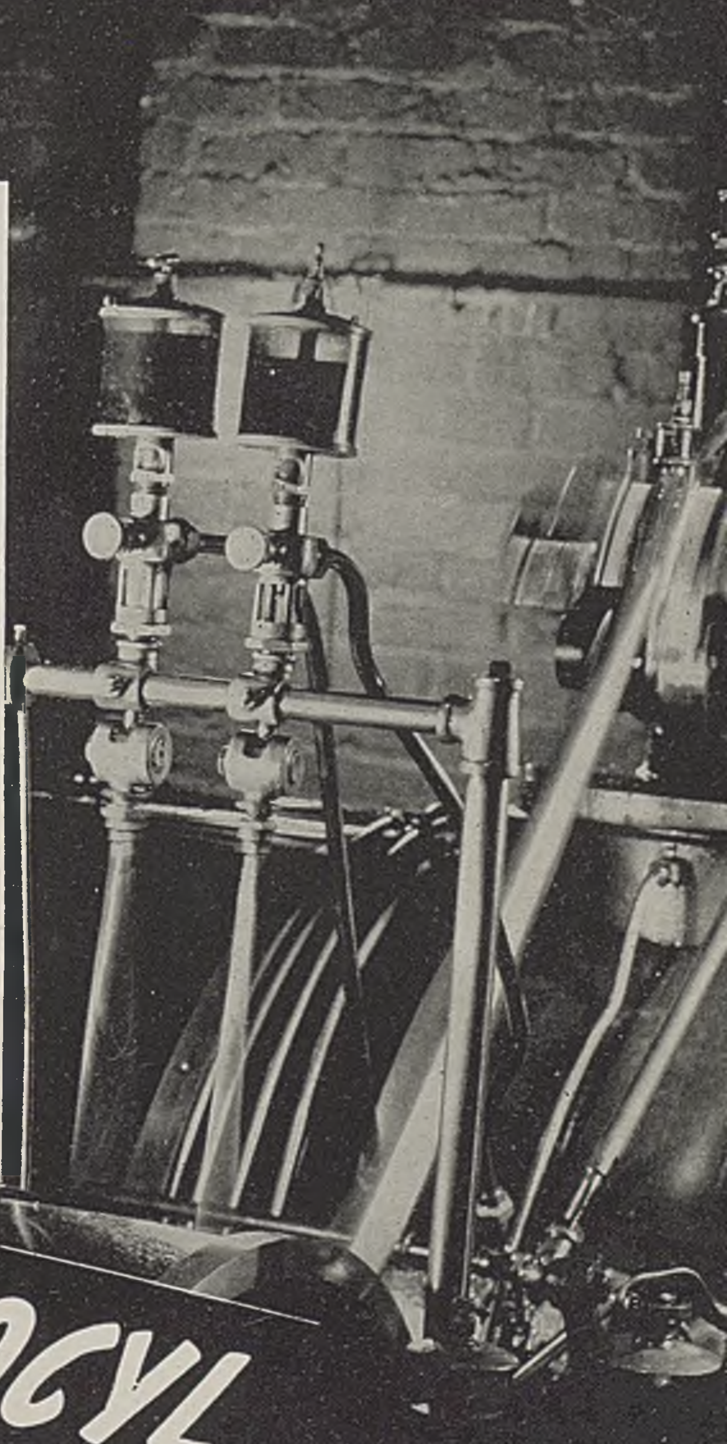
The treating hood, or box, was constructed by installing steel plates on the sides of the screen, as shown in the accompanying illustration. The top of the hood is another steel plate fixed rigidly in place and separate from the screen. As indicated in the illustration, the side plates extend up into a slot made by riveting angles to the stationary top. Thus, the side plates are free to move with the screen, while at the same time

Diagrammatic sketch of arrangement of Staunton treating box on main screen.



AFTER 72,000 HOU…

CYLINDER WALLS STILL SHOW ORIGINAL TOOL M…



• SINCE JUNE 1927 a 480 H.P. Uniflow engine has operated 24 hours a day, six days a week, on StanoCyl Steam Cylinder Oil. On a recent inspection, after 72,000 hours of operation, the cylinder walls still showed the original tool marks and the rings were in perfect condition.

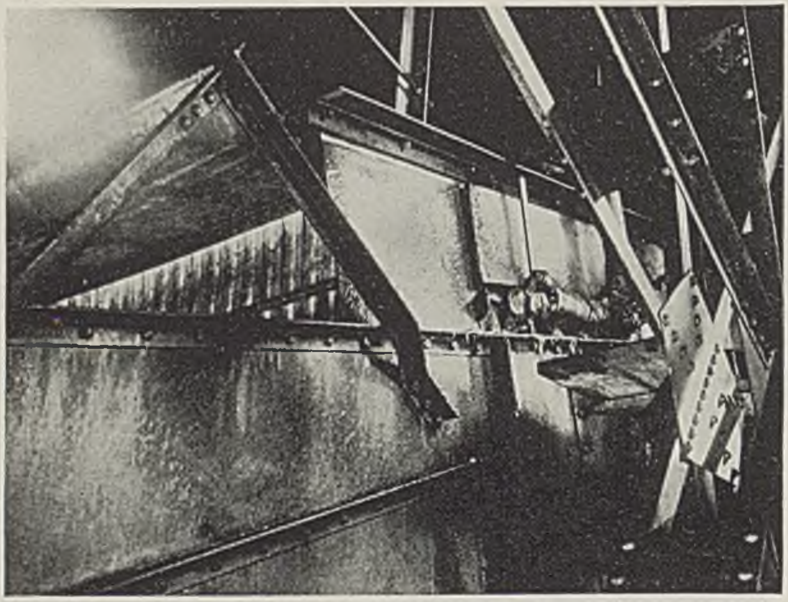
Reports such as this on the excellent lubricating quality of StanoCyl are made more remarkable when you realize that switching to StanoCyl will almost invariably reduce oil consumption. Savings up to 50% have been made in many plants.

There are three grades of StanoCyl to meet every condition of operation. A Standard Lubrication Engineer will gladly recommend the grade you need and help you get the full economy that StanoCyl has brought to others. Call your local Standard Oil (Ind.) office, or write 910 South Michigan Avenue, Chicago, Illinois, and ask to have a Standard Lubrication Engineer see you—his service is free.

STANOCYL

STEAM CYLINDER OIL

STANDARD OIL COMPANY



Showing how the side plates of the treating box fit in the slots formed by the angles on the stationary top plate. Part of one of the curtains shows at the left.

an opening in the top of the box is eliminated.

Lump and egg, as indicated in the sketch, enter the treating box through two curtains made of old fabric belting. The use of two curtains provides an air lock and thus prevents escape of the treating liquid. While a lump is going through the first curtain, of course, the second is hanging down in the proper position to prevent the escape of the spray. By the time the lump hits the second curtain, the first has dropped back into position, and so on. Similar curtains at the discharge end of the box perform exactly the same functions at this end also. Thus, the minimum opportunity for escape of the oil spray is provided.

Lump receives treatment only on the top deck of the screen. A total of ten spray nozzles, however—four on a header across the top and three each on two side headers—assure adequate treatment. Top sprays are directed squarely down on the screen, while the side sprays are directed toward the center and down. Egg falls through the screening section under the treating box into a back chute. Here it receives additional treatment through the medium of nozzles on another header mounted as shown. At the discharge end of the back chute is still another curtain, thus completing the sealing of the treating spray within the space in which it is used and making sure that as much as possible goes on the coal. The supplementary sprays for the egg size naturally result in complete treatment of this size.

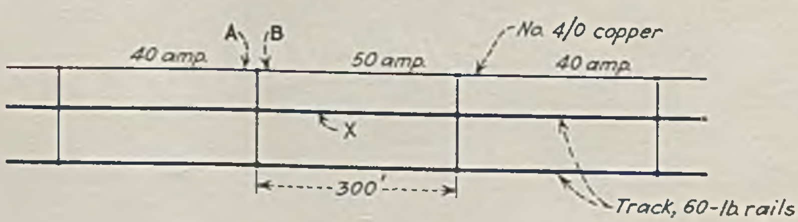
Clip-Over D. C. Ammeter Shows Bond Condition

Three purposes are served by a No. 4/0 round copper wire hung low on the rib and tied to the track every 300 ft. in the Dresser mine of Walter Bledsoe & Co., Terre Haute, Ind. In addition to the usual duties of reducing voltage drop in the track return and of acting temporarily as a standby connection in case of broken bonds, this No. 4/0 wire also serves as a means of making rapid tests of the over-all condition of the bonding.

Chief Electrician James Tweedy demonstrates checking bonds by measuring current in the negative return wire.

The bond testing is done almost as rapidly as a man can walk the distance of the haul. Using a clip-over-type d.c. ammeter (Tong-Test), he stops at each 300-ft. tie wire and checks the current in the No. 4/0 wire at points on each side of the connection to the rail. If at that period of the day the load is of such proportions that he has observed readings around 40 amp. and he then comes to a point where the reading is 40 amp. on one side (such as Point A of the drawing) and there is an increase of about 25 per cent, to 50 amp., for instance, at Point B, it is an indication of one or more bonds in bad conditions in the 300-ft. section paralleling the No. 4/0 wire where the higher reading is found. To make certain the higher reading is not due to a greater load on the circuit the two points A and B are rechecked rapidly once or twice.

A loose track bond at X increases the current in that section of the parallel No. 4/0 copper wire.



Connector Box in Circuit Used With Enos Loaders

For convenience in handling cables carrying 4,000 volts to loading shovels at the Enos strip mine of the Enos Coal Mining Co., Oakland City, Ind., each shovel cable is in two lengths and is equipped with a portable connector box kept in the pit. This box is 350 ft. (by cable) from the shovel. The method is especially useful on loading shovels because most of the machines built for this duty are without cable reels. The connector box also permits practical use of a longer cable connection from shovel to lateral pole line.

Connector box serving a 5-yd. loader at Enos.

Miller connectors are used for the phase

WORD FROM THE FIELD

Midwest Price Hearings Start As Sessions End in East

WASHINGTON, D. C., Nov. 18—After holding hearings here lasting five weeks in regard to proposed minimum prices in Minimum Price Areas 1 and 3, the National Bituminous Coal Commission transferred its activities to Chicago last Monday, when it began hearing evidence on prices in Area 2 (comprising western Kentucky, Illinois, Indiana and Iowa). With four commissioners sitting, representatives of the Indiana producers' board were heard first, testimony proceeding along usual lines until counsel for a group of Indiana and Illinois producers charged that the Hoosier board priced coal on a basis of opinion and not facts.

Chairman Tetlow of the Commission took sharp issue with this contention, calling attention to the record and exhibits submitted. "The exhibits of the Indiana board," he added, "are illuminating. It has given more detailed information than any other district board before the Commission on different sizes, qualities and kinds of coals and related factors."

When district boards 1 and 2 (eastern and western Pennsylvania) adopted an "after-you,-my-dear-Alphonse," attitude on filing analyses of their respective coals, Chairman Tetlow directed them to place their data with the Commission simultaneously. "Nobody can get an advantage over anybody else that will be permanent here," said the chairman. "The very processes here will level out any advantage and bring about equality and fairness." District 2 was represented by Charles F. Hosford, Jr., former chairman of the Commission.

The proposal of quantity discounts submitted in a resolution by District Board 1 (*Coal Age*, November, p. 63) elicited questioning by representatives of other districts. In response to a question whether such discounts would not consolidate a large consumer's fuel business with a single large producer, in order to obtain the benefit of such a discount, rather than to split the business between several small individual producers and lose the discount, Charles O'Neill, chairman of District Board 1, answered in the affirmative. He added, however, that his district was opposed to granting possible double discounts—such as seasonal and quantity allowances. The proposed requirement that a consumer must take 90 per cent of each month's fuel requirements within that month in order to be eligible for the quantity discount, said Mr. O'Neill, would help to level out the violent fluctuations in demand and make the market more constant.

Robinson Run Expands Output

With the installation of equipment completed, the fully mechanized Robinson Run mine No. 2, at Maidsville, W. Va., has increased production to 4,000 tons a day,

as provided in its development schedule, according to L. H. Kelly, president of the Pittsburgh & Fairmont Coal Co. Representing an investment of about $500,000 in modern mining and handling equipment, the property has been developed by the P. & F. and the Christopher Mining Co. The new operation has a tipple capacity for ultimate expansion to 8,000 tons a day, but production this year will be limited to 5,000 tons a day. In addition to combination facilities for rail and river loading, there is a separate tipple for cleaning the coal, patents on which are owned by F. E. Christopher, president of the Christopher Mining Co.

Keeping Step With Coal Demand

Bituminous Production

	1938 (1,000 Tons)	1937* (1,000 Tons)
October 1	7,923	9,808
October 8	7,930	9,648
October 15	8,230	9,802
October 22	8,093	9,619
October 29	8,594	9,269
November 5	7,982	8,880
Total to Nov. 5	276,248	376,332
Month of October	**34,900**	**48.033**

Anthracite Production

	1938	1937*
October 1	898	1,155
October 8	1,147	1,167
October 15	1,172	1,216
October 22	859	1,184
October 29	881	1,047
November 5	913	1,060
Total to Nov. 5	37,690	43,505
Month of October	**4,169**	**4,848**

* Outputs of these two columns are for the weeks corresponding to those in 1938, though these weeks do not necessarily end on the same dates.

Bituminous Coal Stocks

(Thousands of Net Tons)

	Oct. 1 1938	Sept. 1 1938	Oct. 1 1937
Electric power utilities	8,335	7,834	8,944
Byproduct coke ovens	5,952	5,540	7,761
Steel and rolling mills	638	651	1,292
Railroads (Class 1)	4,676	4,556	6,926
Other industrials*	10,087	9,138	13,969
Total	29,688	27,719	38,892

Bituminous Coal Consumption

(Thousands of Net Tons)

	Sept. 1938	Aug. 1938	Sept. 1937
Electric power utilities	3,318	3,315	3,872
Byproduct coke ovens	3,770	3,534	6,284
Steel and rolling mills	652	660	1,000
Railroads (Class 1)	5,943	5,662	6,868
Other industrials*	7,418	7,175	10,075
Total	21,101	20,346	28,099

* Includes coal-gas retorts and cement mills.

N.C.A. Plans to Broaden Advertising Campaign

The advertising campaign initiated by the National Coal Association in 1937 in the interests of bituminous coal and coke will be continued and extended during the coming year, according to an announcement on Oct. 31 by John D. Battle, executive secretary. "We plan not only to continue for 1939 the educational advertising campaign directed primarily to the nation's architects and builders which has been under way for the past twelve months and which has had such good results," said Mr. Battle, "but we are now moving to broaden the field and include additional periodicals intended to reach building managers and rental agents, heating contractors and equipment dealers, and the nation's retail coal merchants.

"All signs point to a boom in the building industry during the coming year, and this advertising campaign is intended to tie in with it, as well as to supplement other promotional activities by our association aimed to expand the markets for bituminous coal. The campaign will begin in December, with its heaviest circulation during the months when new homes and buildings and remodeling jobs are being discussed in the family and with architects and builders. The advertising program for the last half of 1939 remains flexible, pending future developments. Our advertising copy in the trade publications used will again be based on the use of the fundamental principles of modern basement planning so enthusiasticaly indorsed by architects and builders in 1938.

"The bituminous coal industry is awake to its responsibilities and this aggressive campaign represents one of the many steps being taken in the National Coal Association's nation-wide program to render to the American public a service that cannot be equaled by any other fuel."

A.C.I. to Hold Conference On Fuel Engineering

A fuel engineering conference, the 24th in a series of educational enterprises, will be held by Appalachian Coals, Inc., Cincinnati, Ohio, in cooperation with engineers of the Kalamazoo Valley region on Dec. 13 at the Columbia Hotel, Kalamazoo, Mich. J. E. Tobey, manager, fuel engineering department, A.C.I., will preside, and among the papers to be presented are the following:

"The Modern Small Power Plant," H. L. Solberg, professor of mechanical engineering, Purdue University; "Combustion Practices and Experiences With Underfeed Stokers," G. G. Zimmerman, test engineer, Indiana Service Corporation; "Engineering in the Small Stoker Industry," E. C. Webb, engineering service manager, Iron Fireman Mfg. Co.; "Some Fundamentals of Smoke Abatement," J. F. Barkley, supervising engineer, fuel economy

J. B. Morrow

service, mechanical division, U. S. Bureau of Mines; "Combustion of Pulverized Coal," E. G. Bailey, vice-president, Babcock & Wilcox Co.

J. B. Morrow Given New Post

Changes in personnel in the executive staff of the Pittsburgh Coal Co. were announced by Alan M. Scaife, chairman of the board, following a meeting of the directors on Nov. 21, as follows: J. B. Morrow, formerly coal preparation manager, was appointed vice-president in charge of production, replacing L. E. Young, who was made vice-president in charge of engineering, a new position; Harry Miller, formerly production manager, and Ernest Taylor, who was chief engineer, have resigned.

New Preparation Facilities

ANTHRACITE COAL CO. OF PITTSTON, No. 9 colliery, Pittston, Pa.: Contract closed with Finch Mfg. Co. for six 10-ft. and two 12-ft. Menzies cone separators to clean egg, stove, chestnut, pea, rice, barley and No. 4 buckwheat; total feed capacity, 976 tons per hour; to be completed in January.

BINKLEY MINING CO. OF MISSOURI, Macon, Mo.: Contract closed with McNally-Pittsburg Mfg. Corporation for a McNally-Pittsburg Vissac dryer to handle ¾-in.x ½-mm. washed coal at the rate of 100 tons per hour; to be in operation about Dec. 1.

DEANGELIS COAL CO., Carbondale, Pa.: Contract closed with Chance Coal Cleaner for one 15-ft.-diameter Chance cone to handle up to 200 tons per hour of cleaned coal, egg to buckwheat inclusive; addition to existing equipment made by coal company's force; placed in operation Nov. 16.

GLEN ALDEN COAL CO., Huber Colliery, Ashley, Pa.: Fourteen 9½-ft. Menzies cone separators to be installed to clean egg, stove, chestnut, pea, buckwheat, rice, barley and No. 2 barley; total feed capacity, 1,400 tons per hour; installation to be completed this month.

Personal Notes

D. CARL ABERNETHY, formerly mining engineer with the Hudson Coal Co., Scranton, Pa., has accepted the post of chief engineer with the Hardy-Burlingham Mining Co., Hardburly, Ky., effective Nov. 1.

ROLLAND C. ALLEN, executive vice-president of Oglebay, Norton & Co., Cleveland, Ohio, has been made a member of the board of trustees of Battelle Memorial Institute, industrial research organization, Columbus, Ohio, vice Joseph H. Frantz, deceased. Mr. Allen not only is an executive of a large iron-mining and shipping company but also a geologist, mineral economist, president of the Lake Superior Iron Ore Association, and former director of the Michigan Geological Survey. He organized and was first chief of the Division of Natural Resources in the U. S. Treasury, and in 1937 was president of the American Institute of Mining and Metallurgical Engineers.

BLUFORD ASBURY has been appointed foreman at the No. 4 mine of the Raymond City Coal & Transportation Co., Raymond City, W. Va.

GEORGE E. BAYLES has resigned as preparation foreman for the Nellis Coal Corporation, Nellis, W. Va.

J. S. BROWN has been made foreman at Red Parrot No. 1 mine of the Red Parrot Coal Co., Prenter, W. Va.

C. A. CABELL, president of the Carbon Fuel Co., was reelected president of the Kanawha Coal Operators' Association at its annual meeting. W. C. MITCHELL, Hatfield-Campbell Creek Coal Co., was again made vice-president, and D. C. KENNEDY was renamed executive secretary for his 34th term.

ROLLIE S. CORBIN, Huntsville, has been appointed as deputy mine inspector by Chief Inspector Arnold Griffith, of the State Bureau of Mines of Missouri. He succeeds Evan Jones, of Higbee, who was killed in an automobile accident in September. Approved by Governor Stark, the appointment is already effective.

B. H. Schull

New vice-president in charge of operations, Binkley Mining Co.

Rolland C. Allen

WARD H. COWAN has been named foreman at Beechbottom mine of the Wheeling Steel Corporation, Beechbottom, W. Va.

N. R. DECKER has been appointed general superintendent of Nos. 1, 9 and 11 mines of the New River & Pocahontas Consolidated Coal Co., McDowell County, West Virginia.

HOWARD N. EAVENSON, president, Clover Splint Coal Co., Harlan County, Kentucky, was elected a director of Appalachian Coals, Inc., at the October meeting of the board.

LLOYD G. FITZGERALD, formerly mining engineer with the Fourseam Coal Corporation, Diablock, Ky., has joined the Cardox Corporation at Logan, W. Va.

DONALD B. GILLIES, vice-president, Republic Steel Corporation, was elected president of the American Institute of Mining and Metallurgical Engineers by letter ballot, according to an announcement on Nov. 18.

J. M. HOLBROOK has been appointed general superintendent of mines Nos. 1, 3 and 4 of the Pond Creek Pocahontas Co., Bartley, W. Va.

J. B. JAMES has been made foreman at Milburn No. 2 mine of the Milburn By-Products Coal Co., Milburn, W. Va.

J. D. LILLY has been named foreman at No. 3 mine of the Chafin-Jones-Heatherman Coal Co., Peach Creek, W. Va.

G. F. MASH has been appointed superintendent at the Arista and Hiawatha mines of the Weyanoke Coal & Coke Co., Mercer County, West Virginia.

T. W. MATHERS has been made foreman at Harewood No. 116 mine of the Semet Solvay Co., Longacre, W. Va.

JAMES H. MCGRAW, JR., chairman of the board and president of the McGraw-Hill Publishing Co., Inc., has been elected to the board of directors of the American Arbitration Association, whose voluntary industrial arbitration tribunal has just completed its first year of operation with a record of more than 100 arbitrations of labor disputes settled under its rules. The industrial activities of the association, which is a non-profit-making educa-

HOW TO *Save Money* ON TIMBERING

Ties, props and timbering treated with Du Pont Chromated Zinc Chloride outlast 5 replacements of ordinary wood.

WHAT IT IS . . .

Chromated Zinc Chloride is an improved wood preservative. It gives essentially the same treatment as zinc chloride with the addition of a mordant which fixes the preservative more firmly to the wood fibre. This reduces leaching and improves its usefulness in wet locations.

WHAT IT DOES . . .

Timber treated with Chromated Zinc Chloride resists decay and is fire retarding. It is clean, non irritating to the skin and has no odor. Above ground Chromated Zinc Chloride has the added advantage of being termite repellent and readily paintable.

WHERE IT IS USED . . .

Chromated Zinc Chloride treated timber is used for mine ties, props, timbering, safety doors, tipples, village houses and all other wooden construction both under or above ground.

HOW MUCH DOES IT COST

As an example, treated ties cost approximately 1/3 more than untreated ties. They will last an average of 15 years as compared to 2½ years for ordinary ties.

HOW TO GET THIS TYPE OF TREATED TIMBER . . . . . .

This treated timber is available through the majority of treating plants serving the mining areas.

Write for further information about the advantages of Du Pont Chromated Zinc Chloride and the location of your nearest treating plant.

Specify TIMBER TREATED WITH...

DUPONT CHROMATED ZINC CHLORIDE

REG. U.S. PAT. OFF.

E. I. DU PONT DE NEMOURS & COMPANY, INC.

GRASSELLI CHEMICALS DEPARTMENT

Wilmington, Delaware

tional organization, cover more than twelve years of successful practice in the field of commercial arbitration.

T. C. MILLER has been appointed superintendent at Harewood No. 116 mine of the Semet Solvay Co., Longacre, W. Va.

W. L. OSBORNE has been made superintendent at the Empire mine of the Vera Pocahontas Coal Co., Landgraff, W. Va.

OSCAR F. OSTBY, formerly president of Independent Anthracite Coals, Inc., Wilkes-Barre, Pa., and at one time vice-president of Electric Furnace-Man, Inc., New York, has been appointed assistant to the president of Anthracite Industries, Inc. Before entering the hard-coal industry he was general sales manager for the Prest-O-Lite Co. He became sales promotion manager of the Stevens Coal Co. and also was the prime mover in organizing the Anthracite Club of New York and assisted in the organization of similar clubs in other sections of the country.

M. F. PELTIER, vice-president in charge of operations, Peabody Coal Co., was reelected president of the Illinois Coal Operators' Association at its annual meeting. Others reelected were FRED S. WILKEY, secretary; O. M. GORDON, treasurer, and THURLOW G. ESSINGTON, general counsel.

WILLIAM B. RIGGLEMAN has been named foreman at the Edna mine of the Edna Gas Coal Co., Brady, W. Va.

R. S. SADDLER has been appointed foreman at the Vera mines of the Vera Pocahontas Coal Co., Iaeger, W. Va.

C. H. SCOTT has been made general manager at Harewood No. 116 mine of the Semet Solvay Co., Longacre, W. Va.

NORTH C. SHAVER, vice-president and general manager of the Penn Machine Co., Johnstown, Pa., has been elected chairman of the Rail Bond Section of the National Electrical Manufacturing Association, which held its annual meeting at Chicago during the first week in November.

MILLARD STEEL has been named foreman at the Whitesville mine of the Whitesville Mining Co., Whitesville, W. Va.

J. W. STRICKLER has been appointed general manager at the Empire mine of the Vera Pocahontas Coal Co., Landgraff, W. Va.

JOHN E. THOMPSON has been made superintendent at the Bellwood mine of the Bellwood Coal Co., Bellwood, W. Va.

WILLIAM TUCKER has been named superintendent at the Edna mine of the Edna Gas Coal Co., Brady, W. Va.

J. N. WHISTON has been appointed foreman at Osage No. 1 mine of the Pioneer Coal Mining Co., Osage, W. Va.

R. S. WOLFE has been made chief engineer of the Cannelton Coal & Coke Co., Cannelton, W. Va.

WHITNEY WARNER, president of W. H. Warner & Co. and the Warner Collieries Co., has been elected a director and chairman of the board of the North American Coal Corporation, Cleveland, Ohio, vice Frank E. Taplin, deceased. HOYT L. WARNER succeeds his brother as president of W. H. Warner & Co., and K. M. MARQUIS, formerly general sales manager of the latter firm, becomes vice-president.

Coal Cleaning, Combustion and Marketing Themes of Illinois Mining Institute

- 5¾-ton cars of rock loaded for 43c.
- "Prescription-counter" coal essential.
- Sell those only whose needs coal can meet.
- How to sample mine product.
- Two-stage crushing unjustifiable.
- Hand-picking improves coal but little.
- Bi-shifting of washeries cuts labor force 20 per cent.
- Reject in cleaning not a loss.
- In preparing coal for stokers, bins are an asset.
- Vibratory screens suit all sizes of coal.
- Failure to clean sludge an extravagance.
- Stoker coals sell at a premium.
- Sell stoker coal not by size but by trade name.
- New canal may give Illinois 5,000,000-ton market.
- Decreases in energy from coal output overstated.

PREPARATION of coal for the market—issue of the moment in Illinois—occupied the attention of the Illinois Mining Institute at its 46th annual meeting, held Oct. 21 in Springfield, Ill. How to open a closed mine safely and with efficiency, the stoker as the rejuvenator of the coal industry and the new markets likely to be opened to Illinois operators by the extension of navigation in the upper reaches of the Mississippi were other subjects discussed.

A mine long closed, declared Howard Lewis, assistant general superintendent, Old Ben Coal Corporation, offers many difficult problems. He instanced the reopening of Mine No. 11, at Coello, Ill. (*Coal Age*, July, 1937, p. 305). After detailing the work of reestablishing ventilation in the mine, Mr. Lewis added that the danger of rock from the immense falls rolling and sliding down on the loaders was avoided by keeping the slope of the fallen material at a minimum inclination and by using cables, ropes and long poles to pull the rock from the top of the pile.

No explosives were used in the mine until the seals were opened and the entire mine ventilated. All large rocks were broken into loadable size with hammer and wedge. Large timbers and bent and twisted steel beams located under falls were dragged out by locomotives, though a cutting torch sometimes was used to burn the steel into short lengths to facilitate removal.

From the beginning of work on the air-shaft until the production of coal, there was but one lost-time accident and few minor casualties. The first occurred when a surface workman scratched his hand on a rusty nail and thereby lost six days' work. Since reopening of the mine on a production basis, more than 75,000 tons of coal has been produced per lost-time accident. Of the 3,600 mine cars of rock loaded by man power with pit-car loaders, the cost was $1.31 per 6.5-ton car. The other 11,000 mine cars were filled by loading machines for 55c. per car, frequently under the most unfavorable conditions in regard to power, preparation and switching facilities.

Load 5¾ Tons for 43c

Mine 9, in West Frankfort, another Old Ben plant, closed in 1928, was opened, said Mr. Lewis, in the early spring of this year under quite similar rock-fall conditions. In 22 shifts, 1,400 cars, each holding 5¾ tons, were loaded by a three-man crew at a cost per car of 43c. including temporary track repairs, haulage and bottom labor, but here power and switching facilities were superior to those in Mine No. 11 and the rock was less abrasive.

A sprained ankle when a workman slipped and fell was the only lost-time accident in the three-month period of recovery. The falls to be cleaned had heights ranging from 12 to 36 ft., but the risks were reduced, as the operative on the type of machine used at this mine stood 18 ft. back from the edge of the material being loaded. No workman in the No. 9 mine was permitted to work under exposed roof, and all falls were timbered with I-beams before loading was started. The only repairs made were to digging chains, which had to be reriveted weekly. This was done, as also the oiling, by the regular seven-hour shift.

In the minds of forward-looking operators, there is no doubt that washed coal is going to control the market to the practical exclusion of all raw coals, declared J. A. Garcia, Jr., Allen & Garcia Co. With washing will come the blending of different sizes so that "prescription-counter" or "metered-mix" coal will be the rule rather than the exception. More sales have been lost through misrepresentation than through poor quality, though, in most cases, through lack of actual knowledge of the quality of the particular coal to be sold. How much more sensible it would be to make the customer list conform to the character of the coals to be marketed rather than to attempt to make

Coming Meetings

• Coal Mining Institute of America: 52d annual meeting, Dec. 8 and 9, Fort Pitt Hotel, Pittsburgh, Pa.

• Indiana Coal Mining Institute: annual meeting, Dec. 10, Hotel Deming, Terre Haute, Ind.

• New River Coal Operators' Association: annual meeting, Dec. 13, Mountainair Hotel, Mount Hope, W. Va.

• Appalachian Coals, Inc.: fuel engineering conference, Dec. 13, Columbia Hotel, Kalamazoo, Mich.

• American Society of Heating and Ventilating Engineers: annual meeting and symposium on solid-fuels utilization, Jan. 23-27, 1939, William Penn Hotel, Pittsburgh, Pa.

• American Institute of Mining and Metallurgical Engineers: annual meeting, Feb. 13-16, 1939, 29 West 39th St., New York City.

h modern jigs for handling unsized l with the conventional sludge screens with no separate cleaning of carbon. dge losses were as in Table I. They w a saving of 15 tons per hour, or tons per 7-hour shift, which, figuring 200 working days per year, is a saving 21,000 tons of coal. This has been pped with the screenings, and there- e been sold at the same price. With conservative valuation this extra coal overy paid for the extra plant invest- nt in three to four years. The carbon duced by the Rheo. plant has an aver- ash only nine-tenths as high as that m the jig plant.

n another instance, a Rheo. fine-coal t in an existing modern jig-type clean- plant cleaned the sludge from a set- g tank where the jig secondary refuse been crushed to minus ⅜-in. This t is handling 100 to 135 tons per hour king a 50 to 60 per cent recovery. Data the sludge alone show 30 tons per hour overed when the screen analysis of the material is as in Table II. Recovery m the plus 50-mesh sludge is 75 per t, or 17 tons per hour, or 120 tons 7-hour shift. Over-all recovery from total feed is 60 tons per hour, or ut 400 tons per 7-hour shift. This perty normally produces 3,500 tons shift. In this instance, the extra plant t is returned in less than a year.

ptimistic predictions marked the ad- ss of T. A. Marsh, central division en- eer, Iron Fireman Co. Extra work, ra expense and fussiness in coal prepa- ion may be deplored, but it is ushering premium market. Coal held its place the increasing production of heat and gy in the growing country until 1918. m that time, the curve of oil consump- showed a steady rise. Later, the ural-gas consumption curve began to . In 1933, there were 90,000 oil burn- installed, and in 1937 the figure unted to 193,000, whereas in the for- year 18,000 coal stokers were installed in the latter year 107,000.

Driving Oil to the Wall

1932, the ratio of oil burners to kers was 10:1; in 1937 it had fallen 1.8:1. Before long, coal-burner sales exceed oil-burner sales, as is the case ady in St. Louis; since October, 1937, rly three times as many coal stokers e been sold in that city as oil and gas ners combined. In Chicago alone, the Fireman Co. reclaimed 120,000 tons coal output per year by displacement oil burners. Before the advent of n, well-sized coal, added Mr. Marsh, tonnage of the coal industry was never . It was always a "lame duck," a ple for the oil and gas men to knock . When a stoker is installed, a coal tomer is assured for at least fifteen rs.

entral stations and large industrial nts have reached a point of efficiency ond which it is not profitable to go, every additional unit of output from on will be accompanied by an in- ased tonnage. The spreader stoker, an rfeed unit, urged Mr. Marsh, and illus- ted it with a motion picture, meets the blem of undersize (¼x0 or 10-meshx0) high-fusion-ash or low-fusion-ash coal. illustration showed the spreader- ker plant of the Lumaghi Coal Co., ch uses a refuse with 20 per cent of ash. It cost the Lumaghi company 20c. a ton to get rid of this coal, so its fuel costs are now minus 20c. a ton.

Coal producers should not sell coal by dimension but with a trade name. Size does not specify the coal, for each coal is best prepared with its own sizing formula, declared J. G. Bentley, Johnson-March Corporation. Agreed, said W. C. McCullough, United Electric Coal Companies. The coals of northern Illinois can be used in larger sizes than the coals of the southern fields.

When the project to canalize the Mississippi River to a minimum depth of 9 ft. between Alton, Ill., and St. Paul, Minn., is completed a highway of transportation will be created that may enable Illinois to tap new markets in Minnesota and Wisconsin, but the freight rates must be substantially lower than the rail-lake rate from competing Appalachian fields to the upper Mississippi Valley, declared W. H. Voskuil, mineral economist, Illinois Geological Survey. The coal market bordering the Mississippi River in Iowa, Wisconsin and Minnesota uses about 5,000,000 tons of coal. Within the area are St. Paul and Minneapolis and 40 per cent of the population of Minnesota.

Though coal formerly contributed 83 per cent to the energy of fuels expended by the people of the United States, yet in 1937 its contribution had fallen to 50.4 per cent, declared R. A. Sherman, Battelle Memorial Institute, at the banquet with Herbert H. Taylor, Jr., retiring president, presiding and B. R. Gebhart, vice-president in charge of sales, Chicago, Wilmington & Franklin Coal Co., as toastmaster. Yet he could not regard the situation as unlikely to improve. Energy figures for natural gas include the gas used for the manufacture of carbon black and for use in the development of the gas and oil fields, and two-thirds of the gas was used for those purposes. Figures for oil cover also oil used for lubrication and also for gasoline, yet the use of the latter merely had ushered in a new form of transportation for which coal was ill-suited. It never would have developed, probably, if coal had been used instead of gasoline. Depression in the coal industry is due largely to a more economical use of coal as a fuel, and the time is approaching at which it will be uneconomic to produce any further economy in fuel. Meantime, new uses for fuel are developing.

It behooves the American producer to spend more money for research. The expenditure of Bituminous Coal Research, Inc., in the present year at the Battelle Memorial Institute is $20,000, the wage of a good vice-president. In England, $125,000 annually is spent in such research, though the production of Great Britain is little over half that of the United States. Yet this expenditure for research in this country is not a permanent policy of the coal industry and might be discontinued after Jan. 1 of the coming year. The coal industry will continue, but whether it will pass to other hands or remain in the hands of the present operators is a question.

New Illinois Leaders

Paul Weir, consulting engineer, Chicago, was elected president of the Illinois Mining Institute for the coming year at the annual meeting in Springfield Oct. 21. He succeeds Herbert H. Taylor, Jr., vice-president, Franklin County Coal Co., Chicago.

R. L. Adams, general superintendent, Old Ben Coal Corporation, West Frankfort, Ill., was chosen vice-president, and B. E. Schonthal, B. E. Schonthal & Co., Chicago, was again elected secretary-treasurer.

Membership of the executive board is as follows: C. T. Hayden, general manager, Sahara Coal Co., Chicago; F. S. Pfahler, president, Superior Coal Co., Chicago; C. J. Sandoe, vice-president, West Virginia Coal Co., St. Louis, Mo., and T. J. Thomas, president, Valier Coal Co., Chicago, to serve for one year; M. M. Leighton, chief, Illinois Geological Survey, Urbana; James McSherry, chief, Department of Mines and Minerals, Springfield; B. H. Shull, vice-president, Binkley Mining Co., Terre Haute, Ind., and Louis Ware, president, United Electric Coal Cos., Chicago, to serve for two years; D. H. Devonald, assistant to vice-president, Peabody Coal Co., Chicago; L. D. Smith, vice-president, Chicago, Wilmington & Franklin Coal Co., Chicago; L. A. Wasson, assistant general manager, Wasson Coal Co., Harrisburg, and W. P. Young, vice-president, Bell & Zoller Coal Mining Co., Pekin, Ill., for three years.

Rectifier Advantages Stressed At New River-Gulf Institute

Lower per-ton cost by higher efficiency throughout the load range and particularly so during long light-load periods, maintenance advantages over brush-and-commutator rotating machines, resistance to lightning damage, lower starting loads on the a.c. system and higher short-time overload capacity are among the benefits the mercury arc rectifier offers to the mining industry, concluded F. P. Brightman, electrical engineer, General Electric Co., Schenectady, N. Y., in an illustrated talk presented Nov. 10 at the Mt. Hope (W. Va.) meeting of the New River and Winding Gulf Electrical and Mechanical Institute.

Interest in rectifiers was manifest by the numerous questions put to the speaker following his presentation and by a large attendance which, in addition to the engineering membership, included several higher executives of coal companies. Mr. Brightman's talk brought out the advantage of the single-anode Ignitrion-type rectifier for 275-volt mine service as compared to the multiple-anode tank type. The anode can be placed closer to the mercury pool, thus lowering the arc drop to 16-30 volts instead of the 20-30 volts in a multiple-anode unit. Rectifiers can be installed in the same station and paralleled with rotating machines. Spaced some distance apart on the d.c. distribution system, there needs be no special engineering to effect parallel operation with converter or motor-generator units.

The talk included a demonstration of the inflammability of transformer oil as contrasted to the non-inflammable characteristic of pyranol, which is the liquid used in the compact type of transformer particularly suited to underground service. The transformer oil when atomized up through a glass tube containing a coil resistor heated to red and topped by a spark gap caught fire each time. The same experiment with pyranol atomized through the tube produced no fire. Cutaway samples of the Mycalex insulating ceramic seals used in tank-type rectifiers which are suitable for all types of service were exhibited.

Mr. Brightman stated that an Ignitron-type rectifier substation would not be rendered inoperative if one tube of the six failed, but instead the unit could be continued in service at reduced load until the tube was replaced. He foresaw the application of complete inclosures or self-carried houses for truck-mounted portable rectifiers, thus eliminating the expense of preparing special underground rooms. Concrete floors and foundations also can be eliminated.

Missouri Mineral Industries Conference Hears Cheasley on Coal Problems

TECHNICAL PROBLEMS of the coal industry, with special reference to the Southwestern field, were outlined by Thomas C. Cheasley, fuel engineer, Sinclair Coal Co., in an address before the Missouri Mineral Industries Conference, at Rolla, Mo., Oct. 21-22. The conference, sponsored by the Missouri School of Mines and Metallurgy and the Missouri State Geological Survey, was held to better acquaint the mineral industries of the State with the facilities these two institutions have to offer Missouri producers. Mr. Cheasley was one of several speakers who discussed the problems in their respective branches of the mineral industries.

Prefacing his presentation of the engineering phases with a brief review of pressing sales problems, Mr. Cheasley pointed out that coal mining and those dependent upon it are menaced by competition from the so-called laborless fuels. The latest large-scale threat comes from hydro-electric power, which displaced 31,000,000 tons of bituminous coal last year. Proposed hydro-electric plants will have an additional potential displacement equivalent to 45 per cent of the 1936 soft-coal output. Such displacements seriously impair railroad traffic and employment and will cause the abandonment of many mining operations.

Oil, too, continued Mr. Cheasley, is eating into coal tonnage. Fuel-oil consumption last year, he said, quoting figures of the National Coal Association, represented a displacement of 110,000,000 tons of coal. Imported oil was responsible for nearly 57,000,000 tons of this loss. Unless the present tax of ½c. per gallon on this oil is sharply increased, indications are that "cheap imported oil will increasingly take a greater toll." Eastern and northern extension of pipe lines from the Southwestern gas fields also has adversely affected coal tonnage.

Improvement in stokers and better preparation of stoker coals, however, are helping the industry to meet some of this competition. "In nearly every instance," said Mr. Cheasley, "a stoker user may burn coal without dust or dirt, with absolute safety, with practically no attention to the heating plant and at a saving in fuel costs often greater than 50 per cent." Many consumers who switched to other fuels in the belief they could reduce their fuel bills, he added, "have been disillusioned." Small-stoker sales made slow progress during the glamorous '20s and exceeded 1,500 units only once during that period. But sales reached 12,000 in 1931, climbed to over 28,000 units in 1934 and topped 100,000 last year.

These gains were "brought about by the increasing number of people who were interested in automatic firing and the fact that stoker performance was constantly bettered with the aid of coal which was better prepared. Gradually at first, and now with much greater rapidity, home owners and industrial users alike are increasingly using coal again. We feel sure that, as the pendulum swings still further in this direction, employment for miners, technicians, distributors and salesmen of coal will increase to an extent felt nationally."

Coal deposits of the United States have been so thoroughly prospected in the past, stated Mr. Cheasley, that the chances of finding any new large fields are remote. "Discovery now amounts to the location of what might be termed pockets or a body of coal sufficient in size to justify the expenditure for a modern mine set-up of production and preparation machinery. As a rule, when such a body is found today there is seldom sufficiently extended acreage to justify the installation of more than one mine or plant."

Where preliminary engineering reports give ground for the belief that a workable acreage has been found, "the whole property is checkerboarded with the drill." Log records of each hole are essential where stripping is to be employed. In addition to explosive costs and ratio of overburden to coal, "we must know whether a protective coat or layer covers the coal to prevent infiltration of surface waters with their deleterious substances." Coal not so covered usually is unmarketable. "By the same token, if water may reach the coal body, so might the air, with its consequent oxidation, which detracts from the coal quality."

Except where conditions favor steam haulage, continued Mr. Cheasley, most strip pits now use tractors and trailers to transport the coal to the cleaning plant. Generally rough topography necessitating exceedingly long and expensive rights of way to eliminate steep gradients has been largely responsible for this change. Better "grade-ability" of rubber-tired equipment, due in part to selective transmission, makes it possible "to shorten the haulage roads and also keep rails, ties and trains of empty cars out of the pit, where they invariably slow down the operations of the dirt-moving and coal-loading equipments."

Starting with semi-trailers carrying only 6 to 7 tons, today 15 tons or more is common and several units have been built which haul nearly 40 tons in one trailer. The first unit of a new design which will haul 70 to 80 tons per trip

has just been completed. "This latest tractor has two internal-combustion engines of 200 hp. each, using butane as fuel. Instead of the customary clutch and transmission, two d.c. generators are used, connected through foot-pedal controls to two d.c. motors. Each motor drives a separate rear axle. If this unit performs as expected, already equipment more suitable to our needs is available."

Other units, said Mr. Cheasley, have kept pace with the increase in the size of transportation equipment used in stripping. The 6- and 7-yd. (water level) stripping shovels of twenty years ago have grown into 32-yd. machines without sacrifice—and sometimes with an increase—in speed of operation. "An average cycle—i.e., one operation starting at a given point—is completed and the dipper is ready for a successive operation in about 45 seconds." Present-day dipper capacity of loading shovels is as great as that of the strippers of earlier years, but the digging time cycle has been greatly reduced. Wooden tipples loading out only mine-run have given way to modern steel preparation plants turning out a range of accurately sized and cleaned coal.

One of the problems of washing, Mr. Cheasley told the conference, is to determine how much coal must be thrown away with the impurities to produce a fuel acceptable in appearance and performance to the consumer. Since this usually means losses of 18 to 24 per cent of the mine-run feed to the wash box, the problem "is to find and maintain the critical point at which the operation of washing turns from a satisfactory to an economically unsound procedure, because the changing of adjustments due to wear or accident could easily cause the rejection of a large amount of coal without improving the shipped product."

Critical Point in Cleaning

Unfortunately, impurities cannot be removed on a uniform or increasing scale. "There comes a point in the purification stage of nearly all coals where an abrupt change takes place." For purposes of illustration, said the speaker, assume a raw coal with 12 per cent ash-forming materials. A washability curve might show that 95 per cent of the raw coal would float at 1.60 sp.gr. Analysis of the 5-per-cent sink increment might show an ash content of 90 per cent and 10 per cent combustible material. Analysis of both float and sink increments might be continued with a solution change of 0.05 in gravity at each stop. "By the time we reach 1.50 sp.gr., we might find that our sink material runs 18 per cent by cumulative weight and might have an ash content of 70 per cent. The float material could have an ash content of perhaps 8 per cent.

"Now we are approaching the critical point, if we have not already reached it. When Southwestern coals are washed to deliver 9 per cent ash or less, they are usually considered satisfactory for all steam or industrial purposes. While the ash content of a stoker coal is only a guide to the possible performance of a coal in a given plant, nevertheless in many stoker plants the lower the ash content the more acceptable is the coal. The burning characteristics of any coal, however, mean much more than the spot at which a decimal point may be placed by

Thomas C. Cheasley

a fuel chemist when running an ash analysis.

"If with a 1.50-sp.gr. solution we had 18 per cent sink or 82 per cent recovery of the raw-coal feed and then for further purification we used a gravity of 1.45 and found our sink percentage was 22 per cent and the resultant ash in the refined coal was 7.60 per cent, we would have lost 4 per cent of the raw-coal feed to gain a reduction in ash of only 0.4 per cent. Unquestionably this would not be economical for mine operation nor would the slight increase in purification be of any material benefit to a coal consumer.

"Perhaps the latest major improvement in preparation is dustless treatment. The newest development is the use of paraffin wax blended with a certain oil and other ingredients. This material, although applied as a vapor in heated and insulated boxes at a temperature close to 200 deg. F., has the characteristic of congealing or setting up on the coal as soon as it reaches the prevailing atmospheric temperature outside the treating box. The problem in producing this material was to make stoker coal permanently dustless, or until actually consumed, but it was found that the coal was actually preserved. The thin film of paraffin not only held the dust particles but prevented the inherent moisture from leaving the coal, as well as preventing absorption by the coal of added moisture due to rainfall, snow, etc., and, in addition, prevented oxidation."

As an outgrowth of the conference, a committee of 30 representatives of the mineral industries of the State, the railroads, public utilities and the State government was established to bring about closer relationship between these interests and the service organizations maintained by the State, such as the Missouri Geological Survey and the Missouri School of Mines, as well as the district office of the U. S. Bureau of Mines. John Prince, Stewart Sand & Gravel Co., Kansas City, Mo., was appointed chairman of the organization committee with W. M. Weigle, mineral technologist, Missouri Pacific R.R., St. Louis, and G. C. Smith, assistant to the president, Missouri, Kansas & Texas R.R., St. Louis, as fellow members. This committee is charged with effecting a permanent organization.

At *Zanesville* Coal is Brought Withi

PROFITABLE SHOVEL RANG

Hillside Coal Company has found the answer to the high-cost overburden removal problem at its Zanesville, Ohio, pit . . . at the same time, keeps its shovel in constant productive work. Just two LeTourneau Carryalls, behind D8 tractors, owned by Dunzweiler Construction Company, handle all stripping from a 30-acre area. Savings lie in the Carryalls' capacity—in one complete cycle of self-load, -haul, -dump and return—to place the dirt where it need not be rehandled. Although overburden is spoiled 550 feet from the pit, the Carryalls average 175 pay yards moved hourly, 22 out of every 24 hours. That's a combined output of 3850 pay yards stripped every 22-hour day!

As the box cuts deepen, shale rock is bared. Aided by a LeTourneau Angledozer and Rooter on a single tractor, this, too, is moved with the Carryalls, all the way down to the coal seam. The Rooter, with three massive teeth set at a plow-like angle, tears the shale into workable chunks . . . chunks that are readily loaded into the Carryalls and hauled away in almost average dirt time. "Dirt cheap" stripping all the way through, the operators say.

How does production compare with the equipment investment on your job? Your "Caterpillar" dealer affords you the opportunity to make that comparison by a convincing demonstration of LeTourneau savings alongside your present methods. All you have to do is ask him, or write direct to R. G. LeTOURNEAU, INC., Peoria, Illinois, or Stockton, California. Cable address: "Bobletorno".

Angledozers*, Buggies*, Bulldozers, Carryall* Scrapers, Cranes, Drag Scrapers, Power Control Units, Rooters*, Treedozers, Sheep's Foot Rollers.

* Name Registered U. S. Patent Office.

LETOURNEAU

STRIPPING EQUIPMENT

New Trade Pact With Canada Disappoints Coal Men

Failure of the revised reciprocal trade agreement with Canada to afford substantial relief from the tariff and trade barriers which the Dominion has raised against coal from the United States was a keen disappointment, according to producers on this side of the border.

John D. Battle, executive secretary of the National Coal Association, said: "The new agreement leaves Canada free to continue to send Canadian coal into the United States without import duty or excise tax and freezes the present 75c. per ton tariff imposed by Canada on bituminous coal from the United States and $1 per ton tariff on coke. It leaves unchanged the 40c. differential which Canada grants to Great Britain and leaves Canada free to go on increasing the subventions which she grants to bituminous coal mined in Canada. It is announced that the new agreement will so operate as to eliminate a present 3 per cent excise tax imposed by Canada on United States coal and coke, which amounts to around 8c. per ton."

From the standpoint of anthracite, said Louis C. Madeira. 3d, executive director, Anthracite Institute: "Although the new agreement will have the effect of removing the 3 per cent excise tax, it does not touch the duty of 50c. per ton, which is the big obstacle to a greater movement of anthracite into Canada. This omission is particularly surprising in view of the fact that last May the Canadian Retail Coal Association, Inc., officially recommended to its government that Pennsylvania anthracite 'be permitted to move across our borders without restriction.' Their petition said the basic thought behind their request was 'to secure for the Canadian consumer more reasonable prices on his fuel requirements.' "

Launch Advertising Campaign

A newspaper advertising campaign has been launched by the Pocahontas Operators' Association, Bluefield, W. Va., copy being prepared by Geyer, Cornell & Newell, Inc., New York City. The first ads, which are now appearing, stress the advantages of Pocahontas coal, pointing out that a decision of the U. S. Supreme Court has defined the name "Pocahontas coal" as a trademark of coal produced in only three counties in the United States.

Obituary

GEORGE W. SHORT, 49, who for five years was mine foreman for the Jewell Ridge Coal Corporation, Jewell Ridge, Va., died Nov. 12 at his home there. He had been ill for the last two years with a complication of diseases.

E. J. HOEY, 47, mine manager since 1929 at Zeigler No. 1 mine, Bell & Zoller Coal & Mining Co., Zeigler, Ill., was found dead of a heart attack in his automobile Nov. 2 apparently on his way to work. He joined the company in 1926, prior to which time he was a State mine inspector.

JOHN C. SULLIVAN, 69, former president of the Sullivan-Pocahontas Coal Co. and well known in the southern West Virginia coal fields, died Nov. 16 after a short illness. He was one of the organizers, in 1909, of the Sullivan-Pocahontas company, which operated in Wyoming County, West Virginia.

THOMAS WRIGHT SCOTT, 49, widely known figure in coal mining in Vancouver Island, B. C., died in a British Columbia hospital on Nov. 13. Born in Scotland, he went to Vancouver Island in 1911, joining the staff of Canadian Collieries. He became assistant superintendent at the Cadomin mine, Alberta, in 1924; subsequently was made manager of No. 4 mine at Cumberland, and in 1931 was appointed assistant superintendent of the Canadian Collieries and Western Fuel Corporation.

Outfits for Rescue Workers In Anthracite Mines

The figures resembling a popular conception of visitors from Mars are R. Davies, safety inspector of the Philadelphia & Reading Coal & Iron Co., Pottsville, Pa., and two companions modeling up-to-date equipment worn by anthracite miners in rescue work. The devices were demonstrated to an audience of 300 at a safety meeting of the company held Nov. 9 at the Port Richmond (Philadelphia) Y.M.C.A. The equipment shown included the latest-type gas mask, the safety hat, a lightweight improvement on the military trench helmet, safety lamp for detecting poisonous gases, asbestos fire-fighting suits, and an oxygen breathing apparatus and pulmotor. The meeting was conducted by Harry A. Leidich, chief inspector of the company's safety department.

Koppers Mines Resume

Two mines of the Koppers Coal Co.—Federal No. 3, near Everettville, W. Va., and Carswell mine, near Kimball, W. Va. —resumed operations on Nov. 1 after being idle more than six months. About 625 men have been given employment at the two plants. During the suspension, the ventilating system at Carswell was reconditioned.

Operations began on Nov. 14 at the company's newest development, Kopperston, Wyoming County, West Virginia, according to P. C. Thomas, vice-president. A crew of 90 miners, advance guard of

more than 100 who eventually will occupy the company's model town, have moved in. Mr. Thomas said that full-capacity operation would not be reached for a year.

Progressive Gains Disputed By Lewis Union

Claims that 1,208 miners formerly members of the Lynch Employees, a local union at the United States Coal & Coke Co. mines in Harlan County, Kentucky, had become affiliated with the Progressive Miners (*Coal Age*, November, p. 61) are disputed by the United Mine Workers. "The truth" about developments in Lynch, according to the *United Mine Workers Journal* of Nov. 1, is as follows:

"The mine at Lynch is one of the largest in the country, employing in normal times 3,000 men. For years the United Mine Workers were unable to organize the miners at Lynch because of the fight waged against the union by Harlan County operators. There was a mushroom organization at Lynch commonly called the Union of Lynch Employees. It was known as a company union because it was more or less dominated by the company. But when the United Mine Workers succeeded in breaking down the opposition in Harlan County and negotiated a contract with the Harlan County operators, the Progressives formed a contact with the Union of Lynch Employees and issued a Progressive charter. Men employed at Lynch became indignant over this action and their resentment against the Progressives became so strong that the men began flocking into the United Mine Workers in such numbers that the Progressives had no members left.

"On Saturday, Oct. 1, the Union of Lynch Employees held a meeting and dissolved its union, thus leaving the Progressives completely wiped out at that place. William Turnblazer, president of District 19, United Mine Workers, writes the *Journal* that 'within the next few days I will have the supplies of the Progressive local union, and I will have the honor of sending them back to Ozanic.'"

Round-the-World Coal Talks

Keen interest in coal in a number of countries visited on a trip around the world was described by John C. Cosgrove, coal-mining engineer, to 60 members of the Penn State Mineral Industries Society on Nov. 17 at State College, Pa. Presented in the form of a travelog, the lecture was not only instructive but interesting and at times humorous.

Although India produces 25,000,000 tons of coal annually, said Mr. Cosgrove, it is mined mostly in the back country and is used mainly for metallurgical and industrial purposes, being too costly for use by the so-called lower classes. Dried cow dung is a competitor of coal in that country and an accepted article of commerce.

As only about 20,000 tons of coal is produced yearly in the Philippines, said the speaker, the inhabitants were greatly worried lest hostilities between Japan and China would cut off their major source of supply. In South Africa, it was pointed out, about 17,000,000 is mined annually and, because gasoline costs 40c. a gallon, much interest is evinced in the possibility of making oil from coal. Some work is being done in recovering oil from shale.

In Australia, about 11,000,000 tons of bituminous coal and 3,000,000 tons of brown coal are mined yearly, said Mr. Cosgrove, and at one time that country shipped considerable coal in export trade. This activity, however, ceased twelve to fifteen years ago, when the Labor Government came into power and raised prices so high that Australian coal could not compete in the world market. New Zealand has an annual coal output of 2,000,000 tons, which the lecturer said "appeared to be good coal, since I looked in the locomotive firebox and did not see any clinkers."

Some coal of an inferior grade is produced in Brazil, the total reaching only 763,000 tons per annum.

Plastic Explosives Container Honored in Competition

The explosives carrier of the Mine Safety Appliances Co., Pittsburgh, Pa., was chosen for honorable mention in the industrial group at the third annual modern plastics competition, sponsored by the magazine *Modern Plastics*. Developed to meet the need for a safer and more substantial powder container than that afforded by the conventional types in use, the new model, of molded Bakelite, is non-conductive of electricity, moisture-proof and constructed for long service. The container is kidney shaped and has a capacity of twelve 1¼x8-in. dynamite sticks. Flanges on the cover and body seal tightly when the weight of the case is slung from the adjustable web carrying strap, which runs through slots on these flanges. The strap is provided with eyelets through which locks may be inserted when such precaution is required.

Industrial Notes

Crane Packing Co., Chicago, has appointed John Kirgan as New York manager. He was associated with the Ingersoll-Rand Co., in charge of heat-transfer engineering, 1917-32, and water-vapor refrigeration, 1932-38.

R. G. LeTourneau, Inc., Peoria, Ill., manufacturer of heavy grading equipment, announces that E. R. Galvin is its new general sales manager, having resigned from a similar position with the Caterpillar Tractor Co. after eleven years' association with that company. Denn M. Burgess has been promoted from domestic sales manager to general manager of the LeTourneau organization.

Penn Electric Switch Co., Goshen, Ind., announces that D. A. Coon, who

Synthetic Silk From Coal

Nylon, a synthetic silk, which E. I. duPont de Nemours & Co. is to manufacture in a new $7,000,000 plant at Seaford, Del., in competition with Japan's $100,000,000 annual silk business in this country, has a coal base. According to Dr. Charles M. A. Stine, duPont vice-president, nylon—a word coined by the duPont company—is the generic name for all materials defined scientifically as synthetic fiber-forming polymeric amides having a protein chemical structure. Though wholly fabricated from such common raw materials as coal, water and air, said Dr. Stine, "nylon can be fashioned into filaments as strong as steel, as fine as the spider's web, yet more elastic than any of the common fibers and possessing a beautiful luster."

opened the company's Philadelphia (Pa.) branch last spring, has been placed in charge of a new branch opened in St. Louis, Mo., in September. A. L. Rubel, who has been manager of the Boston (Mass.) office since its opening in 1933, succeeds Mr. Coon in Philadelphia. A. W. Barr replaces Mr. Rubel in Boston.

Hercules Powder Co. has appointed J. Rex St. Clair as manager of the Wilmington (Del.) office of its explosives department, vice J. J. Kelleher, resigned.

Hewitt Rubber Corporation, Buffalo, N. Y., has appointed the following new distributors: Joseph Glenn & Sons, Philadelphia, Pa., and affiliate, E. P. Alexander & Sons, Clifton Heights, Pa.; Tools & Supplies, Inc., Indianapolis, Ind.; Campbell Hardware & Supply Co., Seattle, Wash.; Laurence Belting Co., Inc., New York City; and Everson Electric Co., Allentown, Pa.

Seek Equalization of Taxes

Faced with increasing competition from so-called laborless fuels, the Alabama Coal Trade Extension Association is waging a campaign to have the incoming Legislature repeal the severance tax of 1½c. per ton on coal. Appearing before a body of the legislators late in October, Herbert S. Salmon, chairman of the association, charged that taxes on fuel in the State are unbalanced to the detriment of the coal industry in competition with oil, natural gas and hydroelectricity. He said it was not his intention to ask a penalty on anyone but rather for an equalization of taxes.

Rubber Company Has Birthday

The 45th anniversary of the founding of the Manhattan Rubber Manufacturing Co., now the Manhattan Rubber Manufacturing division of Raybestos-Manhattan, Inc., Passaic, N. J., was observed on Oct. 28. Though manufacturing operations were started on Jan. 2, 1894, with 40 men in one small building 50x100 ft., the company now employs about 3,000 persons in a plant that covers 800,000 sq.ft.

of floor space, and auxiliary plants have been established at Whippany, N. J.; Neenah, Wis., and North Charleston, S. C. The company also has an extensive tract on the island of Java, in the Netherlands East Indies, where it raises its own crude rubber.

Carnegie Coal Control Passes To Island Creek

A substantial majority of the stock of the Carnegie Coal Corporation, of western Pennsylvania, which also owns the entire capital stock of the Carnegie Dock & Fuel Co., has been acquired by the Island Creek Coal Co., Huntington, W. Va., according to an announcement by James D. Francis, president of the latter company. The Carnegie company owns several thousand acres of coal lands in western Pennsylvania and West Virginia and has three active and three inactive mines.

At the last meeting of the Carnegie board of directors, three of the former members resigned, the new board consisting of J. T. M. Stoneroad, president; Mr. Donahue, treasurer; J. D. Francis; R. D. Campbell, of Huntington, and William A. Ogg, newly elected executive vice-president.

To Promote Cooking by Coal

Plans for the future development of coal-burning cooking ranges to meet the demand for this type of equipment were the subject of discussion on Nov. 16 by eight representatives of the Institute of Cooking and Heating Appliance Manufacturers and Anthracite Industries engineers at the laboratory of the latter at Primos, Pa. Allen J. Johnson, director of Anthracite Industries Laboratory, invited Alden Chester, vice-president of the Globe American Corporation, Kokomo, Ind., and president of the manufacturers' institute, to name a committee of engineers from the institute to meet with anthracite engineers and determine upon a set of definite specifications to meet requirements for this type of equipment. This will be done at the institute's annual convention, Nov. 30, at Cincinnati, Ohio.

Mr. Chester reported an increasing demand on the part of institutions, restaurants, hotels and the general public for modernized coal-burning ranges.

Sales of Mechanical Stokers Higher Than Year Ago

Sales of mechanical stokers in the United States during September last totaled 20,452 units, according to statistics furnished the U. S. Bureau of the Census by 112 manufacturers (Class 1, 73; Class 2, 44; Class 3, 46; Class 4, 34; Class 5, 14). This compares with sales of 12,859 units in the preceding month and 19,193 in September, 1937. Sales by classes in September last were: residential (under 61 lb. of coal per hour), 18,330 (bituminous, 15,409; anthracite, 2,921); small apartment-house and small commercial heating jobs (61 to 100 lb. per hour), 950; apartment-house and general small commercial heating jobs (101 to 300 lb. per hour), 846; large commercial and small high-pressure steam plants (301 to 1,200 lb. per hour), 267; high-pressure industrial steam plants (more than 1,200 lb. per hour), 59.

LETTERS *To The Editor*

Dynamic Braking

The article in September *Coal Age* (p. 42) describing the d.c. dynamic braking equipment for Consolidation No. 93 rock hoist motor should be of especial interest to operators having similar load-lowering conditions. It often is not clearly realized that an existing induction motor installation is adaptable to this type of control with the resulting economies. However, the number of these installations is increasing, and the General Electric Co. alone has supplied fourteen such equipments, totaling 11,000 hp., ranging in units of 135 hp. to 2,500 hp.

Our records show that the first application of d.c. dynamic braking lowering on a coal hoist was in 1927 at the Northwestern Improvement Co., Roslyn, Wash. This installation was of 800-hp. capacity. This company made a second installation of a similar nature, of 600-hp. capacity, in 1934. In 1913, however, a 200-hp. installation was made at the Cananea Copper Co.

R. S. Sage
Mining and Steel Mill Section
General Electric Co.

Educating the Miner

I consider it a social responsibility to educate coal miners and without a doubt put an end to the tragedies which occur in the industry from time to time. The ever-present accident potentiality can easily be removed by a little education. If coal miners generally could say that "in Nature's infinite book of secrecy just a little can I read," the lives, health and limbs of many courageous men could be saved.

If anyone needs more light (education), it is the coal-mining fraternity. I can't see any who have more courage; their heroism cannot be surpassed. They deserve all that can be done for them. I do hope they are afforded the opportunity to educate themselves against such uncalled-for misery. None of us has much initiative when blindfolded. I hope *Coal Age* will take the initiative toward the end desired—the same initiative it has taken in other mining needs.

W. H. Luxton
Linton, Ind.

Cooperation for Safety

I am a mine official with many years of experience in mine work. To get your employees trained under you and obtain their cooperation, have them work with you regardless of their position. You need all working together for safety and economy. This can be done by letting the workman know that you appreciate his views on the work that he performs.

Too many mine officials underrate the employees; they do not take them into their confidence. I believe when an official goes into an employee's working place he should spend a few minutes with him to talk to him on his working place. If you see it up to standard, you should give him a boost for it and show him how you appreciate the condition of his working place. Very often you can gain a lot of knowledge from your employees if you give them the encouragement to talk to you on safety and economy. Describe fully to him the importance of safety because an accident that may cripple him for life can never be fully paid for by compensation, as there is nothing better than your health.

I believe if more mine officials would work along these lines we would get better safety and more economy from all employees. Let us all encourage our employees, teach safety and economy. That means fewer accidents, less compensation, lower costs and better tonnage.

John Buggy
Chambersville, Pa.

Alabama Mines Add Equipment

Four shaker conveyors of 40 tons capacity each are being installed by the Woodward Iron Co. at its Dolomite mine, near Wylam, Ala. Two chain flight conveyors of 40 tons per hour capacity each also are being installed in the promotion of development work.

The Little Cahaba Coal Co. has resumed operations on a limited basis at the Piper No. 2 mine, Piper, Ala., after having been closed for six months following a fire. Output will be increased as the work of rehabilitation and recovery of working places progresses.

Industrial Committee Named

Members of the committee on industrial power applications of the American Institute of Electrical Engineers, named by President Parker, include J. D. Wright (chairman), General Electric Co.; and these coal-industry members: J. H. Edwards, associate editor, *Coal Age;* L. C. Ilsley, U. S. Bureau of Mines; R. L. Kingsland, Consolidation Coal Co.; Carl Lee, Peabody Coal Co.; and Frank C. Nichol-

BUILT LIGHTER WITH MAN-TEN . . .

Mammoth Mine Shovels do 25% to 60% more work — cut costs up to 40%!

THE ability of U·S·S MAN-TEN construction to increase capacity by reducing dead weight has been spectacularly demonstrated in the super-capacity equipment used in the strip mines of the Middle West.

In dippers and dipper booms of strip and loading shovels, in drag line buckets and in trail cars, re-design with this high-strength, long-wearing steel has shown capacity increases as high as 66% with comparable increases in mine production and substantial reduction in operating costs.

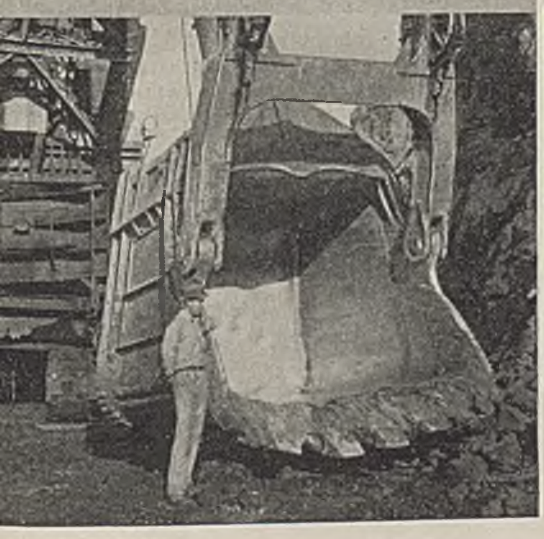
Leading builders and users of such equipment have changed over to MAN-TEN construction because they know what this steel will do. They have watched its performance under all conditions; on one property after another, they have seen it justify every claim made for it.

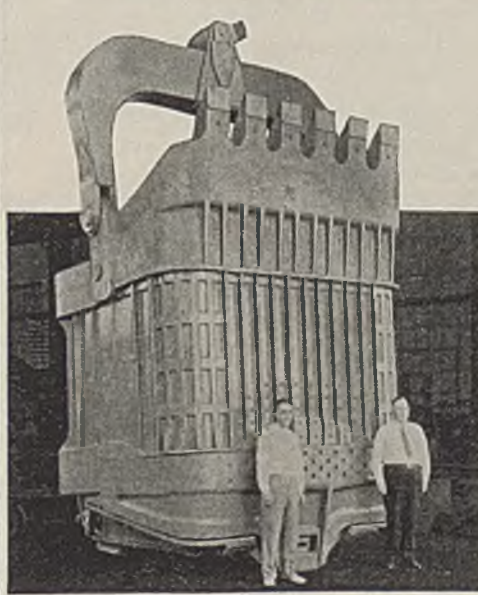
If you want to increase your output, reduce your costs and put your equipment on a better paying basis, investigate light-weight construction with U·S·S High Tensile Steels —MAN-TEN and COR-TEN. We will gladly show you where unnecessary dead weight can safely be eliminated to give you the increased capacity that spells efficiency and means added profits.

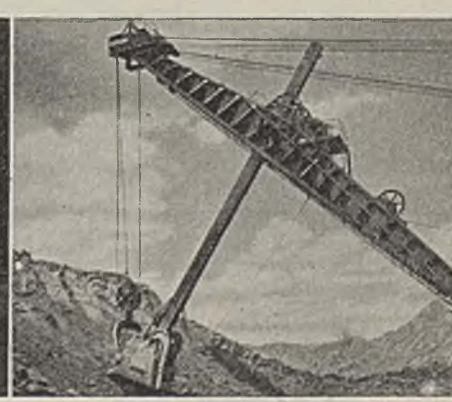
41.6% increase in capacity here. 17 cu. yd. MAN-TEN dipper by replacing a 12 cu. yd. dipper on this 750-B Bucyrus-Erie electric stripping shovel in Friar Tuck Mine, makes it possible to remove 7000 extra cu. yd. of over-burden every 24 hours—with no increase in power equipment.

30 cu. yd. all-welded MAN-TEN *dipper.* Used on 950-B Bucyrus-Erie stripping shovel at the Seeleyville Mine of the Binkley Co. of Indiana. Shovel has 105 ft. boom and 72 ft. dipper handle—52 men can stand inside this giant dipper without crowding.

MAN-TEN *helps increase shovel capacity per cent.* Re-design with U·S·S MAN-TEN make sible to build this 30 cu. yd. dipper so that the n front end, fully loaded, weighs less than the old cu. yd. front end with its load. This 12 cu. yd. c load at every scoop means that additional 14,400 c over-burden are removed every 24 hours; that work is now done in 6 days; that a given yardag excavated in 60% of the time. Excavation cost pe has been reduced 40%. With no change in power eq







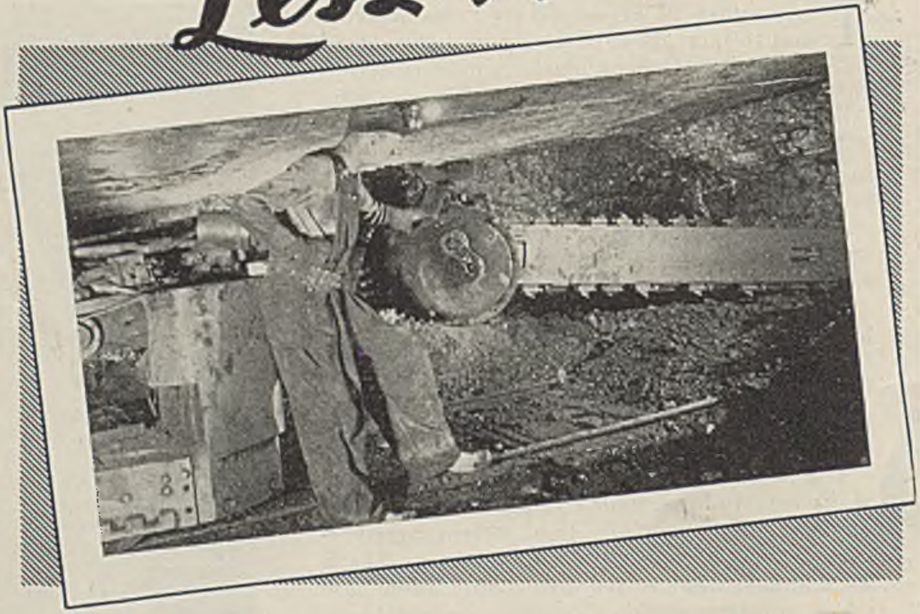
Nearly 2 tons lighter than "light metal" dipper. This 32 cu. yd. Marion dipper built of MAN-TEN weighs 1854 lb. less than same capacity dipper built of so-called "light" metals—will pick up 67 tons over-burden at one bite. Shovel handles 10,000,000 cu. yd. of dirt annually.

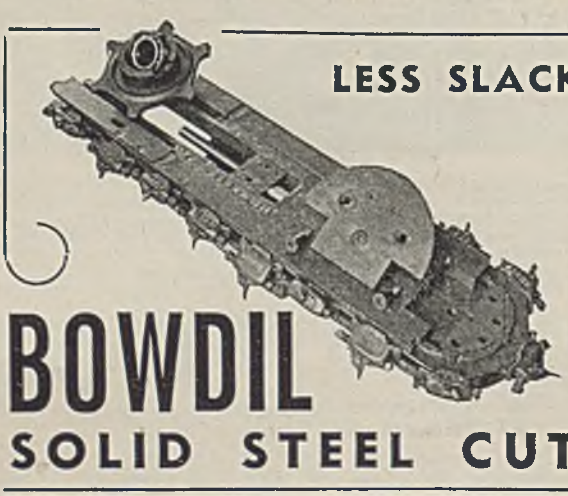
Dipper stick rebuilt of MAN-TEN. On this 10½ cu. yd. electric stripping shovel, in operation light Mine, dipper stick recently built of MAN-T has rendered such improved service that it is no ard practice to rebuild all dipper sticks with tl lasting, abrasion-resisting steel.

U·S·S HIGH TENSILE STEELS

AMERICAN STEEL & WIRE COMPANY, *Cleveland, Chicago and New York*
CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
COLUMBIA STEEL COMPANY, *San Francisco*
NATIONAL TUBE COMPANY, *Pittsburgh*
TENNESSEE COAL, IRON & RAILROAD COMPANY, *Birmingham*

United States Steel Products Company, New York, *Export Distributors* · Scully Steel Products Company, Chicago, *Warehouse Distributors*





son, Glen Alden Coal Co. This committee is a consolidation of three former technical committees, namely: the committees on applications to iron and steel production, applications to mining work, and general power applications. When the board voted on Aug. 2 to authorize the consolidation it was with the understanding that the new chairman would prepare a proposed definition of scope of the committee for submission to the technical program committee and the board of directors.

To Transfer Barren Lands

The Philadelphia & Reading Coal & Iron Co.'s plan to dispose of 123,000 acres of unprofitable coal lands in Schuylkill County, Pennsylvania (*Coal Age*, October, 1938, p. 73), to save $1,000,000 in taxes, was approved on Nov. 23 by Judge Dickinson in Federal District Court in Philadelphia, Pa. Under the arrangement about 10,000 acres is to be turned over to the Anthracite Water Co., Butler Township Water Co. and Silver Creek Water Co., wholly owned subsidiaries, by quit-claim deeds.

The remaining acreage is to be assigned to three new corporations to be formed to take over the land, the capital stock of the three companies to be given to the Reading company for the lands and sold at auction before Dec. 31. The coal company will retain its stock ownership in these water companies and, although the land on which they are now located is to be assigned to them, the transfer of title would relieve the Reading company of personal liability for county and other taxes. The same relief would inure from the transfer of the remaining acreage to the new companies, which would be known as the Grand View Anthracite Coal Co., Western Anthracite Coal Co. and Great Anthracite Coal Co.

Trade Literature

CRUSHING EQUIPMENT — Allis-Chalmers Mfg. Co., Milwaukee, Wis. Bulletin 1815D (8 pp.) describes and illustrates improved Type "B" crushing rolls, with capacity and data table. Bulletin 1467-A (16 pp.) tells about the complete line of Pulverators, or hammer mills, for pulverizing coal, limestone, oyster shells and other nonabrasive materials; in addition to details of design construction there are included size and capacity tables, as well as dimension sheets. Bulletin 1473-A (32 pp.) shows large variety of machinery for crushing plants, indicating particular application to suit local conditions.

ECONOMIZERS—Combustion Engineering Co., New York City (Catalog EE-5, 16 pp.). Describes and illustrates latest designs and details of Elesco fin-tube units and discusses factors governing selection and application of economizers.

ELECTRICAL CONTROLS—Trumbull Electric Mfg. Co., Plainville, Conn. "Trumbullist" (48 pp.) is a complete and compact listing of the company's products, including safety switches, service equipment, meter troughs, multi-breakers, magnetic starters, switchboards and panelboards. Bulletin 400 (36 pp.) covers open knife switches, fuse blocks and cutouts,

Protect eyes with

AMERICAN OPTICAL GOGGLES

F3147 FUL-VUE GOGGLE (PATENTED)

The instant a chip of coal flicks into an unguarded eye, your production cost per ton goes up. Medical costs—compensation costs—cost of lost production—perhaps the costs of training a new man—all result in adding 1c to 5c to your cost per ton.

Yet it is a fact . . . as scores of mine operators will attest . . . that you can guard against these added costs by safeguarding your workers' eyes with American Optical Goggles. Your Mine Safety Appliances Company Representative can tell you the whole story—show you how a *planned eye protection program* can save you money by fitting every man with the proper goggles for his job, from the complete American Optical line. Why not make a note now to talk with him about it, next time he calls?

AMERICAN OPTICAL COMPANY

REPRESENTED IN THE MINING INDUSTRY BY MINE SAFETY APPLIANCES COMPANY

5453

with dimensions. Circular 176 (4 pp.) contains information on multi-breaker service and load centers, types "M" and "MB," carrying service equipment approval.

High-Tensile Steels—Carnegie-Illinois Steel Corporation, Pittsburgh, Pa. (8-pp. booklet). Contains information not only of a technical but of a general nature concerning applications, advantages and fabrication of U.S.S. high-tensile steels.

Hydraulic Couplings — Hydraulic Coupling Division of American Blower Corporation, Detroit, Mich. (Form 3219, 8 pp.). Describes traction-type units for use in connection with electric-motor and internal-combustion-engine drives.

Industrial Lighting Fixtures—Pyle-National Co., Chicago (Bulletin No. 1125, 10 pp.). Shows the suitability of Vaportight fixtures for service where dirt, dust, gases, moisture or other severe conditions are found.

Industrial Railway Cars — Koppel Division, Pressed Steel Car Co., Pittsburgh, Pa. (Bulletin 71, 16 pp.) Presents a general summary of representative Koppel equipment available in standard designs to facilitate selection of the type of car suited to individual requirements.

Lightning Control — Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. "Stop Lightning's Costly Raids with C.S.P. Transformers," a 12-pp. booklet, describes how the "de-ion" gap bypasses lightning surges, characteristics of the "de-ion" gap, and advantages of three-point protection.

Loading Machine—Goodman Mfg. Co., Chicago (Bulletin L-382, 4 pp.). Explains advantages of the "360" track-type loading machine.

Magnets—Stearns Magnetic Mfg. Co., Milwaukee, Wis. (Bulletin No. 25). Features circular, rectangular and hand magnets for magnetic separation and other special purposes.

Permissible Plates Issued

Three approvals of permissible equipment were issued by the U. S. Bureau of Mines in October, as follows:

Sullivan Machinery Co.: Type 8-A track-mounted mining machine; two 50-hp. motors, 220 and 440 volts, a.c.; Approvals 355 and 355A; Oct. 5.

Goodman Manufacturing Co.: Type 724-CJ slate-cutting machine; 100- and 22-hp. motors, 250 volts, d.c.; Approval 331; Oct. 17.

Sullivan Machinery Co.: Type 7-AU mining machine (track-type); 50- and 30-hp. motors, 220 volts, a.c.; Approval 356; Oct. 24.

Coal-Mine Fatality Rate Continues to Ebb

Accidents at coal mines of the United States caused the deaths of 65 bituminous and 5 anthracite miners in September last, according to reports furnished the U. S. Bureau of Mines by State mine inspectors. With a production of 32,010,000 tons, the death rate among bituminous miners was 2.03 per million tons, compared with 2.35 in the corresponding month of last year.

The anthracite fatality rate in September was 1.48, based on an output of 3,381,000 tons, as against 3.53 in September a year ago.

For the two industries combined, the death rate in September last was 1.98, compared with 2.45 in September, 1937.

Fatalities during September last, by causes and States, as well as comparable rates for the first nine months of 1937 and 1938, by causes, are shown in the following tables:

COAL-MINE FATALITIES IN THE UNITED STATES IN SEPTEMBER, 1938, BY CAUSES AND STATES

State	Underground								Persons falling down shafts	Machinery	Grand total
	Falls of roof	Falls of face	Haulage	Explosives	Electricity	Mining machines	Other causes	Total underground			
Alabama	..	..	..	1	1	..	..	2	..	..	2
Illinois	3	..	1	..	..	..	..	4	1	..	5
Indiana	..	..	1	..	..	..	..	1	..	..	1
Iowa	..	..	..	1	..	..	..	1	..	..	1
Kentucky	5	1	4	..	2	..	2	14	..	..	14
Ohio	1	..	..	..	..	..	..	1	..	..	1
Oklahoma	..	..	1	..	..	..	..	1	..	..	1
Pennsylvania (bit.)	8	1	6	1	1	..	..	17	..	..	17
Virginia	1	..	..	..	..	..	..	1	..	..	1
West Virginia	14	..	4	..	1	2	..	21	..	1	22
Total (bituminous)	32	2	17	3	5	2	2	63	1	1	65
Pennsylvania (anthracite)	2	1	1	1	..	..	..	5	..	..	5
Total	34	3	18	4	5	2	2	68	1	1	70

FATALITIES AND DEATH RATES AT UNITED STATES COAL MINES, BY CAUSES*

January–September, 1937 and 1938

	Bituminous				Anthracite				Total			
	Number Killed		Killed per Million Tons		Number Killed		Killed per Million Tons		Number Killed		Killed per Million Tons	
	1937	1938	1937	1938	1937	1938	1937	1938	1937	1938	1937	1938
Falls of roof and coal	439	307	1.341	1.305	93	91	2.495	2.780	532	398	1.459	1.486
Haulage	176	105	.538	.446	21	16	.563	.489	197	121	.540	.452
Gas or dust explosions:												
Local	10	17	.030	.072	...	2	.....	.061	10	19	.027	.071
Major	47	60	.143	.255	...	18	.....	.550	47	78	.129	.291
Explosives	30	18	.092	.077	11	10	.295	.306	41	28	.113	.104
Electricity	40	26	.122	.111	3	2	.080	.061	43	28	.118	.104
Machinery	24	14	.073	.059	2	...	.054	.....	26	14	.071	.052
Shaft	12	4	.037	.017	4	3	.107	.091	16	7	.044	.026
Miscellaneous	30	15	.092	.064	12	10	.322	.306	42	25	.115	.093
Stripping or open-cut	15	5	.046	.021	5	8	.134	.244	20	13	.055	.049
Surface	46	20	.140	.085	13	7	.349	.214	59	27	.162	.101
Total	869	591	2.654	2.512	164	167	4.399	5.102	1,033	758	2.833	2.829

*All figures subject to revision.