PROCEEDINGS

of the

ILLINOIS MINING INSTITUTE

FOUNDED FEBRUARY, 1892

Sixtieth Year

1952

Annual Meeting
SPRINGFIELD, ILLINOIS
October 24, 1952

CLAYTON G. BALL

President, 1952

In Loving Remembrance

WILLIAM ORTMAN, Feb. 22, 1931
S. W. FARNHAM, March 12, 1931
H. C. PERRY, April 13, 1931
A. J. SAYERS, Oct. 11, 1931
C. E. KARSTROM, March 24, 1932
JOSEPH D. ZOOK, May 28, 1932
EDWARD CAHILL, Aug. 4, 1932
JOSEPH VIANO, Dec. 12, 1932
JOHN ROLLO, Feb. 6, 1933
DAVID I. ROCK, Aug. 2, 1933
WM. HUTTON, Aug. 18, 1934
FRED K. CLARK, Oct. 24, 1934
ERWIN CHINN, April 16, 1935
ADAM CURRIE, June 12, 1935
W. H. SLINGLUFF, Sept. 10, 1935
CHAS. B. SPICER, Oct. 26, 1935
NELSON P. MORRIS, Sept. 3, 1936
DON WILLIS, Dec. 9, 1936
T. E. COULEHAN, Jan. 11, 1937
ALBERT WEBB, March 5, 1937
H. B. COOLEY, March 23, 1937
C. W. SWANSON, July, 1937
JOSEPH McFADDEN, Sept. 15, 1937
E. G. LEWIS, Sept. 21, 1937
E. L. STEVENS, Sept. 28, 1937
W. C. ARGUST, Dec. 17, 1937
H. H. TAYLOR, SR., Dec. 28, 1937
E. L. BERGER, May 27, 1938
J. I. THOMPSON, June 24, 1938
P. W. MacMURDO, July 11, 1938
J. A. EDE, July 26, 1938
M. C. MITCHELL, Sept. 11, 1938
C. F. HAMILTON, Sept. 22, 1938
H. C. LONGSTAFF, Oct. 12, 1938
JOHN JOHNSON, Jan. 2, 1939
C. A. BLOMQUIST, Jan. 9, 1939
JOHN WHITE, April 15, 1939
CHARLES HAFFTER, May 21, 1939
BRUNO F. MEYER, July 21, 1939
JOHN A. GARCIA, Aug. 11, 1939
A. J. MOORSHEAD, Oct. 16, 1939
HARVEY E. SMITH, Nov. 6, 1939
C. W. McREAKEN, Nov. 30, 1939
C. C. HUBBART, March 4, 1940
SAMUEL HANTMAN, Sept. 13, 1940
SIMON A. BOEDEKER, Oct. 12, 1940
JOHN H. DAVIS, Oct. 21, 1940
S. J. WILLS, Oct. 22, 1940
HARRY HANTMAN, Nov. 5, 1940
J. W. GLENWRIGHT, Nov. 27, 1940
J. C. WILSON, Dec. 18, 1940
NICHOLAS CHRISTENSEN, Dec. 26, 1940
JOHN W. POLING, Jan. 31, 1941
JOHN T. RYAN, Feb. 20, 1941
M. F. PELTIER, April 2, 1941
F. M. BEAN, April 30, 1941
F. M. SCHULL, Aug. 20, 1941
C. J. SANDOE, Aug. 29, 1941
F. F. SCHLINK, March 15, 1942
FRED F. GERMANN, March 31, 1942
JOHN MENTLER, April 28, 1942
HUGH MURRAY, June 5, 1942
G. D. COWIN, June 14, 1942
JAMES M. ROLLO, June 15, 1942
SYDNEY A. HALE, Aug. 12, 1942
BYRON BROWN, Sept. 17, 1942
J. E. SEYMOUR, Nov. 21, 1942
OTTO AWE, Dec. 6, 1942
A. F. ALLARD, Dec. 29, 1942
THOMAS R. STOCKETT, Feb. 15, 1943
A. R. JOYCE, April 7, 1943
W. S. BURRIS, April 9, 1943
A. H. MALSBERGER, May 7, 1943
J. B. FLEMING, May 19, 1943
H. T. MORGAN, May 29, 1943
E. W. HASENJAEGER, July 29, 1943
C. W. WATERMAN, Aug. 7, 1943
J. R. HURLBURT, Sept. 6, 1943
JAMES S. ANDERSON, Sept., 1943
F. F. JORGENSEN, Nov., 1943
E. W. BEARD, Jan. 5, 1944
W. M. ELDERS, Jan. 22, 1944

In Loving Remembrance

THOMAS ENGLISH, April 3, 1944
FRANK TIRRE, May 22, 1944
*J. K. CHILDS, June 10, 1944
W. S. STINTON, Dec. 6, 1944
E. W. HAWLEY, Jan. 29, 1945
J. C. ANDERSON, July 7, 1945
F. A. FLASKAMP, Aug. 12, 1945
JOHN M. DILLAVOU, Aug. 19, 1945
STANLEY A. TRENGOVE, Dec. 28, 1945
H. A. ZELLER, Jan. 22, 1946
M. K. HERRINGTON, May 11, 1946
L. W. BALDWIN, May 14, 1946
C. P. HOY, May 30, 1946
STUYVESANT PEABODY, June 7, 1946
PETER A. CASSADY, June 18, 1946
JOHN F. GOALBY, June 7, 1946
OSCAR WINTER, Sept. 21, 1946
GEORGE HOOK, Sept. 29, 1946
E. J. KRAUSE, Sept. 30, 1946
H. E. MABRY, Nov. 8, 1946
J. R. PEARCE, Dec. 10, 1946
E. R. ARMSTRONG, Feb. 17, 1947
JOS. P. LENZINI, Feb. 20, 1947
JOHN H. BAUER, March 12, 1947
ARTHUR PHILLIPS, June 27, 1947
LEE HASKINS, Sept. 19, 1947
C. H. BURKHALTER, Oct. 18, 1947
JETT J. WEST, Nov. 11, 1947
THOMAS MOSES, Feb. 20, 1948
W. H. HUBELI, April 3, 1948
G. E. LYMAN, April 27, 1948
WALTER M. DAKE, May 13, 1948
ARLEN "ZACK" JENNINGS, July 30, 1948
ERNEST L. STEPPAN, Aug. 7, 1948
KENNETH DONALDSON, Aug. 18, 1948
PAT HEAP, Sept. 23, 1948
F. E. FINCH, Nov. 2, 1948
J. E. BARLOW, Nov. 5, 1948
J. W. STARKS, Feb. 3, 1949
D. W. MARSHALL, March, 1949
JAMES WHITE, March 17, 1949
W. W. PAAPE, March 18, 1949
JAMES W. BRISTOW, April 14, 1949
GEORGE F. CAMPBELL, June 18, 1949
E. J. BURNELL, July 22, 1949
LOUIS W. HUBER, Aug. 7, 1949
JOHN RODENBUSH, Nov. 1, 1949
R. G. LAWRY, Dec. 24, 1949
WALTER A. BLEDSOE, March 1, 1950
A. S. KNOIZEN, April 29, 1950
H. C. FREDERICKS, Aug. 16, 1950
JOSEPH E. HITT, Sept. 21, 1950
ARTHUR C. GREEN, Oct. 31, 1950
A. P. TITUS, Nov. 9, 1950
A. W. DUNCAN, Nov. 20, 1950
GILBERT W. BUTLER, Nov. 26, 1950
FRED W. RICHART, Dec. 10, 1950
CHARLES L. BOWMAN, Jan. 30, 1951
B. P. MELTON, February 22, 1951
A. F. KEENAN, March 18, 1951
GEORGE M. LOTT, April 12, 1951
D. F. McELHATTAN, April 12, 1951
M. J. CHOLLET, April 20, 1951
WILLIAM BURNETT, JR., June 14, 1951
E. J. COFFEY, July 20, 1951
A C. CALLEN, July 30, 1951
F. E. WEISSENBORN, August 7, 1951
R. A. BARTLETT, November 26, 1951
D. D. WILCOX, November 30, 1951
A. D. BUSCH, January 1, 1952
F. H. SEYMOUR, February 20, 1952
C. M. O'BRIEN, April 16, 1952
JOHN L. CLARKSON, June 9, 1952
HARRY VOGELPOHL, June 15, 1952
HECTOR HALL, August 21, 1952
J. J. RUTLEDGE, September 11, 1952
NORMAN PRUDENT, September 18, 1952
WALTER WHITING, September 25, 1952
D. W. JONES, November 26, 1952
G. H. BERGSTROM, December 11, 1952
W. J. JENKINS, January 12, 1953
FRED J. BAILEY, January 16, 1953

* Killed in Action

OFFICERS 1952

PRESIDENT

Clayton G. Ball
Chicago, Illinois

VICE-PRESIDENT

William W. Bolt
Farmersville, Illinois

SECRETARY-TREASURER

B. E. Schonthal
28 E. Jackson Boulevard
Chicago 4, Illinois

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J. S. Forman***
A. G. Gossard*
E. E. Green***
Lawrence Kiss***
Rice W. Miller**
Moss Patterson***
H. A. Reid*
F. E. Snarr*
G. Don Sullivan*
Frank L. White**
Henry C. Woods**

* Term expires 1952
** Term expires 1953
*** Term expires 1954

OFFICERS 1953

PRESIDENT

William W. Bolt

Pawnee, Illinois

VICE-PRESIDENT

Harold L. Walker

Urbana, Illinois

SECRETARY-TREASURER

B. E. Schonthal

28 East Jackson Boulevard

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John R. Foster ***	Moss Patterson **
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Lawrence Kiss **	Frank L. White *
H. C. Livingston ***	Henry C. Woods *

* Term expires 1953
** Term expires 1954
*** Term expires 1955

PAST PRESIDENTS OF ILLINOIS MINING INSTITUTE

FOUNDED FEBRUARY, 1892

1892-93	JAMES C. SIMPSON, Gen. Mgr., Consolidated Coal Co., St. Louis, Mo.
1893-94	JAMES C. SIMPSON, Gen. Mgr., Consolidated Coal Co., St. Louis, Mo.
1894-95	WALTON RUTLEDGE, State Mine Inspector, Alton, Ill.
1895 } 1911 }	Institute inactive
1912-13	JOHN P. REESE, Gen. Supt., Superior Coal Co., Gillespie, Ill.
1913-14	THOMAS MOSES, Supt., Bunsen Coal Co., Georgetown, Ill.
1914-15	J. W. STARKS, State Mine Inspector, Georgetown, Ill.
1915-16	WILLIAM BURTON, V. P., Illinois Miners, Springfield, Ill.
1916-17	FRED PFAHLER, Gen. Supt., Superior Coal Co., Gillespie, Ill.
1917-18	PATRICK HOGAN, State Mine Inspector, Carbon, Ill.
1918-19	WILLIAM HALL, Miners Examining Board, Springfield, Ill.
1919-20	WILLIAM HALL, Miners Examining Board, Springfield, Ill.
1920-21	FRANK F. TIRRE, Supt., North Breese Coal & Mining Co., Breese, Ill.
1921-22	PROF. H. H. STOEK, Mining Dept., University of Illinois.
1922-23	JOHN G. MILLHOUSE, State Mine Inspector, Litchfiield, Ill.
1923-24	D. D. WILCOX, C. E., Superior Coal Co., Gillespie, Ill.
1924-25	H. E. SMITH, Gen. Supt., Union Fuel Co., Springfield, Ill.
1925-26	E. G. LEWIS, Supt., Chicago-Sandoval Coal Co., Sandoval, Ill.
1926-27	WM. E. KIDD, State Mine Inspector, Peoria, Ill.
1927-28	JAMES S. ANDERSON, Supt., Madison Coal Corp., Glen Carbon, Ill.
1928-29	JOHN E. JONES, Safety Engineer, Old Ben Coal Corp., West Frankfort, Ill.
1929-30	PROF. A. C. CALLEN, University of Illinois, Urbana, Ill.
1930-31	JOSEPH D. ZOOK, Pres., Illinois Coal Operators Assn., Chicago, Ill.
1931-32	GEO. C. MCFADDEN, Asst. Vice-Pres., Peabody Coal Co., Chicago, Ill.
1932-33	CHAS. F. HAMILTON, Vice-Pres., Pyramid Coal Co., Chicago, Ill.
1933-34	HARRY A. TREADWELL, Gen. Supt., C. W. & F. Coal Co., Benton, Ill.
1934-35	C. J. SANDOE, Vice-Pres., West Virginia Coal Co., St. Louis, Mo.
1935-36	T. J. THOMAS, Pres., Valier Coal Co., Chicago, Ill.
1936-37	W. J. JENKINS, Pres., Consolidated Coal Co., St. Louis, Mo.
1937-38	H. H. TAYLOR, JR., Franklin County Coal Corp., Chicago, Ill.
1938-39	PAUL WEIR, Consulting Mining Engineer, Chicago, Ill.
1939-40	ROY L. ADAMS, Old Ben Coal Corp., West Frankfort, Ill.
1940-41	DR. M. M. LEIGHTON, State Geological Survey, Urbana, Ill.
1941-42	J. A. JEFFERIS, Illinois Terminal Railroad Co., St. Louis, Mo.
1942-43	CARL T. HAYDEN, Sahara Coal Co., Chicago, Ill.
1943-44	BEN H. SCHULL, Binkley Mining Co., Chicago, Ill.
1944-45	GEORGE F. CAMPBELL, Old Ben Coal Corp., Chicago, Ill.
1945-46	JOSEPH E. HITT, Walter Bledsoe Co., St. Louis, Mo.
1946-47	ROBERT M. MEDILL, Dept. Mines & Minerals, Springfield, Ill.
1947-48	HARRY M. MOSES, H. C. Frick Coal Co., Pittsburgh, Pa.
1948-49	J. ROY BROWNING, Illinois Coal Operators Assn., Chicago, Ill.
1949-50	T. G. GEROW, Truax-Traer Coal Co., Chicago, Ill.
1950-51	G. S. JENKINS, Consolidated Coal Co., St. Louis, Mo.
1951-52	CLAYTON G. BALL, Paul Weir Co., Chicago, Ill.

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REPRINTS from "Coal Age," Through Courtesy of McGraw-Hill Publishing Co., Inc.

PROCEEDINGS OF ILLINOIS MINING INSTITUTE
SIXTIETH ANNUAL MEETING

Held in Springfield, Illinois

FRIDAY, OCTOBER 24, 1952

MORNING SESSION

10 O'clock A.M.

The Sixtieth Annual Meeting of the Illinois Mining Institute was called to order in the Abraham Lincoln Hotel, Springfield, Illinois, the morning of October 24, 1952, President Clayton G. Ball presiding.

President Ball: Gentlemen, it is now my privilege to welcome the members of the Illinois Mining Institute to the 60th Annual Meeting of your Institute. It is always a pleasure to have so many here and to learn from "Operation Downstairs" that the enrollment at this moment is equaling any record heretofore.

I have been asked to request that any of you who might not have enrolled, please do so. And, even more important, the hotel needs to know how many members will be at the banquet tonight. If you have not purchased your tickets as yet, we urge you to do so as soon as possible.

As most of you know, there is a short business meeting of the Institute before we proceed to the papers with the first order of business usually being to call your attention to the fact that the Minutes of the last meeting have appeared in the printed Proceedings of the Institute, of which most of you have copies, and unless there are any questions, the President will dispense with the reading of the Minutes. There being no questions, we will proceed to the report of the Secretary-Treasurer, B. E. Schonthal.

SECRETARY'S REPORT

At the beginning of this, our 60th Annual Meeting, your Institute had a membership of 1261 members. At our dinner session tonight we will announce how many new members have been added. We are happy, of course, at maintaining our membership at well over 1,000.

As of October 15, our cash balance in the bank was $1003.89. We own $10,000 cash value of interest-bearing bonds.

During the past year we had the misfortune to lose five of our members to death. Proper messages of condolence were sent to the families of all.

Our 1952 Proceedings is now being compiled. We are grateful to the advertisers who continue to support our efforts.

Your Secretary has been grateful for the fine cooperation given at all times by your officers, executive board, committees, and all other members at all times. At this, our sixtieth annual meeting, your Secretary is presenting his report for the twenty-third consecutive time. We look forward to continued growth and activity of the Illinois Mining Institute.

Respectfully submitted,

B. E. SCHONTHAL, *Secretary-Treasurer*

* * *

President Ball: Thank you, Mr. Secretary-Treasurer.

Are there any questions on the Secretary's report? If not, I will hear a motion for its approval and adoption.

Mr. Crawford: I so move.

Mr. G. C. Lindsay: I second the motion.

President Ball: It has been moved and seconded that the report of the Secretary-Treasurer be adopted. All those in favor will signify by saying "Aye." Opposed. It is unanimously carried.

The next item of business is the report of the Nominating Committee, of which Mr. Harry A. Treadwell is Chairman. Mr. Treadwell is not here. Mr. Schonthal will read his report.

NOMINATING COMMITTEE REPORT

October 24, 1952

To the Membership of the Illinois Mining Institute:

As Chairman of the Nominating Committee of the Illinois Mining Institute, I wish to report that the Committee unanimously recommends to the membership the following nominations:

OFFICERS

PRESIDENT:

William Bolt,
Pawnee, Illinois

VICE PRESIDENT:

Harold L. Walker, Head, Department of Mining and Metallurgical Engineering, University of Illinois, Urbana, Illinois

SECRETARY-TREASURER:

B. E. Schonthal
Chicago, Illinois

EXECUTIVE BOARD

Stuart Colnon	Freeman Coal Mining Corporation, Chicago, Illinois
John R. Foster	Chicago, Wilmington and Franklin Coal Co., West Frankfort, Illinois
H. C. Livingston	Truax-Traer Coal Company, Chicago, Illinois
George C. McFadden	Carmac Coal Company, Chicago, Illinois
R. H. Swallow	Fairview Collieries Corporation, Indianapolis, Indiana

Respectfully submitted,

H. A. Treadwell, *chairman*
Roy L. Adams
J. A. Jefferis

* * *

President Ball: Gentlemen, you have heard the report of the Nominating Committee. What is your pleasure on this report? Are there any questions? If not, the President will hear a motion to adopt the report of the Nominating Committee.

Mr. Crawford: I move the adoption of the report and that the Secretary cast the ballot.

President Ball: Is there a second to that motion?

Mr. Lindsay: I'll second it.

President Ball: It has been moved and seconded that the report of the Nominating Committee be approved and the Secretary be instructed to cast the unanimous ballot for the nominees. Will those in favor please signify by saying "Aye." Opposed. It is unanimously carried.

Gentlemen, the next order of business is the report of the Scholarship Committee. The Chairman is Professor Harold L. Walker. Professor Walker.

SCHOLARSHIP REPORT — 1952-1953

By H. L. WALKER

Head, Department of Mining and Metallurgical Engineering
University of Illinois, Urbana, Illinois

I am always pleased to make an annual report to the Institute on scholarships and student enrollment at each of the annual meetings. In general, the outlook for graduating engineers, in all categories, for employment in industry remains bleak. For the school year 1952-1953 it is estimated that we shall graduate, in the United States, less than 25 per cent of the engineers needed by industry, and there does not seem to be any material improvement in that estimate for the next three years.

I believe the coal mining industry in the State of Illinois will be interested in knowing that 50 per cent of the graduating mining engineers were employed in the petroleum industry, and this in spite of the great need for coal mining engineers. Graduate mining engineers fit well into the requirements of the petroleum industry as field men for exploration and production. The petroleum industry is making a strong bid for the services of these graduates and their recruiting programs are considerably more active than the recruiting programs of the mining industry.

This year we shall have nineteen young men receiving baccalaureate degrees in mining engineering and I can recommend each and every one of them to the industry. If the mining industry in this state is really in need of young engineers I advise you to take active steps in the very near future with respect to interviews and employment.

There are fourteen holders of mining engineering scholarships for the current semester. Below I have tabulated the sponsor of the scholarship, and the name of the boy holding the scholarship with his home address. I am pleased to be able to introduce these young men to the Institute at this meeting.

ILLINOIS MINING INSTITUTE

Warren E. Holland	3244 Emmaus Zion, Illinois

OLD BEN COAL CORPORATION

William H. Donley	1008 East Clark West Frankfort, Illinois
Darwin E. Neihaus	906 S. McClellan West Frankfort, Illinois
Donald C. Simpson	Valier, Illinois
Jack E. Tisdale	426 South Central Benton, Illinois

PEABODY COAL COMPANY

Charles E. Childers	1003 West Franklin Taylorville, Illinois
Richard L. Sloan	109 North Jackson West Frankfort, Illinois
James P. Snider	402 East Ford Harrisburg, Illinois
William H. Stoewer	616 Spare Street Galena, Illinois
Tommy S. Ullom	R. R. 3 Benton, Illinois
Richard J. Trainor	R. R. 3 Pontiac, Illinois

HENRY A. PETTER SUPPLY COMPANY

Gordon D. Upchurch	111 Martin Street Benton, Illinois

ALFRED E. PICKARD

Ronald D. Aiken	422 West Church Benton, Illinois

SAHARA COAL COMPANY

Joseph J. Yancik	Mount Olive, Illinois

There are thirty-five student mining engineers attending this meeting of the Institute and it pleases me to be able to introduce them as a body. Will all the students in mining engineering please stand so that the members of the Institute at this meeting may have a chance to see you.

This Mr. Chairman concludes a brief report of the scholarship committee for the 60th Annual Meeting of the Institute.

President Ball: Thank you very much, Professor Walker. The Institute always has a wholehearted interest in the scholarship activities being carried on at the University of Illinois and elsewhere and it is especially gratifying to see the recipients of these scholarships and their classmates at our annual meeting.

In line with the same subject, and it is one in which we are all tremendously concerned, I know, I would like to call upon Maurice Cooper of the National Coal Association, whose full-time work is along the same lines of education in our colleges for the young men who are to enter the coal mining industry. Mr. Cooper.

Mr. Cooper: Mr. President, it is always inspiring to hear Professor Walker speak on the subject of mining engineering education and it is certainly very inspiring to see the group of students he brings with him to these meetings. In the educational work in which I am engaged on a full-time basis, we are trying to promote the very subject of scholarships that has been made so prominent here this morning. We hope the time is coming when every company producing 500,000 tons or more per year will provide for a scholarship at its own state university. Illinois, being one of the most productive of the states in the matter of bituminous coal, could well afford to provide scholarships by the companies for young men attending the University of Illinois, and we hope that in time the present number represented by these men this morning may be doubled.

President Ball: Thank you, Mr. Cooper.

This completes the formal agenda of the business meeting, unless there is any unfinished business, new business, announcements.

Secretary Schonthal: None.

President Ball: That being the case, we will proceed to the technical portion of the program. It is my great pleasure at this time to turn the meeting over to the Chairman for the session this morning, Mr. Ivan Given – most of you know him – Editor-in-Chief of COAL AGE. Mr. Given.

Chairman Given: Thank you, Mr. Ball, and gentlemen:

I was thinking when Mr. Ball asked me to preside at this morning's session, back to my first connection with the mining industry, or my first visit to Illinois. It goes back to 1932 or 1933, and it was rather continuous for many years. I have always found it extremely pleasant and I always look back and say that Illinois was certainly something to visit in those days, and still is. Consequently, I am really pleased to have some small part in this meeting this morning.

I am not going to make any extended remarks, except I do want to express my pleasure that I shall have some little part in connection with this 60th meeting of the Illinois Mining Institute. With that, I shall get down to the meat of the business this morning and start introducing our speakers.

As you gentlemen are well aware, the belt conveyor has made for itself a very prominent place in the coal mining industry by its contribution to higher efficiency and to lower cost. That contribution reflects, of course, the very intense and continuing study of all the factors involved in rendering the belt more efficient. That study continues and this morning we shall hear something that is being done today and that may be done in the future to improve this machine that contributes to efficiency and low cost.

The topic of the first speaker this morning on belt conveyors can possibly best be described by citing the title, which is "The Use of Untreated Cotton-Nylon and Ustex Treated Cotton-Nylon Conveyor Belts in the Coal Industry." The author is Mr. H. E. Pruner, Belting Engineer of the United States Rubber Company at Chicago, Illinois, and it is my pleasure at this time to introduce Mr. Pruner.

THE USE OF UNTREATED COTTON-NYLON AND USTEX-NYLON CONVEYOR BELTING IN THE COAL MINING INDUSTRY

By H. E. PRUNER

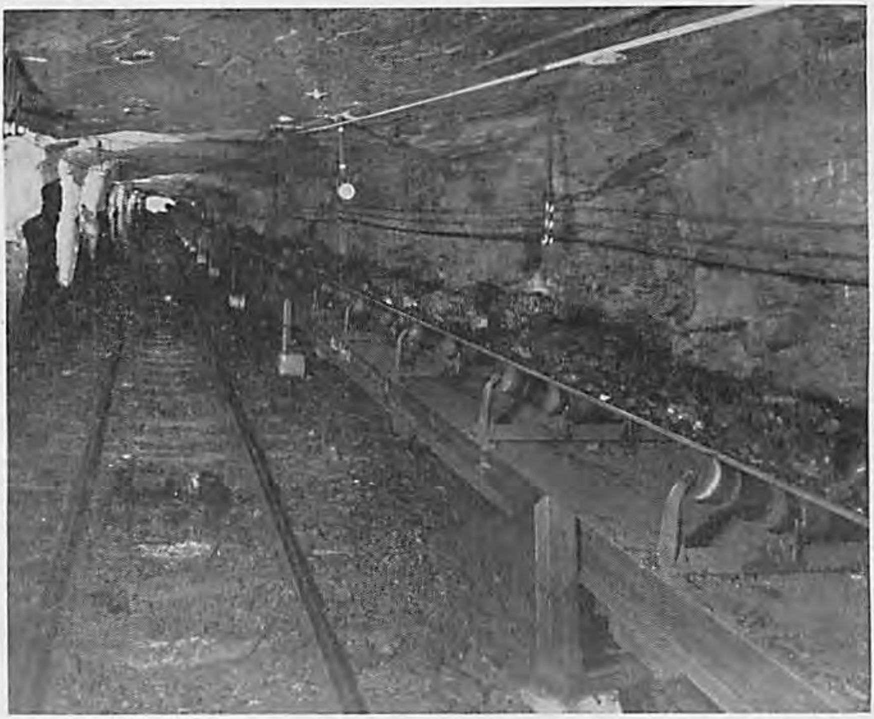
Belting Engineer, United States Rubber Company
Chicago, Illinois

The first installation of note involving the use of conveyor belting for hauling coal in conjunction with mining operations was a 19-flight system at the Colonial Dock of the H. C. Frick Coke Company, Uniontown, Pennsylvania. This installation is now a part of the U. S. Steel Company family. It was installed in 1924 and has transported over 85 million tons of coal to date from the Colonial Mines to awaiting barges in the Monongahela River, a distance of 4⅓ miles.

The latest available figures on the use of conveyor belting in the coal industry, as taken from Mechanization Magazine and Bureau of Mines Publications, indicate that at the end of 1950, a total of 5,175,000 feet, or approximately 1,000 miles of conveyor belting were in operation in this Nation's coal mines. Of this, approximately 3,100,000 feet, or 590 miles are in operation underground; 325,000 feet, or 62 miles in slopes; 1,500,000 feet, or 285 miles in cleaning plants and tipples, and 220,000 feet, or 42 miles in strip mining and overland haulage. To these figures, it is estimated that an additional 250 miles of belting have been installed, making the total footage in use in coal mines, today, approximately 1,250 miles.

Paralleling the increased use of conveyor belting were improvements in construction, design and strength of the belting itself. Highlights along the way were the introduction of belts made from 42-ounce duck in 1929 and 48-ounce duck in 1938, by the U. S. Rubber Company. Cord type belts were introduced by the B. F. Goodrich Company in 1932. The first Steel Cord Conveyor Belt was manufactured by the Goodyear Tire & Rubber Company and installed in 1942.

Subsequent to the introduction of 48-ounce duck conveyor belting, the U. S. Rubber Company continued research and development work in an effort to secure constructions with which to meet the requirements of extremely high-tension installations. All available materials, in various types of combinations including steel, synthetic fibers, ramie, glass, and treated cotton, were explored. Weighing every factor, the



Picture No. 1
View looking up slope of Style CL Ustex Nylon conveyor belt installed at Moffat Coal Company, Storrs Colliery, Scranton, Pennsylvania.

highest rating was given to a belt manufactured from a new fabric comprising a combination of Ustex treated cotton and nylon. In this new fabric, the Ustex treated cotton was used in the warp or lengthwise direction, with the nylon in the filler or crosswise direction.

The Ustex treatment is one of chemical and mechanical nature. The treatment increases the density of the cotton yarns, orients the fibres and produces a chemical change in the structure of the cotton. The Ustex treatment produces a cotton yarn of high tensile strength, low elongation and excellent aging characteristics. Ustex yarns and nylon fibres are woven into a belt fabric by specially designed looms. The fabric is dried, frictioned, skimmed and manufactured into a conveyor belt by the conventional techinques developed many years ago for the manufacture of duck and rubber belting.

Concurrent with the development of Ustex Nylon fabrics, a line of untreated cotton-nylon fabrics was developed. These fabrics are designed for use in conveyor belting where the extremely high strength of Ustex Nylon is not required, but additional strength over that available from 42-ounce and 48-ounce duck is necessary.

Five constructions of conveyor belting manufactured from these fabrics are now available —

Style	Maximum Operating Tension (pounds per inch ply)	Treatment
XN	50	None
YN	70	"
85	85	Ustex
CX	110	"
CL	150	"

The maximum operating tensions have been conservatively established, utilizing a large margin of safety between operating tension and ultimate belt strength. This margin of safety is 1¼ to 1½ times larger than published values used with steel cord conveyor belts. Untreated cotton-nylon and Ustex Nylon conveyor belts are available in a range of operating tensions from 200 to 2,000 lbs. per inch of width. Research and development work is continuing on belts of still higher strength.

By the use of nylon in the fill or crosswise fibres in the fabric, the crosswise strength needed for proper load support is obtained. The inherent strength of the nylon also resists longitudinal ripping and tearing of the belt. Flexibility is also imparted by the nylon, creating optimum belt troughability which, in turn, provides a true running belt, eliminating edge wear and spillage. The high fatigue strength and flexibility of the nylon prevents failure by longitudinal flexing fatigue.

Ustex Nylon belts go through three stretch-removing steps in the process of manufacture: (1) The Ustex treatment removes over 50% of the inherent elongation in the cotton fibres; (2) Ustex Nylon fabric is woven with a small amount of crimp, eliminating further elongation, and (3) The belt is stretched in the press during vulcanization, removing still more elongation. However, a definite amount of elongation is left in the belt to provide elasticity for the all-important ability to dissipate the effect of shock and impact. This is done by distributing the shock and impact over a wide area, thereby preventing localized strain and incipient damage. Extremely high modulus, practically no-stretch belt constructions have little ability to "roll with the punch." The maximum elongation exhibited by any Ustex Nylon conveyor belt in service to date is 0.7%.

As natural and synthetic rubbers have a high affinity for cotton, no special treatment of the fabric is required to obtain good adhesion between the rubber and the fabric. In case of steel cords, brass plating is necessary and, with 100% synthetic fibre fabrics, such as an all-rayon fabric, a chemical dip is required.

The diameter of pulleys used with Ustex Nylon belting is not governed by face pressure against the pulley, as in the case of belts having a

Picture No. 2
View looking toward coal preparation plant of Style CX Ustex Nylon conveyor belt at Pond Creek Pocahontas Coal Company, Mine No. 3, Evanston, Kentucky. Belt handles 400 tons per hour of run-of-mine coal. The lift of this belt is twice the height of Niagara Falls.

strength-carrying member consisting of a layer of cords in a single plane. Pull-through of the cords can occur if the ratio of belt tension to pulley diameter is not correct. The cross-section of an Ustex Nylon belt consists of several plies of fabric, the number depending upon the strength requirements of the belt; therefore, the tension in the belt is distributed throughout the entire width and thickness of the carcass and not concentrated in a single plane. This eliminates the possibility of any carcass pull-through on bending over pulleys.

Although untreated cotton-nylon and Ustex Nylon belts are of plied construction, the moduli of the fabrics are not high enough to build up critical stresses in the outer ply when bending over pulleys of conventional conveyor diameter.

In the Spring of 1948, the United States Rubber Company installed an Ustex Nylon conveyor belt at the Hawkins Mine of the Cleveland Cliffs Iron Company, Nashwauk, Minnesota. Before the belt left the factory, it was completely tested for strength and quality. This belt has operated through four seasons, and at the end of the 1951 season had handled in excess of 5,100,000 long tons of iron ore. During the off-season, the belt was moved to the Holman Cliffs Mine of the same company, where it was to operate on a new installation. A 200-foot piece of this belt was returned to the factory during this change-over so that complete tests could be carried on to determine its present condition. Listed below are the results of the two tests, the original conducted in March 1948, and the one on the returned section in June 1952.

	Original Belt 3/12/48	Returned Section 6/5/52
ADHESION		
Carrying Side		
Cover from Breaker	48 Lbs.	51 Lbs.
Cover from Carcass	22 "	22½ "
Pulley Side		
Cover from Carcass	18 "	18¼ "
Between Piles		
1-2	24 "	23 "
2-3	26 "	27 "
3-4	27 "	30 "
4-5	28 "	27½ "
5-6	25 "	24½ "
6-7	25 "	28 "
COVER TENSILE	3570 lbs./in.^{2}	3770 lbs./in.^{2}
BELT BREAK		
Ultimate Strength		
Lbs. per in. width	5825 lbs./in.	5970 lbs./in.

From the above comparison of test results, it can be seen that no appreciable deterioration took place in the adhesion between the covers and carcass and between plies. The tensile strength of the cover deteriorated slightly; however, it is still over the 3,500 lbs. per sq. in. minimum for this grade of belting. The outstanding fact brought out by these tests is that the carcass has only lost 2½% of its original strength in four years of operation. This very small deterioration can be attributed to the Ustex treatment given the cotton fibres. The aging characteristics of the cotton has been improved by the pH change accompanying the Ustex treatment.

Since there is no metal in the carcass of these belts, there is no chance for loss of strength due to corrosion.

Picture No. 3

View of third section of an overland belt haulage system carrying strip mine coal from crusher to tipple. This conveyor system consists of three flights, 1,400 centers, 3,100 ft. centers and 1,700 ft. centers. The belt is 30", 4 ply, Style XN. The training is excellent throughout its entire length over the rough terrain. This system of belt conveyors replaced trucks which were continually in difficulty with mud during the Spring and Fall, and snow during the Winter.

As untreated cotton-nylon and Ustex Nylon belts are of plied fabric construction, they can be made endless in the field by vulcanization as easily and efficiently as any conventional duck and rubber conveyor belt. Also in the case of accident, temporary repairs can be readily effected by rip plates or fasteners, or permanent repairs can be made by vulcanization, utilizing the same techniques that have been developed for repairing duck and rubber conveyor belts.

At the present time, there are over 40 miles of untreated cotton-nylon conveyor belt in operation, and of this figure, approximately 30 miles are being used for underground coal haulage. The majority of this 30 miles of belting consists of 30″ or 36″ wide, 4 ply, Style XN construction which was designed specially for underground coal haulage. Approximately 10 miles of Ustex Nylon conveyor belting are installed with 50% of this footage in use in coal slopes.

The first Ustex Nylon coal slope conveyor belt was installed at the Moffat Coal Company, Storrs Colliery, Scranton, Pennsylvania, in 1948.

At the time of its installation, it was the longest, highest lift, single-flight coal slope conveyor belt in the world. It has 2,600 ft. centers, a 643-foot lift, and has handled approximately 1,500,000 tons of anthracite to date.

Other coal slope installations are located at the Pond Creek Pocahontas Coal Company, Mine No. 3, Evanston, Kentucky; the Jamison Coal & Coke Company, Farmington, West Virginia; the Colorado Fuel & Iron Company, Allen Mine, Weston, Colorado, and the Guyan Eagle Coal Company, Mine No. 5, Amherstdale, West Virginia.

During the month of November 1952, a new Ustex Nylon slope belt will be installed at the Freeman Coal Mining Corporation, Mine No. 4, Pittsburg, Illinois.

Accompanying illustrations show some interesting installations of untreated cotton-nylon and Ustex Nylon conveyor belting.

DISCUSSION

Chairman Given: Thank you, Mr. Pruner, for an excellent paper.

Now, as is customary, we have an opportunity for questions or discussion. I should think that Mr. Pruner might have brought out some points that would have raised some questions.

Mr. Cooper: Mr. Pruner referred briefly to glass belts. We wonder what he thought the future might be in that respect.

Mr. Pruner: Primarily, glass is being used in belts handling hot materials. Glass fibres have high tensile strength combined with the ability to withstand high temperatures. Although the glass fabrics on the market today are strong, they have relatively poor resistance to internal abrasion. This characteristic would limit their use in high-tension belt installations, as the flexing over the pulleys would cause premature breakdown of the glass fabric. You can take a piece of glass yarn and attempt to break it in your hands and you will find it will cut through your fingers before it will break. However, you can take that same piece of fabric and rub it between your fingers and it will crumble from abrasion. Until this shortcoming of the fabric is overcome, I doubt whether we will see it used in any high-tension belt installations. It does a very good job handling hot materials where cotton will char and deteriorate from heat, while the glass is relatively unaffected.

Chairman Given: Are there any other questions?

Mr. Reuben Tucker: What effect does this treatment have on mildew?

Mr. Pruner: The treatment, as covered in my talk – the Ustex treatment, is used for obtaining additional strength from long staple cotton fibres. This treatment has no effect on the mildew resistance of the fabric.

The nylon fibres in both the untreated cotton-nylon belts and the Ustex Nylon belts are impervious to the attack of mildew. However, the cotton, where it is required, can be and is treated for mildew protection. This is not done to the individual yarns, but it is done after the cotton and nylon are woven into the fabric and the entire fabric is treated before it is built into a belt. The word "untreated" did not allude to mildew treatment; it is a treatment for extra strength.

Mr. Robert Fletcher: Mr. Pruner, in your early statements as to the length of belt underground, was that the belt length or conveyor length?

Mr. Pruner: That was total belt length.

Mr. Fletcher: So we cut it in half.

Mr. Pruner: That's right, sir, we cut it in half as far as total conveyor length is concerned.

Chairman Given: Thank you, sir, very much.

Picture No. 4
Typical underground gathering installation utilizing 30", 4 ply, Style XN belting. This is a part of a 15,000 ft. belt system in a West Virginia mine.

Now, gentlemen, we will turn to another phase of what we might call the machine age in coal mining. In fact, machines are so common now that I have difficulty — I don't know whether any of the rest of you do or not — in remembering back to the days when we had anything else but machines. The State of Illinois incidentally was one of the leaders in making the machine an effective tool for cost reduction in coal mining. I don't think we've seen anything yet, looking at what is going to happen in the future in machine mining.

That is the topic of our next paper, Mechanized Mining Trends in the Coal Industry, and the author of this paper is Mr. George C. Lindsay, Editor of MECHANIZATION Magazine, Washington, D. C., and I now have pleasure in introducing Mr. Lindsay.

MECHANIZED MINING TRENDS IN THE COAL INDUSTRY

By George C. Lindsay
Editor, Mechanization Magazine
Washington, D. C.

It is a relatively simple task to assemble data on the application of mechanical equipment to the coal industry from the early use of machines up to the present, but evaluation of the trends in that application has often been overlooked because of the seemingly rapid developments in that connection. All of you are no doubt familiar with the development and use of mechanized equipment in our industry, and I am sure that many of you are more familiar with certain phases of coal-mine mechanization than I, but a review of the phenomenal progress achieved through the medium of mechanized mining never fails to increase the personal pride I have in being affiliated with the coal industry.

Cutting Machines

With your permission, I shall review, sketchily and briefly, the history of mechanization in coal mining, to effect a basis for certain comparisons and for evaluation of trends. Twenty years before the turn of the 20th century, it was the contention of some far-sighted operators and others interested in the coal industry that it could be adapted to the use of machinery. Now, we know the accuracy of their predictions. Inventors first directed their attention toward a machine or device to cut the coal which, under the system of complete hand mining, was the most arduous task. Puncher-type coal-cutting machines, compressed-air driven, first came into prominence in the 1880's. Other types of early cutting machines included those that used multiple pick-point bits either around the circumference of a wheel, mounted on a rotating bar or fastened to endless chains. In 1889, the potent force of electricity made itself felt through application to machines designed for coal cutting. What is believed to be the first electric coal cutter in the world was manufactured in 1889 and installed in an Illinois mine that year. It was only a year later that Sperry—the same who is famous for the gyro compass—invented an electric longwall cutting machine, which is believed to be the first of its type put to use in this country. Longwall mining was destined never to be too popular here, and development of the longwall cutter was closely followed, about 1910, by development of a shortwall-type machine that proved to be the first in a long series of machines, some types of which are being used today. This particular machine was one that miners had been searching for. It had the tremendous advantage of being powered electrically, which meant that it could be transported from place to place and motive power could be used to unload the machine from its truck, to sump in, to make the cut, and to reload the machine on the truck prior to moving to the next place.

Inventors had been busy for 20 years in designing devices to reduce manual labor in the process of coal cutting. You know, of course, how later development of machines for thin-seam mining, adoption of thin cutter bars, longer bars, hydraulic control, faster feeds, improved cutter chains and eventually the automatic disposal of cuttings—the bugduster—were developed and applied to the cutting machines. Likewise, mounting of cutters for ease in transporting them, adaptation of mounted machines to bottom, center and top cutting, and eventually, about 1940, the development of the universal cutting machine.

Transportation

The application of electric power to the processes of underground mining actually was the basis for the rapid expansion in the use of mechanical equipment in mines. One of the first electric locomotives was installed in an Illinois mine about 1890 or 1891. It is said to have replaced 12 mules, to have provided for better haulage speed, increased capacity of trips, and for increased length of haul. Most of the first locomotives were of single-motor type. It is believed that one of the first mainline haulage locomotives, single-motor type, made its appearance about 1902, and the following year a gathering locomotive with an electric cable reel made its appearance. It was not until World War I days that the 2-motor locomotive began to out-number its predecessor in coal mines. You all are aware of the rapid advances made in electric locomotives, since that time, to those multiple-motor streamlined, heavy-weight high-speed types, modern in all respects, that are being used today.

Loading

When referring to the degree of mechanization in mines today, it is common to limit that reference to only one phase of mine mechanization—mechanical loading. It was one of the last phases—though not least important—to receive the attention of the inventors of mechanized mining equipment. It was logical that the sequence in mechanization of the various phases followed in the order of cutting, drilling, haulage and loading, for a successful mechanical loading system is dependent upon the high efficiency in the operation of the other phases.

Some of the early attempts at mechanical loading devices included a crawler-mounted power shovel, which was tested in a Pennsylvania anthracite mine about 1916. Scrapers were introduced around 1918. Certain difficulties in application and operation of such machines as the power shovel led, during the 1920's, to a search for a completely new and different type of loading equipment. Consequently, both the track-mounted and crawler-mounted machines made their appearance. Also in the late 1920's, several other types of loading equipment, or aids to loading, were developed and applied; some of these were the pit car loader and other types of hand-loaded conveyors, and the shaking conveyor. The latter actually had its beginning in European mines, was first tried in this country right after the first World War, but grew in favor during the 1920's and 1930's. It was in the west that the shaking conveyor was pioneered in this country, and the "duckbill" loading head was developed.

Analysis of Trends

So much for the background of the development of mechanical equipment and its application to the coal industry, sketchy and incomplete as it may be. However, definite trends in mechanization are indicated in the history itself. It will be noted that the first machines to be designed for use underground were those that attacked the most laborious phases of mining, which of course points out the principal reason for the mechanization process in the beginning. To indicate how rapidly the new machinery was adopted and put to use, 25 percent of all coal mined underground was cut by machines in 1900; 10 years later it had risen to 42 percent; then to 62 percent in 1920. First published records of mechanical loading were released in 1923—when 0.3 percent of underground output was so loaded. By 1930 it had increased to 10.5 percent, the same year that 81 percent of underground output was cut by machine.

As newer machines were developed to encompass all the mining phases, mechanization began to take on a new meaning. Machinery began to be designed with a view to increased capacity, to fit natural conditions encountered in mining particular seams, to enhance quality of the product mined, and to fit into a new pattern of mining which now is commonly referred to as a conventional or cyclic system. In the early 1920's, mechanization ceased to mean the mere substitution of mechanical for physical energy; a new system of mechanized mining was evolved around the ability to load coal mechanically.

During the dark decade after the big depression, *efficiency* in the application of the mechanized mining system became the watchword. The coal industry, which had been highly optimistic after World War I and had built producing capacity far beyond the point it should have, was shocked to learn that the postwar market's firmness was artificial, having been supported largely by strikes and car shortages. A fuel transition had already set in; all fuels were abundant, but the increasing demand for liquid and gaseous fuels placed the oil and gas industries in a good economic position for growth. It was during that decade, from 1929 to 1939, that the coal industry was faced with a declining market and a genuine need for efficiency, which meant more tons per man day, or lower cost of production. It was then that the mechanization program in coal mining met its real test—and, we are happy to say, passed it with flying colors.

The record shows that, during that 10-year period, (1) percent of coal cut by machine underground, already mounting to *four-fifths* of the total underground output in 1929, rose nearly 10 percentage points;

(2) percent of underground output mechanically loaded more than *quadrupled;* (3) percent of total output mechanically cleaned *trebled;* and (4) percent of total output mined by stripping increased about *2½ times.* The accent in mechanization during that period was on mechanical loading. The net result in efficiency through mechanization during that period was an overall increase in tons per man day of a little less *than 10 percent,* or an increase of nearly a half a ton per man day. That increase does not consider the decrease in working time effected during that period.

Then coal went to war again. In a short 3-year period, 1939 through 1942—the latter being our first full year of war—annual bituminous-coal output increased almost 200 million tons, or nearly 50 percent. Total annual output continued to rise to set a new record high in 1947 of more than 630 million tons. The rapidly increasing demand for coal was occasioned by the country's skyrocketing demand for energy to fight the war, then to catch up in postwar years with a huge backlog in demand for civilian goods.

During the first eight years of the 1940 decade when coal output was climbing, the mechanization program continued to grow; in fact it was mainly through an increase in mechanization of mines that the higher and higher annual output was possible, for there were 20,000 less employees at coal mines in 1947 than there were in 1940. Here is that 8-year record: (1) percent of underground output cut by machine remained at about 90, even though actual tonnage cut increased about *20 percent;* (2) percent of underground output mechanically loaded *nearly doubled* to reach 61 percent in 1947, while actual tonnage mechanically loaded *more than doubled;* (3) tonnage mechanically cleaned increased *72 percent;* and (4) output mined by stripping increased about *3⅓ times.* The accent during that period was on stripping, but mechanical loading underground continued its rising trend.

As to the trend in the use of specific types of mechanical loading equipment underground during that period, the number of self loading conveyors in use increased *133 percent,* number of mobile loading machines increased *108 percent,* and number of hand-loaded conveyors increased *76 percent;* but number of pit car loaders dropped *90 percent* and number of scrapers fell *42 percent.* The machine-type loading devices were much favored during the period, for output from such devices increased *125 percent* as compared with an increase of only about *35 percent* in output handled on hand-loaded conveyors. Also, tonnage loaded by machine-type loaders in 1947 represented *85 percent* of all coal mechanically loaded underground that year.

Continuous Mining Machines

The most recent application in mine mechanization as it concerns production at the face is, of course, the continuous mining machine. Its availability as a commercial machine in 1948 brought with it a revolution in mechanized coal mining, and that revolution occurred at a time when the former mechanization program based on the use of conventional mechanized equipment was not quite two-thirds complete. It may be news to some that the principle of continuous mining is not new, although its practical application in this country has just begun to take hold. There was in active use in England as early as 1870 a mechanical device that utilized the system of removing material from a solid face at an underground operation without drilling or blasting. It is believed that the first application of such a device in this country was in the early 1920's. Yet it has been only during the past four years—*three quarters* of a century after its first use—that the continuous mining machine has become to be accepted as a part of mechanized coal mining.

Time is not available to discuss the various types of continuous mining machines now available commercially. The April 1951 issue of MECHANIZATION contains a rather complete coverage of types known to exist at that time, and a few additional types have been put to practical test since then. The impact of the application of the new principle of mining upon the coal industry is the important phase under discussion.

At present, it is estimated that roughly 175 continuous mining machines of eight or nine different types are actively engaged in nearly 100 mines in the bituminous-coal industry. Based upon experience in their operation to date, currently operating machines are capable of producing in excess of 50 tons per man per shift in the producing section. The recent availability of continuous-type haulage equipment for use behind the mining machines is expected to make possible attainment of even higher productivity rates. However, not all continuous mining machines in operation are considered an improvement productivity-wise over the conventional type of equipment, because of special natural conditions at the production site have not been conducive to operation of the machines as they are being made available today. Yet, the principle and system are new to coal mining, and the current problems in continuous-type machine operation will surely be solved in the future, just as problems in operation of conventional-type mechanical equipment were solved in the past. *It is my firm conviction that, some day, the rate of coal output underground from continuous-type machines will far exceed the current rate of mechanically loaded output from deep bituminous-coal mines.*

In evaluating coal's current position regarding mechanization, we note that there are in use in bituminous-coal underground mines about 4,350 mobile loading machines including continuous-type units, 4,450 hand-loaded chain conveyors, 1,270 conveyors equipped with duckbills or other self-loading heads, an insignificant number of scrapers and less than a dozen pit-car loaders. There are an estimated 3,800 power shovels and draglines in use at surface or strip mines. An estimated *63 percent* of total underground output was loaded by machines in 1951, *28 percent* was hand loaded, and about *9 percent* was loaded onto conveyors. Roughly *81 percent* of total underground output was from mines that used loading devices, and of that tonnage nearly *80 percent* was loaded by machines. It is evident from those data that the trend in mechanical loading today continues in favor of the loading machine, including the continuous type, and further the trend seems to be toward the use of trackless-type equipment. The trend in use of transporting media behind mechanical loading machines has been toward the use of shuttle cars, the tonnage so loaded having increased about 2½ times since 1945. Mechanized cutting and drilling, of course, continued at high rates already achieved some years ago. Output by stripping, all of which is considered to be mechanically loaded, fell slightly this past year to 22 percent of total bituminous-coal output. The total rate of mechanical loading for the industry this past year is thus estimated to be 77½ percent, including the strip output.

Trends in other directions indicate an emphasis on equipment designed for thin-seam operation, since depletion of thicker seams, particularly in the eastern fields, has been relatively rapid. There is a tendency to revive longwall mining or modifications of it for future application to thin seams, and several types of foreign-made equipment are now being tested underground in the Appalachian fields.

Roof bolting has shown a phenomenal growth during the past few years; there are about 550 mines now using the process successfully, and those mines are installing bolts at a rate of 2½ to 3 million monthly. As can be expected, development of both pneumatic and rotary drills for this work, plus development of dust collectors for use with both types, has been rapid.

Without being more specific, all the other phases of mining including transportation, power, ventilation, mine dewatering, safety, etc., have benefited from advances in equipment and methods of application, which have been brought about by the increasing tempo in application of mechanized equipment to the strictly coal-producing phases. Since 1948 the impetus given to the mine mechanization program has been a need for *increased efficiency* in mining. In the 1948-1951 period, average realization dropped consistently every year, while average cost of production increased, so that at present the industry faces a real problem in maintaining even a small degree of margin on which to operate.

Coal's Future

In view of coal's present relative position, what about the future? It is here that I must assume a combined position of fortune teller and Vice President in Charge of Hope. Consensus of several surveys made both by government and independent economists indicates that coal currently is experiencing a slump in the total US energy-supply picture —not necessarily volumewise—but that the supply-demand estimate for the future of petroleum and natural gas industries indicates a heavier reliance on coal sometime before the turn of the next century. After thorough research on the subject, MECHANIZATION prepared and published in November 1951 a study that conservatively estimated a *billion-ton year* for the coal industry by the time our present total energy-demand doubled, which may occur at any time between 1975 and 2000, depending upon economic and political developments. However, coal, already straining to meet competition of oil and gas costwise and facing another decade or two during which that competition is expected to increase, is thus placed in an unfortunate position of having to dig for a living in the meanwhile. Furthermore, it must not only find the method of overcoming that obstacle, but it must prepare itself throughout the interim period so that it will be in a proper position to carry the burden of a greatly increased demand upon it for energy when oil and gas will no longer be able to carry their proportionate loads. It must be stated, too, that failure to solve these heavy problems may eventually lead to nationalization of our coal industry and possibly to a mortal break in our national economy.

What is the answer? In my own humble opinion, continued mechanization at an accelerated rate to effect a proper increase in efficiency of coal production is the only solution that appears feasible at this time.

Turn for a moment, if you will, to look at the size of the problem that confronts our industry during the next couple of decades. Assuming that our economy progresses at a rate that would call for realization of the doubled energy-demand by 1975, and assuming the projection for a billion-ton year to be correct, our mining capacity to produce coal in that quantity at that time should have been increased about 400 million tons above our present capacity. In addition, another 600 million tons of producing capacity at the very least will be necessary because of depletion of our current mining facilities throughout the next 25 years. It appears, then, that by the time coal assumes the major burden of supplying the necessary energy for progress in the US, it must have more than doubled itself in terms of present production capacity. In terms of capital required for expansion at such a rate—based on current estimates of $10 or more per annual ton of output for a completely modern mine, including land and mineral rights, equipped with facilities for cleaning to zero—the figure mounts rapidly to the neighborhood of *10 billion dollars.* That is more than triple the estimated investment in our entire coal-producing industry today. Furthermore, that figure does not include probably an equal amount of capital that will be required to build new synthetic-fuel and chemical industries, which will be necessary to make up the deficiency of the gas and oil industries to supply the greatly increased demand for liquid fuels and chemicals when the time comes.

Based on that projection, it is useless to deny that the coal industry faces a grave problem, considering that at the moment average margin to the coal producer is shrinking, and it is from that margin that risk capital must be made available. However, the problem *must* be solved, and it *will* be solved. Remember that one of the most unprofitable periods in coal's history—from 1929 to 1939—was accompanied by a relatively rapid rise in the installation of mechanized equipment and thus great improvement in the mechanization program.

Possibly it may be clear now that I do have a basis for my conviction that continuous mining in the industry is to see a rapid development in the future. In my opinion, our present machines are but a stepping stone to further advancement; future machines and systems—some of which are already on the drawing board—will be built around production efficiency that will shoot for as much as *75 to 100 tons per man per day for every employee on the mine payroll.* That sounds fantastic, I know, but the need is there, and past experience in coal production indicates that the industry has never failed to meet the demands placed upon it.

SUMMARY

In review, the trend of mechanization in coal mines has passed through three, and is entering a fourth stage. First, mechanical power was substituted for physical and animal power with the early application of cutting, drilling and haulage machines. Then, with the application of mechanical loading equipment, a new system of mechanical mining that involved the use of a continuous cycle was developed. It is obvious that the cutting, drilling, blasting and haulage phases had to be developed first to make the loading phase effective. Third, at a time when the mechanization program with the use of conventional type equipment had reached only about two-thirds of its goal of complete application, the continuous mining system was applied to revolutionize the original mechanization plan. Fourth—the stage which is just beginning—mechanization at an accelerated rate with the use of drastically improved equipment has moved from the *realm of expediency* to the *realm of necessity for industry survival.* It is the most important period we have ever faced in the history of our industry, and I sincerely hope that I may be around to see its successful culmination.

* * *

Chairman Given: Gentlemen, is there any discussion on this paper? I might say this is one of the most able treatments of the subject that I have ever had the pleasure of listening to. Is there any question or discussion?

If not, we now shift the scene. We shift the scene a little into the past. I had the pleasure of being on some of the boat trips that the Illinois Mining Institute has taken in the past. We will now review one of those boat trips by the magic of the motion picture film. I think perhaps I can introduce this best by reading the notes that our capable and able Secretary has incorporated in the program.

"Several years before he passed away in 1939, John Garcia, Sr., presented us with some edited movie film of one of our early boat trips. We have identified it as the 1928 trip down the Mississippi, with a stop at Cape Girardeau, Missouri.

"Many of our staunch members have passed on since that time, but we think many of those at our 60th meeting will get a kick out of viewing the old times — and some of our old-timers. Your Secretary has attended meetings of many Institutes throughout the country during the years. Wherever he goes, he meets many who either remember the boat trips or have heard about them.

"The boat is no more. The trips are no more. But those who attended them will never forget them. To those who never had that privilege — sit back and relax with us — back in 1928."

By the way, I might say that our Secretary has a letter to read in connection with the old boat trips and he also will contribute a slight running commentary.

Secretary Schonthal: I would like to read a letter I have here from Captain Buck Leyhe, whom you all remember. I wrote him and asked him if he could come to this meeting. He has kept up his membership in the Institute during all these years, but he just couldn't make it. I received a letter written in his own handwriting and am going to read it.

EAGLE BOAT STORE COMPANY
St. Louis, Missouri

October 13, 1952

"Mr. B. E. Schonthal, Secy.
Illinois Mining Institute
Chicago, Illinois

"Dear Mr. Schonthal:

"Please pardon such a late reply to yours of the 24th ult. I am not too well and can hardly walk. I am afraid I cannot make it to the convention. You know I would like to be there and see the boys. For twenty-seven or twenty-eight years that is one trip I always looked forward to making. Everything was always O.K., just so the boys had plenty of baked beans. Those cooks that put them out are all gone and no more like them to be had. I often think how Captain Henry and you got along making arrangements for the trip and just think, Henry passed away four years August 29.

"I am afraid to leave home. There are so many things I have to do to take care of myself that I could not do away from home, and I am afraid of a stroke at my age. I will be 80 years old next February.

"I had a prostate operation last March. It seems to be O.K.

"I met Mr. Jones of the Roebling Wire Rope at the Club several days ago. He has retired and living in Florida, and met Mr. Jenkins a couple of times the last two weeks. He was telling me Sam Jenkins is living in Florida. He was one of three that made arrangements for the first boat trip.

"I am sorry I cannot be with you and remember me to all the boys.

"With best regards,

"Yours sincerely,

W. H. (Buck) Leyhe"

I wrote Captain Buck and told him we were sorry that he couldn't be here.

It was my pleasure to make my first boat trip in 1924 and I never missed one until the old boat finally went down. The Cape Girardeau was the boat that was on when I started taking the trips, but it was sold to the Green Packet Company. * * *

This picture was taken by John Garcia and I think it was in 1928. Jim Anderson, "Madison Jim," as we called him, was President. John Garcia gave him the reel and Jim gave it to me. After we sent the programs out, Stuart Jenkins uncovered a reel taken the same year, 1928 or 1929 and sent it to me. This first reel won't take over 15 minutes, I think, and if you want to see the second one that Stuart sent, we'll show you the second one. I'll try to identify these people as far as I can. This first reel is the one that John Garcia edited.

. . . Both reels were shown at this point and the session adjourned spontaneously without remarks by the Chairman. . . .

Showing of "Mississippi River Boat Trip" as Special Sixtieth Anniversary Feature concluded the morning session.

FRIDAY AFTERNOON SESSION

October 24, 1952

The session of Friday afternoon was called to order by President Clayton G. Ball at 2:00 o'clock.

President Ball: Gentlemen, may I remind you once more of the urgent desirability of picking up banquet tickets if you don't already have them. The hotel needs to know the number of our guests and members who will attend the banquet and the deadline is getting closer all the time.

We have a fine group of papers this afternoon and we want to proceed with dispatch now in order that you may have a few moments to take a nap after the meeting. Please return to the room here at 6:30 for the Banquet.

I would like to present at this time, and it gives me great pleasure to do so, Mr. Earle Snarr, who, as most of you know, is general superintendent of the Chicago, Wilmington & Franklin Coal Company, living at Benton, Illinois. He will be the Chairman for this afternoon. Mr. Snarr.

Chairman Snarr: Thank you, President Ball, Members of the Institute, Students and Guests: Your Program Committee has arranged for three papers to be given this afternoon. I think probably each one of them will attract much interest and there should be a discussion following each one of them, so rather than for me to use up time, I think we should get into the program and allow some time for discussion.

Our first paper this afternoon is entitled, "Preparation of No. 6 Coal at C. W. & F. Orient Mine No. 3, Waltonville, Illinois." This paper will be given by John A. Garcia, Jr., of Allen & Garcia Company, Chicago, Illinois. Mr. Garcia.

PREPARATION OF NO. 6 COAL AT C. W. & F. ORIENT MINE NO. 3, WALTONVILLE, ILLINOIS

By JOHN A. GARCIA
Allen & Garcia Co.
Chicago, Illinois

Before going into the details of the new C. W. & F. Preparation Plant at Orient Mine No. 3, Waltonville, Illinois, I would like to mention a few of the preliminary factors which influenced its design. In looking at a completed plant many are puzzled by what seem unnecessary, or at least unusual, designs, made by the engineers and/or management. But good design starts back of putting lines on paper and first considers fundamentals such as characteristics of seam, mining methods underground, location, markets, and even of management's experience and desires.

First of all, the C. W. & F. management early and consistently has recognized the depletion phase of the coal business and has taken steps down through the years to insure a continuous supply of coal in the ground to enable them always to be able to amortize expenditures made on the surface. This may seem an obvious necessity for a coal company, as, of course, it is, but it also means, in some instances, radical differences in preparation plant design because of differences in coal characteristics. Here at Waltonville there fortunately were not too many variations from this source as the No. 6 seam at Waltonville is practically the same as at Orient Mines Nos. 1 and 2. But still certain units had to be handled differently for a different coal.

Another preliminary factor which influences design is the need in the modern preparation plant to provide for all contingencies in the erratic changes of the coal market, both as of today and what may transpire in the future. This factor did have an effect on the design of Orient No. 3. It was desired, and the plant is now able to make, any and all combinations of sizes, or to change sizing while running. This gives the great advantage of keeping the sales department and the operating department constantly tied in together. The design actually leaves space for additional units which in the future can be used to augment production of special purpose coal. This makes for true flexibility of preparation plant performance.

Another factor which influenced design was the desire on the part of management to incorporate those units with which all levels of management formerly had been familiar. This, of course, has an effect on maintenance costs, not only in the carrying of spare parts, but in the ease and rapidity with which repairs and changes can be made. And there is another intangible effect of this procedure in the psychology of all levels of management in that they know what the units are capable of doing. This makes for good management morale and the increase of over-all efficiency. Actually, C. W. & F. management made the choice of most of the units in this plant upon which the design was based.

The final result was the design and construction of one of the largest commercial coal cleaning plants built in recent years. We hesitate to say it is the largest because there are so many measuring sticks on size, but it certainly is one of the largest. More important than size, however, is its flexibility and efficiency. It combines both wet and dry cleaning, plus the removal of fine mesh coal by prior treatment, which, by the way, greatly reduces the sludge problem; units are controlled centrally from panel boards; the dust problem was greatly alleviated in the cleaning plant by doing the fine screening in the Portal House; and finally, we know of no plant that can make such a large number of "prescription counter" sizes while the plant is running continuously. Heretofore, many plants manufacturing multitudinous different sizes first made five or six basic sizes of washed coal, elevated them to separate storage bins and then loaded out the "prescription counter" coal on the following shift. In this plant the cleaned products are separated on classifying screens and flow to separate conveyors which take them to shallow surge bins for the prescription blend or direct to either railroad cars, retail bins or to the clean coal crushers. Any sized coal in excess may go to retail bins, to storage, to crushing, or to railroad cars, and from those cars back into the system when desired through the track hopper. To put it as briefly as possible, if the Sales Department can sell the daily output tonnage-wise, the Preparation Plant can manufacture the sizes and qualities necessary as shown on the orders. The question put to the buyer is never, "Can you take 10 no-bills of egg size coal?" but rather "What size, quality and quantity do you want today?" I think to those whose interest is in the sales end of the coal business this situation would be most welcome.

The plant is approximately 20 miles north of Orient No. 2, near Waltonville, Jefferson County, Illinois. Three railroads service it—the C. B. & Q., the Missouri Pacific and the Illinois Central. It is in a splendid position to reach its important markets.

In physical appearance it is large, compact and functional. The main slope conveyor gallery runs into the Portal House and from here another belt conveyor gallery runs up and into the main Preparation Plant. Between the Portal House and the Main Plant stand the seven reinforced concrete storage bins topped by the tripper conveyor gallery. The visual impression is one of tremendous size and compactness. The wash house and offices are located approximately one quarter mile to the west near the air shaft which is also the man and material hoist shaft. This keeps the offices and the wash-change house free of dust and dirt. By the way, an elevator is used to get the men in and out of the mine. The usual parking lot is provided for employees cars.

There is nothing unusual in the choice of units but we feel that the A & G design is worthy of some detailed comment.

Now, as to the actual flow of the coal through the plant. The main slope belt out of the mine is quite famous and no doubt you have seen pictures and descriptive material on it. It was designed and erected by the C. W. & F. management and associates in collaboration with the Goodyear Tire and Rubber Co. It's a modern miracle of design and efficient performance. Twelve hundred tons an hour of crushed 6 x 0 coal will eventually come up this 42" belt which runs at 625 F.P.M. The raw 6 x 0 may be loaded out as raw 6 x 0 or be diverted to the night storage bins as 6 x 0 straight, or may be separated into 6 x 2 and 2 x 0, the 6 x 2 crushed to 2 x 0, the products reassembled and stored as 2 x 0, or the 6 x 2 stored and the 2 x 0 loaded out raw or crushed. Provision also is made in the Portal House where this raw screening is done (on 10 ft. wide shaker screens) to run the 2 x 0 over vibrating screens and load out 2 x $\frac{7}{16}$ raw. The resulting $\frac{7}{16}$ x 0 would go to cleaning or to storage. There are dust collecting hoods over all dust points in the Portal House and the dust is pumped or blown to the dust bin through ducts.

The storage bins are really huge surge bins holding 3100 tons or about 2½ hours of running time, and in conjunction with the conveyors and cleaning units they are responsible to a great extent for the plant's flexibility and smoothness of operation. In case of breakdown of either the wet or dry cleaning processes they give invaluable aid in keeping the Preparation Plant running, if they are full, or the mine *and* part of the Preparation Plant running if they are empty.

The wet plant, consisting at present of one Jeffrey 84" 2 compartment 5 cell Baum jig, is set up to take the raw 6 x $\frac{7}{16}$ from the Portal House. Space has been left to provide a second jig when the mine reaches its full capacity. This jig also takes the dry middlings from the Roberts and Shaeffer Super Airflow tables after they have had the 14M x 0 screened out and it also takes the recirculation of the crushed middlings from the jig. This gives the Jeffrey jig a heavier media such as is desired by the Jeffrey people. There really is nothing very unusual about the wet system that you don't see elsewhere except the use of the combination Head Tank and Classifier, which is another C. W. & F. innovation and helps immensely in keeping slurry out of the circulating water system. This large classifier tank acts in many ways like the Dutch cyclone classifiers, but in addition, of course, gives us a "Head" for the recirculating water.

The clean 6 x 0 jig coal goes over a 1 millimeter opening sieve to classifying screens where five sizes are made—$\frac{7}{16}$ x 0, 1 x $\frac{7}{16}$, 1½ x 1, 2 x 1½ and 6 x 2.

The $\frac{7}{16}$ x 0 *wet* washed coal is a combination of the dry table middlings and the wet middlings. This $\frac{7}{16}$ x 0 wet washed coal is then run over a sieve and a dewatering screen which dewaters and at the same time eliminates the 10M x 0. The final $\frac{7}{16}$ x 10M from the wet system joins the dry $\frac{7}{16}$ x 10M for loading out in cars, for blending purposes or to the retail bin. The resulting 10M x 0 being from a middlings product is of comparatively high ash and is returned to sump, dewatered and sent to refuse.

One other size, the 6 x 2, may be modified to 6 x 3 and 3 x 2 if such a sales demand is present. Let me mention here that all these sizes as they are ready for final destination are oil treated.

Space has been left for the installation of a heat dryer for the $\frac{7}{16}$ x 10M if it is ever decided in the future that it is necessary. We also can include a heat dryer back of the clean coal crusher if this should be needed. At present one clean coal crusher has been installed to handle 250 TPH and provision has been made for Crusher No. 2 to increase the crushing up to 500 TPH. The crusher of course handles only the 6 x 1 sizes.

This brings us to the Dry Cleaning and Dedusting System which in our opinion is rather well arranged and efficient. It will handle up to 600 tons per hour of $\frac{7}{16}$ x 0 coal. This feed is first broken down into $\frac{7}{16}$ x 10M and 10M x 48M. A battery of Allis-Chalmers sizing screens with 10M openings delivers the $\frac{7}{16}$ x 10M to a surge bin from which the coal flows to Roberts and Schaefer Superflow Tables. The clean $\frac{7}{16}$ x 10M coal is aspirated after cleaning and then goes to final destination. The dry middlings and refuse from the $\frac{7}{16}$ x 10M Superflow Tables are fed to the jig. The 10M x 0 thru product of the Allis-Chalmers screens passes thru the aspirators which remove the 48 mesh x 0 dust and the 10 x 48M goes to its surge bin and thence to its Super Airflow Tables. The clean 10M x 48M goes direct to railroad cars or for blending and the middlings go over the same dry middlings screen and into the jig. The aspirated 48M x 0 on the raw feed and on the clean $\frac{7}{16}$ x 10M is conveyed to the Dust Collecting System where it is stored in a hopper and loaded out through the dust bin to the railroad track.

I don't believe I mentioned the fact that from the clean coal crusher (which crushes any or all of the 6 x 1 sizes to 1 x 0) we can also make over double deck and single deck vibrating screens, a 1 x $\frac{7}{16}$, a $\frac{7}{16}$ x 10M and a 10M x 0.

Let me close by saying that the Allen & Garcia Company thoroughly enjoyed doing this job. Our relationship with the C. W. & F. management was, as always, extremely pleasant and stimulating. The different manufacturers on the large important units such as Dust Collectors from Buell Engineering, crushers from American Ring, Belt Idlers from Link Belt, fans from Clarage, Vibrating screens from Tyler and Allis Chalmers, the jig and feeders from Jeffrey, the air tables from Roberts and Schaefer, the steel fabrication from Pan American Bridge—and all others I may have over looked were extremely cooperative and pleasant. We know the plant will justify all the hard work put into building it.

* * *

Chairman Snarr: Thanks, Mr. Garcia.

I wonder if we have some questions at this time? Does someone want to ask some questions of Mr. Garcia before he gets away? (No questions asked.) I might add that I hadn't read Mr. Garcia's paper before he presented it; therefore, I didn't want to say anything about this plant while introducing Mr. Garcia. I have seen it once or twice and there are some things about it that are probably a bit unusual. I think you should know that in the design of this plant, it was necessary to deal with one of the things that George Lindsay spoke of this morning; that some people in the country were going into the mining of coal by continuous miners. All the coal coming from this mine happens to be mined by continuous miners and therefore, of course, you have different size proportions of coal than you would have from a conventional mechanized mine. As a consequence, you need to consider your equipment for cleaning this coal will not be the same as it is in the normal mine having the larger sizes. You do have more of the minus 10 mesh sizes to contend with and proportionally less of the larger sizes. In this particular mine, all coal plus six inch is crushed to minus six inch in the mine before it comes out. Therefore, the dry cleaning portion of the plant handles approximately 50 per cent of the total output and the wet side 50 per cent, so you do have a different problem in screening and dewatering and those things.

Does that bring up any questions on the paper? If not, we will proceed to our second paper of the afternoon, which is one that should be of interest to us here in Illinois, where we, too, are anxious to provide safer transportation for our miners. These people over in Ohio have made considerable advances in the development of special Mantrip cars and we are glad to have them bring their experience to us. This paper, entitled "The Use of Mantrip Cars Underground in the Mines of Hanna Coal Company," will be given by Mr. Evan G. Adams, who is General Superintendent of the Piney Fork No. 1 Mine of the Hanna Coal Company at Piney Fork, Ohio. Mr. Adams.

Mr. Adams: Mr. Chairman and members and guests of the Illinois Mining Institute:

Just a moment ago Mr. Garcia asked me to take some of the strain off of him. I told him I would, I would relieve him of probably 30 per cent of it. But I feel this way, that in the Mining Institute we are all coal miners; we all speak the same language, so there is no use to tell you I am a little nervous, but, nevertheless, we are one big happy family.

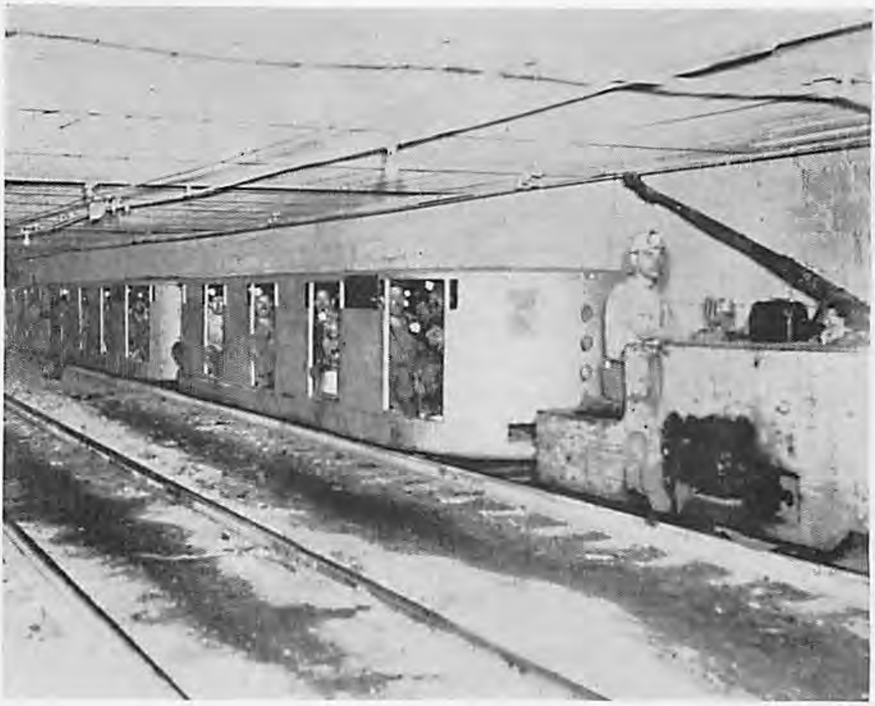
THE USE OF MANTRIP CARS UNDERGROUND IN THE MINES OF HANNA COAL CO.

By EVAN ADAMS
General Superintendent, Piney Fork No. 1 Mine
The Hanna Coal Company
Division of Pittsburgh Consolidation Coal Company
Piney Fork, Ohio

As is quite evident from my appearance, I am younger than some of the men assembled here today, but even I can remember but a comparatively few years ago when ten or twelve men were crowded into a two ton mine car, drawn by a mule, which was the primitive "mantrip" of that day only a few years ago. My memory also includes sitting on the pass-way waiting for the last coal trip of the day to reach the bottom so our mantrip could start its way outside and home. Strange to say, many of us enjoyed our mantrip ride particularly if we were one of the favored few who got to ride the first car.

Fortunately this phase of coal mining, like many others, has felt the effect of progress, safety and efficiency and today we find a surprisingly large number of mines who transport their men into and out of the mine in well constructed, covered mantrip cars. Certainly no one regrets these changes for the better as they contribute to the well being and safety of our workmen and to the smooth and efficient functioning of the present-day mechanized coal mine.

All three of the underground mines operated by the Hanna Coal Company, Division of Pittsburgh Consolidation Coal Company in Eastern Ohio are equipped with mantrip cars. The mantrip cars to which I shall refer in this paper are installed at the Piney Fork No. 1 Mine of our company. The first installation of mantrip cars at this mine were home made ones. We converted some old steel mine cars which were being replaced at one of our mines by larger cars into mantrip cars. The sides of this mine car were built up, the cars were roofed with steel plates and entrance to the cars was provided on one side by means of a sliding door. This door was installed on the side opposite the trolley wire and since it was necessary to haul our mantrips for quite a distance along an outside tramroad, the solid sliding door helped keep the cars from becoming too cold. In the summertime these doors were replaced with perforated steel plate. The main function of these doors, of course, was to insure that the men would not be able to extend any part of their body outside the limits of the car. Our present mantrip cars were manufactured by the Watt Car and Wheel Company of Barnesville, Ohio, and the Differential Steel Car Co. of Findlay, Ohio.

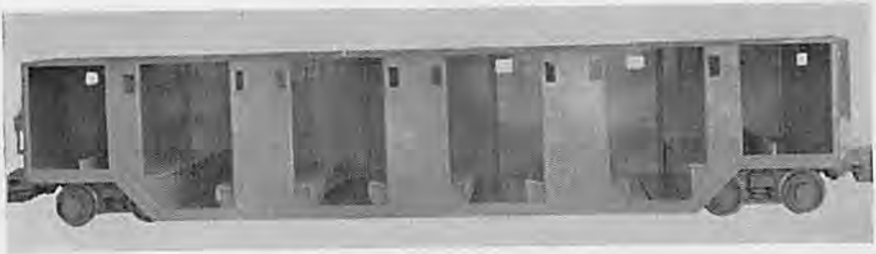


Differential Steel Car Co. Car

In the construction of these mantrip cars, an all welded steel car is designed and built by Watt Car Company, Barnesville, Ohio, with a top and enclosed on all but one side. The top of steel is covered with an insulating material to keep electric wires from burning a hole through and causing burns or excitement in case it came in contact with electric cables. The seats are so arranged that thirty-two men can ride very comfortably. Our cars over all dimension is 7 feet wide, 22 feet long and 52 inches high from top of rail, eight rows of seats, four men per seat. In each end of these cars is a compartment separated from the men for any hand tools or small supplies that might be wanted to go in as the mantrip goes in or out.

The men from each crew ride in their own mantrip car which is labeled with their crew number. Their immediate supervisor rides in this car with them. We provide an empty car or "caboose" between the locomotive and the first mantrip car. No one rides in this first car. Another so-called "caboose" is hauled on the rear of the trip where the trip rider and foreman ride. Each foreman, of course, is responsible for seeing that his men are loaded and properly seated in the car before the trip proceeds underground.

Our mine produces coal on one shift per day but we also have a second shift which performs various types of mine machinery maintenance



Watt Car & Wheel Company Car

work. The day shift trip is scheduled to leave the portal building at 7:10 a.m. Our men are advised by an electric buzzer when it is time to load into the trip. Our present travel time amounts to approximately thirty minutes each way. The men are transported by means of this trip to the man station nearest their working section. These man stations are located as close as practicable to the working areas so that the workmen have comparatively short distances to walk to the working faces. After stopping at the first working section the mantrip then proceeds on further inside until it has delivered each crew to its destination. The mantrip cars are then parked on a side track near the section furthest inby ready for its return trip at the conclusion of the shift. The locomotive is then assigned to coal hauling service.

At certain designated times near the end of the shift, the men on each crew walk to their mantrip waiting station in time to catch the outbound mantrip.

The dispatcher at this mine has his headquarters on the outside of the mine and during the progress of the mantrip both into the mine at the beginning of the shift and out of the mine at the end of the shift, the motorman is in constant touch with this dispatcher by means of the trolley phone installed on his locomotive. As a matter of fact, no trips at this mine move onto the main line without clearance from the dispatcher.

Any system for transporting persons, while it attempts to run on schedule all the time, cannot always do so. I imagine many of you in this room today have encountered delays in airplanes or in trains in coming to this meeting. When I am on the job at the mine and we have delays in our mantrip schedules, I am sometimes encouraged a little bit when I think that those companies whose main business is transporting men, also have such delays. However, all in all, we have surprisingly few delays either transporting our men into or out of the mine. At our particular operation we have double track haulage for approximately ⅔'s of the distance which we haul our mantrips. This, of course, is a help in maintaining mantrips as well as coal haulage schedules. The two other mines of our company, while they do not have the advantage of double track main line haulage, do have smooth functioning block signal systems which aid them in maintaining safe haulage schedules for both men and coal.

Visitors at our mine have asked me this question, "Your haulage road here at the mine is in A-No. 1 condition; you have the roof timbered and lagged with the timber supports hitched into the rib. It seems to me you have very little danger of a mantrip accident with the timbering job you are doing and with the fact that since all timber supports are hitched into the rib, there is no danger of knocking out timbers in derailment, why then do you need to invest in mantrip cars?" Our answer to this is three-fold.

First, we do agree that our roof support is what we feel more than adequate and there is little danger of a fall on a mantrip. However, if we were to provide transportation for our men in open coal cars, we would lose at least one trip of coal per day by holding out enough cars for the mantrip. This would mean then that in order to maintain our production we would have to provide additional coal cars which are almost as expensive as mantrip cars. Furthermore, we are prohibited by legal requirements from riding men on the wire side in open cars. This would mean that even in our large ten ton steel mine cars we could haul only a maximum of ten men whereas with our mantrip cars we are able to accommodate as many as thirty men. It becomes obvious therefore, that if we provided enough open cars to transport our men that it would require three times as many cars.

Second and closely related to the paragraph immediately above is the complications and loss of production which arises in case there is any delay during the operating shift either on the section or at the preparation plant. If coal cars must be counted on for duty as mantrip cars, certainly any such delays will be much more costly and will hinder production much more than if they were used exclusively for coal haulage. Where mantrip cars are used, they are used exclusively for mantrip purposes and thus are always available for that duty.

The third factor which we believe is important in providing adequate covered mantrip cars is the good feeling and the high morale which this consideration on the part of the company has upon the workmen. We believe that any reasonable actions the management takes for the comfort, health and safety of its people is well repaid in good will and productivity.

* * *

I might add there has been quite a bit of discussion of why or could we afford Mantrip cars? But, taking it all into consideration and studying it from every angle, we have come to the conclusion that it wasn't a question of whether we could afford them; it was a question of whether we could afford to do without them.

Chairman Snarr: Thank you, Mr. Adams, for your fine paper.

This is something that we haven't heard too much about in our Institute and we appreciate Mr. Adams coming the distance he has from

Ohio to give it to us. There should be some questions on this and we would like to hear from you now. Mr. Adams has brought some photographs of these Mantrip cars which he will leave here and if there are those of you who would like to look at them after the meeting, we will be glad to have you see them.

Would anybody like to ask Mr. Adams some questions on this car? If not, we will go ahead.

We have another paper and with it, some slides, I understand. The title of the paper is "Auger Mining in Illinois Coal." This paper will be given by Robert W. Guthrie, Assistant District Manager of the Cardox Corporation, Benton, Illinois. Mr. Guthrie.

AUGER MINING IN ILLINOIS COAL

By ROBERT W. GUTHRIE
Assistant District Manager, Cardox Corporation,
Benton, Ill.

I would like to discuss with you, a relatively new and highly profitable method of mining coal. By "new method" I mean, and I would like to emphasize, that this is a method within itself, not an improvement or an adoption of methods which we are now familiar, namely deep mining and strip mining. This method is called Auger Mining.

The Cardox-Hardsocg Auger Miner will never replace, and certainly makes no claims of replacing conventional methods of mining coal. On the contrary, we depend on conventional stripping to do the Auger Miner's development work. This development work is done automatically for the Auger Miner by common stripping methods, aided by the old law of Marginal Productivity, and the rule of thumb which states, in fact, that usually you can only afford to remove a foot of overburden for every inch of coal.

When the overburden gets too high, the stripping must stop. The coal seam is exposed, and roadways have been developed to the overburdened area. A lot of money has been spent here, the coal cannot be stripped, but with no further development costs, an Auger Miner, manned by an operator and his helper—two men—can mine this otherwise unprofitable coal at the rate of 150 ton per 7 hour shift, 21½ ton per hour, 71½ ton per man shift, or more.

By definition, an auger miner is an adequate power unit attached to a screw conveyor, which is used both as a conveyor and a shaft to drive and revolve a cutting head as deeply and as quickly as possible into a seam of coal. Cardox has developed a line of Auger Miners which have proved to be adequate in drilling up to 42″ diameter holes consistantly over 100′ in depth.

Because of the heights of some seams and the partings in others, these augers are made so that, by the means of hydraulic floor jacks, they can be used to drill immediately above the floor or as high as 60″ above it. In the case of a wide seam, this allows holes to be drilled first in the top and then in the remaining lower part of the seam. Where a parting is to be avoided, the coal can be drilled first above and then below this parting. There are in operation some coal augers capable of drilling 60″ diameter holes up to 280′ in depth. Because of the limited number of hiwalls with benches wide enough to accommodate machines of this size, Cardox has gone into production on the 42″ diameter and small Auger Miners.

The power unit for the 42" auger is a 145 HP industrial type motor. This power is transmitted through a hydraulic pump, which creates the lift in the four floor jacks, the thrust to the cutterhead, and the hydraulic hoist for lifting the cutting head and auger sections into place. When the Miner is in position to drill, this 145 HP is transmitted through a clutch, hydraulic coupling, gear reduction and Kelly bar, to the augers which rotate at about 50 revolutions per minute.

The operator controls the jacks, hoist, thrust, and retraction from one control bank of levers. The revolutions of the cutting head are constant; but they are started and stopped through manipulation of the clutch, which is operated at the side or the front of the machine. There are extensions on the thrust, retraction, and hoist controls, located in front of the machine so that the operator can assist his helper in connecting the auger sections.

The machine is constructed in two parts, the live and the dead frame. The dead frame consists of four corner posts, which are cylindrical. These posts contain the four floor jacks. They are cross and angle braced, so as to be absolutely rigid. Besides the floor jacks, one of the front posts supports the hoist and hoist boom, on its top. The live frame, which contains the drilling machinery, is located within the dead frame and is mounted on rollers, which allow the live frame to run forward and backward about 6½ feet. The power to move the live frame is hydraulic and is transmitted through two pistons and airplane cables.

The augers are 6' in length and are made in various diameters. The auger diameter, in nearly all cases, is one inch less than the cutterhead diameter. These augers are coupled with 3½" square shanks and matching sockets. Rounded ends on the shanks guide easily into the sockets in the coupling process. There is a loose fitting hole in both coupling ends, so that a spring pin may be used to secure the connection when the auger string is retrieved. This pin has no force applied to it during the drilling process.

To drill, the machine is brought into position, usually perpendicular to the coal face and at a distance from it of approximately 6½'. The cutting head is then attached to the Kelly bar. At this point comes the most exacting and time consuming part of the operation—the aligning of the machine. The plane in which the coal seam runs, may or may not, be previously known; however, from experience we have found that the coal seam can be followed, with little difficulty, up, level, or down, as long as it stays in a single plane.

The outstanding and most perplexing problem connected with auger mining has been the developing of a simple but very accurate method of lining up the drill so that a hole almost as large in diameter as the height of the coal seam, can be drilled into this seam for 100' or more without running into top or bottom, or the previously drilled hole. In the beginning of our experimentation, a string of 40' or 50' of augers was a very unruly thing indeed, when drilled into a seam of coal. The cutterhead, of course, must take the blame for such unruliness, and many designs of cutting heads were experimented with before encouraging results were obtained.

All heads tried showed a tendency to drift to the right, due to the clockwise rotation of the augers, but this was unimportant since the holes paralleled each other. Finally a good fast head was developed, which was capable of making good lump, or finer coal, depending upon the internal design. This head, while showing an alarming tendency to drop in an accelerating curve, ending in the bottom at 40 to 50 feet, was at least consistent in its action. Once the head was well started in the coal, no means was found of influencing its direction, either by fast or slow drilling, or by changing the elevation or angle of the machine. Levels were run on the top of each hole—to discount the effect of auger abrasion on the bottom—and the results plotted on a graph. This consistency, while in itself discouraging, gave rise to the feeling that once the answer was found as to how to keep the cutterhead boring in a straight line, we would be rewarded by consistency in this action as well.

The cutting head was redesigned by placing a series of lugs in a circle around the rear rim of the cylinder. These acted as a fulcrum for the weight of the auger string, leveling up the head. Previously, the weight rested on the bottom bit, forcing the head down. Initial results were too good, and the head regularly climbed into the top. By gradually reducing the size of the lugs, the right size was found, enabling the head to stay in any plane in which it was started. A further improvement was made by replacing the solid lugs, which seriously reduced drilling speed, with small rollers, which encircle the cutterhead. This cutterhead has proved highly successful in all veins of coal where it has been tried.

Now that the head was developed to the extent that it would go consistently in the direction it is aimed, it became necessary to devise a quick and simple method of correctly aiming the cutterhead in the first place. This has been accomplished with a system of levels and protractor, mounted by the operating controls on the drill. This device enables the operator to set the drilling angle, which is also the angle of the coal seam, in a matter of seconds.

When a new seam of coal is entered for the first time, and the angle of the seam is not previously known, the hole may be set and drilled in a level, which I will call 0 degree. If the cutterhead runs into top or bottom, the angle of drilling the next hole can be set accordingly until the correct angle is established. Then as the drill moves from hole to hole along the highwall, if the cutterhead again goes into top or bottom, the operator can again make a slight change in the drilling angle. For example, our first drilling in the Illinois No. 5 seam went as follows:

Hole No.	Drill Setting	Path of the Drill
1	0 degree-level	Hit bottom at 70′
2	¼ degree up	Hit bottom at 80′
3	2 degree up	Hit top at 40′
4	1½ degree up	In coal 154′
5	1½ degree up	In coal 154′

Although we do not necessarily recommend drilling holes as deep as 150′ for maximum efficiency in production, the accuracy of the entire system is proved by the fact that in the Illinois No. 5 seam we are getting a good percentage of 150′ holes, 39″ in diameter, in a seam which is 50″ to 54″ in height. This leaves approximately 6″ of coal top and bottom, for variance, in 150′ depth. The average rib which we are leaving between holes is about 8″ to 10″ wide.

Once the plane of the seam is determined, the Cardox drill may be set at the required angle by means of its four hydraulic floor jacks, which may be worked as a unit or individually. When the machine is set, the jacks are locked into place. The actual drilling starts now. The cutting head is securely drilled into the coal, then the Kelly bar is detached and retracted. The hydraulic hoist is quickly hooked into a six foot auger section, which is lifted, swung into place, and attached to the Kelly bar on one end and the cutterhead on the other. This operation takes about one minute. The power is again transmitted to the augers by use of the clutch, and the six foot section of auger is drilled into the coal. When the one hole is completed, the cutterhead and the entire string of augers is detached from the Kelly bar, and left in the hole. The machine is then lowered onto two parallel beams, which have on one side, angles attached as rails. The machine has, on the underside of the frame, flanged wheels that run on these rails, so that the machine may be easily moved over to the next hole. The parallel beams are tilted, making an inclined plane, and the drill rolls into the next position by the force of gravity.

After the machine is moved over to the new site, it is again lined up, and the extra cutterhead starts the new hole. This time, when the head is detached, a chain is fastened to the stored string of augers on one end, and to an extended puller bar on the live frame of the machine. When the Kelly bar is retrieved, this automatically pulls a six foot section of auger from the adjacent hole. The hydraulic hoist is hooked into the auger, which is then detached, swung over into place, and attached to the cutting head and the Kelly bar, as before. This operation continues until the second hole is completed, and the drill is again moved for a new hole. In order to facilitate moves of any distance, the Auger Miner has detachable pneumatic tired wheels.

The coal which is produced with the Auger Miner deserves some discussion. To date, no screen test has been run on Auger Miner coal in Illinois, therefore I can only pass on to you what men in the industry, who have seen a lot of coal, have estimated sizes to be. Actually these estimates should be fairly reliable, because they were made independently upon examining a stockpile of hundreds of tons of Illinois No. 5 coal which had been Auger Mined, and the estimates were relatively consistent. With this understanding then, of how these figures were arrived at, I can say that we are getting with a 37″ diameter cutterhead, 60 to 70 percent plus 3″ lump, and about 40 percent plus 6″ lump.

A lump of Auger Mined coal has a maximum size also, which we do not find in conventional mining methods. Using a 37″ cutterhead, the lump cannot be larger than 35x16x10″, and we have been getting some lump of this size. Like conventional methods of mining, we can take steps to reduce the size of lump coal, should the operator so desire. Unlike conventional methods of mining, the lump coal is not structurally weakened in the mining process, and receives its first jolt upon being dumped from the conveyor onto the waiting truck. It would follow then that this lump is more solid, and will stand up better in transportation, than would be possible had it been mined by any other method, with of course, the possible exception of Airdox.

The lump of coal which you see before you has been mined from the Illinois No. 5 seam of coal with a 37″ cutterhead. It shows very clearly the bit pattern of the cutterhead, and may be of interest to you. You can readily see that Auger Mined coal is trademarked in the mining process, and a load of Auger Mined coal can be quickly recognized as such.

There is no method of mining coal known to me, which can be entered into with as small an outlay of capital, and I refer to initial and operating capital, when such outlay is considered on a per tonnage basis, as the Auger Mining method. I know of no piece of equipment in the mining industry which can yield as great a percentage return on the original investment.

I have seen no mining operation which approaches the safety conditions enjoyed in Auger Mining. I know there is no other coal mining method which can be entered into with less experience and coal mining "know how".

Few operations with which I have been acquainted can boast of 50 or more ton per man shift. I know of no mining method besides Auger Mining where coal can be produced without some unproductive development work. As far as I know, there exists no other mining method which has been simplified to the extent that one operation produces coal.

The Cardox Corporation, along with the many other designers and manufacturers of mining machinery and equipment, are constantly working with you, the operator, to develop and perfect methods of mining coal—enough coal to satisfy America's market, and at a price which will be competitive in that market. This is our job, and to it we are all dedicated. The Auger Miner is the Cardox Corporation's latest contribution to this, our common goal.

* * *

Chairman Snarr: Thank you, Mr. Guthrie, for that excellent paper. There should be some questions, certainly, on this last paper. It is new. Maybe some of the strip mine boys want to know some more about this auger mining. If you do, fire away, and I am sure Mr. Guthrie will try to answer them for you.

Mr. Cooper: What is the minimum distance between the holes? That is, how much of a rib do you have to leave? I didn't hear you mention that.

Mr. Guthrie: Well, as I say, in this Illinois No. 5 coal, we have been getting away with 154-foot holes with an 8-inch rib between the holes.

It will vary from mine to mine, of course, like everything else does in the mining industry, but this coal is awfully hard and the chances are that as far as the holes squeezing or falling in or anything like that, we could get away with probably an inch or two. But the idea is to keep that hole out of the one you have just drilled and so far an 8-inch rib is about the best we have done. That has also been about the average.

Mr. Chedsey: How much room does it require back from the face to handle all your apparatus? What is the minimum width of face?

Mr. Guthrie: I would say a 16-foot bench will do. You see, you have to be sure you can bring the truck in on the same side of the river you are going to take it out on. Other than that, 16 feet is enough.

Mr. Johnson: On that seam with 42 and 46-inch diameter drills and figuring an 8 or a 12-inch rib, have you figured the percentage of recovery within the limits of the drill?

Mr. Guthrie: On a 37-inch cutter head and an 8-inch rib in this vein, we are now getting about a 55 per cent recovery.

Chairman Snarr: Are there some more questions back there? If not, I want to, on behalf of the Institute, thank these three gentlemen who brought the program to us this afternoon and also thank the audience for your courteous attention. I will turn the meeting back to President Ball at this time.

President Ball: I am glad you gave Mr. Snarr a hand. I want to thank him, as an explanation of the hand-clapping, for his very fine conduct of the meeting this afternoon.

I believe before we adjourn Mr. Schonthal has an announcement to make.

Secretary Schonthal: I would just like to request again those who expect to attend the banquet tonight to get their tickets, because when I came up here at 2:00 o'clock, we had, I think, about 625 registrations, plus 35 students, and I don't know how many are going to be at the dinner. I don't know how many dinner tickets were sold, but it looks to me as though we might have a good crowd and I would like to avoid any confusion. It will give the hotel a better chance to figure out how many they are going to take care of. So it will be very helpful if those who haven't got tickets, if they can use them, will secure them as soon as possible.

President Ball: The banquet is at 6:30 and the meeting stands adjourned until that time.

(Recessed at 3:15 P.M.)

FRIDAY EVENING SESSION

October 24, 1952

The banquet session, President Clayton G. Ball presiding.

President Ball: Gentlemen, members of the Illinois Mining Institute and guests:

I would like to repeat at this time a statement by the officers of the Illinois Mining Institute and the Executive Board that it is a pleasure to have such a fine turnout. We welcome you again, as already once done this morning. I especially want to compliment so many of you for having been here at 10:00 o'clock this morning. Our latest information is that as of 6:00 o'clock this evening, 110 new members had been enrolled in the Institute. The total registration, including 35 members of the University of Illinois student body, has come to 734, a little bit short of the last couple of years but still a very good record.

I have one or two small matters to take care of before introducing some of the distinguished gentlemen at the speakers' table. A small matter in the history of the Illinois Mining Institute, but a very important one to me, is the opportunity right now of expressing my great feeling of humility but pride in having been asked to serve as President of this Institute for the past year. It is a great honor and I have felt greatly indebted to all of you for the opportunity.

I want to tell you I worked pretty hard at this job. Every once in a while the telephone would ring and Secretary Schonthal would call me up and ask me if it was all right if he did something, and I would say yes, it was all right, and that concluded that business.

I would like now to introduce the gentlemen seated here at the speakers' table. On my left, on your right, we first have three representatives of the press, and a very good press it is. Mr. George Sall of the Mining Congress Journal. Will you please stand and take a bow.

Mr. George C. Lindsay, Editor of Mechanization Magazine, who presented a fine paper this morning. Mr. Lindsay.

Mr. Ivan A. Given, Editor-in-Chief of Coal Age, who presided at the session this morning and did a splendid job. Mr. Given.

We next have a representative of the National Coal Association, a staff member of that important body, who has been kind enough to come here several times lately and take in this meeting with us, Mr. Maurice D. Cooper.

One of the senior members of the mining fraternity is in this room, Mr. W. J. Jenkins. In addition to his distinguished record as an operator and participant in Illinois mining activities, Mr. Jenkins is the head of a family of three generations, all of them Life Members, by the way, of the Illinois Mining Institute.

The next is John R. Foster, a newly-elected member of the Executive Board. Mr. Foster, as you know, is with the C. W. & F. Coal Company.

Another newly-elected member of the Executive Board, Stuart Colnon of the Freeman Coal Mining Corporation. Mr. Colnon.

A Past President of the Institute and a newly-elected member of the Executive Board, George C. McFadden.

I see a couple of names here, including my own, that I don't think I will call right now.

Starting on my right and your left there is a vacant chair, which we ordinarily wouldn't ask you to notice, except it was to have been occupied by another newly-elected member of the Executive Board, Mr. H. C. Livingston of Truax-Traer Coal Company, who found at the last moment that he couldn't be here.

On his left, if he were there, is Mr. Lawrence Kiss, a past and present member of the Executive Board.

Next is someone you all know, of course, Mr. H. A. Treadwell, President of the Illinois Coal Operators' Association and a past President of the Illinois Mining Institute. Mr. Treadwell.

If I may digress just a moment, the name of this Institute perhaps has reached farther than you think. The next gentleman I wish to introduce is from Cheltenham, England, Mr. Hugh L. Holt.

Next is Mr. J. S. "Jack" Forman, a member of the Executive Board.

Ernest Green of the Old Ben Coal Corporation, also a member of the Executive Board.

R. H. "Dick" Swallow, a newly-elected member of the Executive Board, of the Fairview Collieries Corporation.

We had a lot of elections this morning and the next gentleman, who was elected unanimously as the incoming Vice President of the Illinois Mining Institute, is Professor Harold L. Walker, head of the Department of Mining and Metallurgical Engineering of the University of Illinois.

In expressing my own appreciation and deep gratitude for the opportunity of being President of the Institute during the past year, I would be woefully remiss if I did not give all the credit in the world, as so many before me have also done, to our Secretary-Treasurer, B. E. Schonthal.

I believe I will pass by the gentleman on my right for a short time. You have seen the program and the title of the major event of the evening, a very provocative title, I might add. I don't know what it means, either.

A short review of the background of the speaker is intriguing also. He is a Wisconsin dairy farmer, has been a dairy farmer all his life. He tells me that he has a farm east of Madison which he runs on a practical, realistic basis. He didn't tell me the acreage. I suppose it is just as large as some of our big strip mines, maybe larger.

His record includes the holding of a host of organizational positions. He has acted as an adviser, consultant or secretary to a number of organizations in Wisconsin having to do with such things as dairy farming, tobacco, labor relations and many others too numerous to mention. I think he feels that his chief contribution right now is acting in the service of some 90 associations which are federated in a Wisconsin State Council and which deal with such problems as cooperative education, public relations, state and federal legislative activities, and many others.

This brief review of his background makes me think that perhaps he is very much interested in what might be called the green stuff. Now, green stuff might be money. I have no particular association with it, but that association with money reminds me just a little bit of the farmer down in Oklahoma on whose farm a great gushing oil well was brought in. He immediately set out to build a home to replace his two-room shack and he designed it himself, a home of 70 rooms, and when the builder got to looking at the plans, he pointed out that there was no bath room in all these 70 rooms. Well, the farmer drew himself up proudly and said, "Of course, I realize now that I am one of those *filthy* rich."

Another connotation of green stuff that occurs to me is that leaves of the grasses, the crops and all those things contain this magic green ingredient, chlorophyll. This reminds me of a fellow I saw down in the drug store this morning who asked the druggist for some green aspirin tablets. The druggist was a little perplexed and tried to find out what it was and this friend of mine said, "Oh, you know, it is what you have for bad breath and stuff." He said, "I sure need some green aspirin tablets, I have such a stinking headache."

Well, I think we had better find out what the speaker means by his relationship to green stuff and I now introduce Mr. Milo K. Swanton, who will talk on the subject, "Blind Gamblers are Gone Gooses," or, "What Goes Up Must Come Down." Mr. Swanton.

BLIND GAMBLERS ARE GONE GOOSES OR WHAT GOES UP MUST COME DOWN

By MILO K. SWANTON
Executive Secretary
Wisconsin Council of Agriculture Co-operative
Madison, Wisconsin

President Ball, officers and directors of the Illinois Mining Institute and friends:

This is the first time I have stood before a group of coal mine operators. I am at home with agricultural groups and because of the many similarities and objectives that coal and milk producers share, we do have a great deal in common.

As I was saying to your Chairman while we were eating, to me, it is a great privilege to come down here to the capital of your great State of Illinois. Up in Wisconsin we look to Springfield with a high degree of reverence because it was the home of Abraham Lincoln. During the Civil War we sent the highest number of troops in proportion to our population of any state in the Union. The names of Springfield and Abe Lincoln are synonomous to us.

I realize, too, that you people here are closer to the present political kettle than we are up in Wisconsin. But I told your good Secretary I wasn't going to talk politics. I will only point out that even we in Wisconsin haven't escaped the usual political jargon coming from both parties on the national, state and county levels. As a farmer, there is one thing I can say to you, Mr. Chairman. After all is over, we farmers are convinced, because both parties have put "it" on so thick and so deep that we are going to have pretty good crops next year.

Furthermore, I would like to suggest, if there are any politicians in the room, that I think they ought to confine some of their cutting remarks to the budget and to taxes.

Now I don't feel too bashful about coming down here and speaking to a group in the State of Illinois because, after all, our football team did take yours this year, but they didn't do so well last year. I notice you had one fellow on the program here today who came from Ohio. I'm hoping there aren't too many from Ohio in this audience tonight. We didn't do so well in football over there recently.

The idea of farmers rubbing shoulders with you people in the mining industry is quite significant. Your good Secretary and I have something in common because he, too, is a Wisconsin Dairyman as well as being

Secretary of your organization, and a mining equipment salesman. I can see that he is a jack of all trades. No doubt many of you have diversified interests also. Although like millions of others, I do not have a direct interest in the mining of coal, yet I, like all citizens, have an important indirect interest. Really we do have much in common.

I come to you today as a producer. You people are producers — producers of goods for human consumption. I am interested in the production of food and fibre. You are interested in the production of coal. Together we are all interested in the consuming public.

More than that, we are all interested in Mother Earth. We all are interested in natural resources. I am interested in those natural resources found in the surface part of the soil. I am interested in potassium and nitrogen, calcium and various minerals. These elements we convert into products of the farm for human consumption.

You people are interested in the element, carbon, in the form of coal, and from the standpoint of sales for human consumption in one way or another. We as farmers and you as coal operators are interested in cost of production. You are interested in methods of recovery. We are interested in methods of production. You are concerned with labor problems, transportation costs, market trends and competition by alternate products. So are we.

In other words, while I don't belong to your particular club, yet, whether I am a farmer in Wisconsin and you are a coal mine operator in Illinois, we are all in a larger sense in business together. If I leave nothing else with you tonight, I hope it will be the thought that in America we all must build the thought of working together, each within the strata of our own industry and then across the board among all our industries.

Yes, you and I are interested in natural resources. I want to point out to you people, and I realize that you are well aware of the fact, that the strength of any nation lies in its natural resources multiplied by its people. To be a strong nation it must have the resources. Also it must have ambitious people. When a nation has these two basic requisites it is able to build a national strength outstanding in the world.

I come to you this evening as one outside your coal industry, looking upon it from the distance of another state where Mother Nature wasn't so kind to us in that she didn't give us any coal. We hear much about America's great steel industry. Yet we realize that America couldn't have a steel industry without the wedding of iron ore and coal. Coal is an integral part of the steel industry.

There are many, many other industries too that depend on coal. In the manufacture of fertilizer, in some instances a half ton of coal is required to make a ton of fertilizer and, one ton of fertilizer can create 12 tons of agricultural products.

In our state we have some other natural resources, but because we don't have coal, we are not in a position to develop them. For example we have a good quality sand for the manufacture of glass and clay for manufacturing brick. Without the coal, somebody else makes the glass and somebody else makes the brick. Here in the State of Illinois where you people operate your great coal industry, many industries exist that are impossible in many states like Wisconsin.

Oh, so frequently in our own Wisconsin dairy industry "We can't see the forest for the trees." People right in the heart of a great activity are often without full realization of the importance of their own contributions to society. Perhaps you who are right in the middle of the coal mining industry do not realize the full significance of your contribution to national welfare and strength. I'm afraid none of us, not even you people, give the credit to the coal industry that it deserves.

On our farm and in our home we are using coal to heat our home and for our farm use. Also the electricity we use on our farm is generated from coal shipped in by rail. And, although the Madison Gas and Electric Company is hooked up to a high line coming from a hydroelectric plant only 35 miles away, they find it economical to use coal to generate electricity. On this basis we enjoy one of the lowest electric rates in the Middle West.

To me, it is of interest to know that even in the much-talked about Tennessee Valley they are today building and have built steam generating plants to carry through. Right now on the Ohio River is being built one of the largest coal burning steam generating electric plants in the world. After all, folks, *your coal is the most dependable source of energy that we have in these United States.*

I have been asking myself and struggling with some questions. What can I, as an outsider, say to you people today, any more than to give you the impressions of a rank outsider who doesn't know much about your industry? Certainly, I can't say anything to you about efficiency of production. I have been studying your program. I am sorry I couldn't be here to listen to your program today. It is evident to me that you people are using the very best production methods.

Only yesterday I checked with our Wisconsin state geologist, Dr. Ernest Bean, one of the outstanding geologists of the nation. He told me that you people in Illinois are doing one of the most efficient coal recovery jobs in America. Your contribution is outstanding in the way of making a basic natural resource available for human consumption, using the most modern methods. In our game of dairy production we are also struggling for production efficiency. Hence, although our fields of operation may differ, yet we both are facing similar problems and are fighting to win the same battles of efficiency.

My next point takes me back to what I said a moment ago. Remember Bobby Burns, who wrote that famous poem when he saw a louse on a lady's hat in church:

"Oh wad some power the giftie gie us
To see oursels as ithers see us."

Some of your competitors I'm afraid are outclassing you in the field of public relations. The oil, gas and hydroelectric people are telling a rather romantic story of how they are harnessing this or using that. They are telling consumers how to use these substitutes for coal. They are painting nice word pictures about these alternative products and devices. While it is a struggle to produce, it is still a bigger battle to sell in today's highly competitive world.

Believe you me, fellows, we have the same thing in the dairy industry, and may I add – and I think Mr. Schonthal knows what I am talking about – we dairymen have our backs to the wall fighting a fight against what in my opinion is dirty, unfair competition. It is a terrific challenge, not to us alone but to the whole program of soil conservation and to the interests of the consumers of America.

I mention this only because I feel your position as coal mine operators is comparable with our situation as an industry involved in battling competition and with a great need for more effective public relations. I concede that we dairy farmers have not done a good job in the field of public relations. I am wondering if you people likewise might do a better job.

Public relations is the art of understanding as well as being understood. It is the art of eliminating misunderstanding. I know how newspapers are. Too often they publish scare words in headlines telling about strikes, idleness and all that sort of thing. It is up to you and to me in our own industries to put across new concepts and understanding about the significant contributions being made. Your coal industry is a vital link in the chain of American strength. As coal operators you are investors in America's future. You are gambling for America – not alone for yourselves.

When mentioning this matter of better understanding and the elimination of misunderstanding, I recall two ladies who drove into a filling station. The young man in charge, gallant and wanting to be of service, dashed out and asked, "What can I do for you, madam?" As he asked the question, he looked down and on the floor of the car where he saw some peanut shells. Obviously they had been eating peanuts. One of the ladies replied, "Do you have a rest room?" But he was a little hard of hearing and he misunderstood. He said, "Just a minute, I'll go to the office and get you one." He came back a little later shaking his head and said, "Well, madam, I'm awfully sorry. You know I've looked all over for a whisk broom and I can't find one anywhere. Now I'll tell you what to do. You just drive over near the tire rack and I'll use the air hose to blow it out for you." (Laughter)

It is easy to be misunderstood. It is more difficult to be understood. You people have that challenge to meet in your coal industry.

Oh, we say what goes up must come down, but in your coal industry you get your coal up and it stays up. It is not going back down. Getting that coal up means employment to hundreds of thousands of people – that is assuming they are working. Anyway it is not your fault if they don't. It means investment of capital. It means employment of men in many other allied industries. Bringing up your coal means so much to millions in every industry and in nearly every walk of life. To every life, in some way, coal contributes something.

The many Macs here tonight are not all Scotch, are they? I'm reminded of a green kind of an Irishman who came over from the Old Country.

Like a lot of Irishmen, he was a little bit hungry when he landed in New York. He went into a restaurant, sat down at a table, and noticed some people nearby eating something he had never seen before. He called the waitress over and asked, "Waitress, what are them folks atin' over there?"

"Why," she said, "they're eating raw oysters."

"Be gorry!" he said, "would you be bringin' me some of them?"

She brought him the oysters. "Now," he said, "madam, would yez mind tellin' me how you ate them things, anyway?"

"Why, yes," she said, "it is very simple. Eat them just as they are. Some like them with pepper and salt and some put a little vinegar on them. That's all there is to it."

She went on about her work and he started in on his oysters, but she got along better than he did. A little later he called to her again, "Madam, would yez mind comin' back here? Say, how the divil did you say you ate them things, anyway?"

She said, "Why, I told you how: just put a little pepper and salt on them or vinegar, and swallow them."

"Now, wait a minute. I would like to have you take that big fellow over there on the carner of me plate and show me just how you ate it."

She did, as Pat watched her in wide-eyed amazement. He said, "Did you ate it?"

"Why, yes!"

"Well," Pat asked her, "is it down?"

"Why, certainly."

"Well, will it stick?"

"Why, positively."

"Now you know that's a funny thing. Sure I had that same fellow down three times and the divil a bit of him would stick." (Laughter)

Well, folks, it all goes to show that you can't keep a good fellow down. Right now you coal operators may feel down because so much coal is up. Certainly this up and down, economically speaking, in your coal industry, is of great concern to the whole country and not to you alone. Your problems are also ours. It will help if together you people tell the facts and bring new understanding to your fellow Americans about the importance of your industry.

May I dare to make another comment? It has nothing to do with your methods of mining. It has to do with today's price trends. Certain factors, and may I say philosophies, have a one way pressure on prices — going hell-bent upward without realizing that to some degree, whatever goes up must ultimately come down. I am not accusing you of this. A lot of factors enter into these pressures, and I would like to discuss with you what I call the theory of escalation.

Let me start first of all with agriculture. We talk about parity. Yes, our parity is a design to keep agriculture somewhere near in relationship with business and industry and labor. In other words, farm parity is tied to cost of production. It is a form of escalation.

Wage rates, of course, are tied to cost of living. But cost of living is only made up in part of the original cost of food and fibre. The cost of processing and distributing that food and fibre is largely a labor cost. It seems to me, gentlemen, that too often we are chasing ourselves around and around in an ever upward spiral. The whole inflationary trend has been going on for quite some time, as we all know. We are all in it together. The trend has been one step at a time but it keeps on moving upward.

It is too easy for all of us to become part of the problem rather than part of its solution. It has been easier to lean on excuses gathered from the drift of other economic groups than to recognize that there will be a going down in the future following today's going up. By leaning on the other fellow's trends we excuse ourselves with the feeling that the other fellow is to blame. The current theory of price and wage escalation can be a one way street to future economic disaster.

It is comparable with a car jack that has no release and keeps raising the car ever upward until it topples over. That's the danger we Americans face for the future. Let's not forget that what goes up must ultimately come down. In today's all-out struggle between capitalism and communism, it is up to us to keep our own economy in just as strong a position as we possibly can. Wage and price escalation are sure to weaken our economy.

Certainly you people in Illinois don't have the cold weather that we have in Wisconsin. One time I was doing some extension work for the University traveling way up in the musky fishing area around Rhinelander, Wisconsin. It was back in the days before they had built the Oneida Hotel and there were just two hostelries in that town in 1916. One was the Commercial Hotel, a pretty good place to stay in. The other was called the Rapids House that you never went to unless you had to. One beastly cold morning we were seated in the train waiting for it to pull out of the City of Rhinelander. And all of a sudden we saw that old-time carryall coming down the main street, the driver high on his seat whirling his blacksnake whip over the horses' backs as they came down to the depot on a dead gallop. There was just one passenger. The driver whirled around, backed up to the depot platform, and this one passenger got out. He was a little, weazened fellow. Although it was 35 below zero the old fellow hadn't even taken time to put on his overcoat. He rushed into the railway coach and thrust his coat over the back of the seat near where I was seated. He had a glass tumbler in his right hand that he set up on the window ledge and then, with his lips tightly drawn over a toothless mouth, he turned to me and said, "Hey! Did you happen to stay in the Rapids House last night?"

I had to admit I was one of the victims. "Well," he said, "if that ain't the damndest place to stay in. You know, they don't feed you nothin'. They don't call you in time to make your train in the morning. The place is so buggy I couldn't sleep all night. It was so damn cold I couldn't get my false teeth out of the glass this morning." (Laughter)

That was way back years ago but, you know, when the thirties came along, I often thought of that little old man and his frozen assets. Yes, we could have some of them again. Folks, it is a challenge we need to think about. It is very easy to say that the other fellow is causing the inflation and, as a farmer, I am convinced that somebody else is causing it, and somebody else is just as convinced that we are causing it. So who's who?

What are we going to do about it? One thing I believe we cannot do is to artificially clamp price control lids upon our various products. Whether it is yours or whether it is mine. I do not believe an artificial economy in the long run is constructive to the building of a strong America. Neither do I believe, as a farmer, that price rollbacks and production subsidies are the answer.

During one year of the war when milk subsidies were forced upon us, it was a matter of taking it or leaving it and then being thrown by an unnatural handicap. By comparison let me explain a situation in our state. When they wrote our Wisconsin Constitution they forbade our state of ever going into debt. And I recall as a kid when our old state capitol burned. That was in 1904. Then as a youngster going to school, I watched for ten years our new capitol being built, and if you were to go through that building today with a guide, he would tell you that it took ten years to build it, and you would think, "Well, of course, a magnificent building like this, costing $7,400,000 prior to World War I, I can see why it took ten years to build it."

The reason that it took ten years in building is because we could not go into debt. The legislature, in its good judgment, said, "We cannot break the backs of the taxpayers, so we will spread this over a ten-year period."

But, fellows, in one year of federal milk subsidy, it cost the taxpayers of America seven times as much in one year to pay the milk subsidy in our state as it cost our state over a ten-year period to build our state capitol.

Folks, that kind of artificial economy can defeat freedom of enterprise in America and bring ultimate ruin to the best that has made America great.

The time is coming, in my opinion, when we, as American people, are going to have to face the issue of maintaining a strong economy at home and at the same time maintaining a military strength abroad, along with our sister countries. I say that military power is the only language that those who do not believe in our capitalistic system can understand. If we are going to maintain our military power and our economy at home we are going to have to do some thinking in advance.

We will have to be intelligent gamblers. We cannot take the chance of being blind gamblers or we will be gone gooses. It means weighing our world responsibilities in the light of our own economic ability at home. It will mean the payment of taxes more than we like to pay. I don't like them and neither do you.

But blind payment of taxes is not the answer. There must be greater economy in government. While we maintain a strong military force we must also watch very carefully our military expenditures, demanding the same economy in the War Department that we believe should be applied elsewhere in federal, state, and local governments.

As we face today's conflict of the "isms" there is demanded of you and me an understanding and a leadership resolute and fearless if we are to preserve our capitalistic system. Incidentally, Mr. Chairman, mine is a relatively small farm. But whatever the size may be, I am a part of the capitalistic system, a system that Americans too often have been inclined to ignore or at least not to appreciate fully. Capitalism is the system of independent and private enterprise. It is the system of security that is guaranteed by work and by advance thinking, yes, by taking chances on the future. It involves faith and effort. That is intelligent gambling. It is America's system of intelligent and self-made security.

Sometimes I think that insecurity with its urge to do better for ourselves and our fellow men is desirable. It helps you and me to do better work and to attain greater heights. It was a feeling of insecurity that brought the pioneers to this land from whatever country they may have come.

I will never forget my old English grandmother, who left England about 100 years ago, in a sailing vessel. They were out on the ocean six weeks, their sails partly destroyed and the boat itself listing badly and taking water, so that every man, woman and child had to pail and pump. They drifted back to Liverpool. Storm tossed, sick and weary, 24 hours later she stepped on another sailing vessel and started again for America. I couldn't understand how she had the courage to face the second voyage. "Well," she said, "we had parted with what we had in England. My older brother, already in America, said we would have an opportunity to be free and if we worked hard we could own some land."

In America it is that opportunity to have and to hold; it is that opportunity to build if we ourselves will. I wish we could get more people in the ranks of labor, and agriculture, as well as in the mining industry to feel that they are definitely an integral part of that thing we call American life and Business. I would that more people could appreciate the spiritual as well as the material values derived from ownership. Those who own whatever it may be, are better citizens in our capitalistic economy. Nothing can take the place of self-help and self-made security.

When God made the oyster, he gave it a certain amount of natural security. He gave it a house. The oyster lies at the bottom of the ocean and if it wants a little food, it just opens up its house and gets it. That is a sort of natural security but not a self-sacrifice security. Yet all the while Mr. Oyster is a prisoner within his own security.

My point is that if we get too much governmentally given security we lose our initiative, and next we surrender some of our freedom. Remember, gentlemen, in the pride of ownership there is a power of production and a resultant high calibre security that nothing else can equal.

Look at the eagle. He wasn't given the kind of security that was guaranteed to the oyster. The eagle has to hunt its own food. It must fight its own enemies. It must build its own house. And when it builds its house it is high on a cliff, usually facing the wind, where the storms can strike, but where no enemy can reach. All the while the eagle is living, it is living a life of independence, a life within its own security. And, folks, it is the eagle, not the oyster, that is the emblem of America.

It seems to me that at a time like this we should think in terms of working together, not only as capital and labor within your industry and within mine, but across the board, whether it be in the professions, agriculture, mining, manufacturing, or whatever it may be.

We have in this country a sort of "groupist" regime. We have built cooperatives for farmers; we have built institutes for miners; we have built chambers of commerce for business men; we have built unions for labor. Too often and too long we stand in our own little bailiwicks, without realizing the interrelationship between all of our groups. We have to lean upon each other. We cannot do our work and live alone. Definitely we are all integral parts of the thing we call American life and business.

Over in Europe the trains are different than they are here. This event took place in a first class compartment of a train moving through Scotland. In a compartment of this train there were three men, an Englishman, an American and, of course, a Scotchman. And the Scotchman, proud of his country, was pointing out here and there a wee hoos on the hillside and the beautiful heather along the way. All the while he was smoking like a regular Vesuvius, which was against the rules in a first-class compartment.

The Englishman was annoyed and he asked the Scotchman if he would please refrain from smoking. But the Scotchman — you know how obstinate some of them are — just puffed his pipe all the harder. At that, the Englishman, thoroughly exasperated, pulled the cord and called the conductor. When the conductor came, he said, "Mr. Conductor, I would like to ave you observe that this Scotchman insists on smoking, which is against the rules in this first-class compartment, and I would like to ave you put im aut."

Whereupon the Scotchman jumped up and said, "Mr. Conductor, there's one thing I want you to know, and that is that this Englishman is riding in this first-class compartment on a second class ticket."

It was the Englishman that had to get out.

When it was all over, the American, who, like a soldier walking his beat, had observed everything that took place, turned to the Scotchman and said, "Harry, you're a pretty clever duck. You would be a good candidate as a detective for Scotland Yards. But would you mind telling me, how in the world did you know that this Englishman was riding in this first-class compartment on a second class ticket?"

"Well, sir, mon," he said, "sure I'll tell you. I saw a part of his ticket sticking out of his pocket and, judging by its shape and its hue, it is the same kind of a ticket as me own." (Laughter)

Well, folks, my point is that it doesn't make much difference whether we are riding in a first or a second or a third-class compartment. It doesn't make any difference whether I am a dairy farmer and you are the operator of a coal mine in Illinois or whether it is somebody running a store in the City of New York. My point is that today, if we are going to strengthen the economy of America, we are going to have to wake up and realize that we are all in business together, that we are all on the same track and we are trying to go in the same direction. All of which means that we are going to have to do some thinking in the future – not blind gambling on the future, but constructive thinking.

And now I want to turn briefly to the international scene. I don't know how you people feel about this. I feel that here is the greatest of all challenges to all of us in the years that lie ahead. It is the building of a strong America with her allies in the non-communist world. For decades there has been going on in this world a carefully planned design by Moscow to wipe out our capitalistic system and destroy the things that we have stood for and that have stood by us. We are going to meet that challenge only if we are good gamblers and not blind gamblers. We must gamble on the future because the future is indefinite and therefore, to that extent, it must be a gamble. But if we are blind gamblers, we will be separated, one by one – we will then be gone gooses.

Just as America is crying for better inter-group teamwork and understanding within, so also the world is in dire need of international teamwork and pulling together. The tragic cost of international understanding is known to all Americans whose sons are in service. Until the world is safer than I think it is now, that effort must go on. But let us not pull our economy down to the breaking point. Meanwhile if we think and prepare only for war we are blind gamblers and we might be gone gooses.

Let us strive for peace and world understanding. Let us not forget that today is October 24 – United Nations Day. And I know of no better way to express the hope of world peace than to go back 110 years to a poem written in 1842 by Alfred Lord Tennyson. It is, in my opinion, one of the most marvelous predictions ever penned in the English language. May I read from that poem entitled Locksley Hall?

"For I dipt into the future, far as human eye could see,
Saw the Vision of the world, and all the wonder that would be;
Saw the heavens fill with commerce, argosies of magic sails,
Pilots of the purple twilight, dropping down with costly bales;
Heard the heavens fill with shouting, and there rain'd a ghastly dew
From the nations' airy navies grappling in the central blue;
Far along the world-wide whisper of the south-wind rushing warm,
With the standards of the peoples plunging thro' the thunderstorm;
Till the war-drum throbbed no longer, and the battle-flags were furl'd
In the Parliament of man, the Federation of the world.
There the common sense of most shall hold a fretful realm in awe,
And the kindly earth shall slumber, rapt in universal law."

Gentlemen, imagine, in 1842, predicting the nations' airy navies grappling in the central blue, and the dropping down of the costly bales. Exactly 100 years later that was happening in the world.

Thinking, foresight, dreaming! But had he left us in the dilemma of his predicted world war, had he not brought up the hope of some type of international law, then it would be a pessimistic picture indeed. But, folks, it seems to me that from this foresight of more than 100 years ago we today can take new hope. Let's try to make international understanding a reality.

We have to gamble, yes; we can't do otherwise except to gamble on the future. It is a future of confusion and uncertainty. It is a gamble that requires vision. We can't face the future blindly. If we will make our country, our economy and our own industry strong at home, if through the idea of working together within each industry, and among all the various major economic segments in America, we can achieve a brighter future. Let us build and preserve our American capitalistic system. Then we will not be blind gamblers. Then we will not be gone gooses.

* * *

President Ball: Thank you very much, Mr. Swanton, for your perceptive and instructive remarks.

I might add one small suggestion, perhaps, that here in this room we might have some talent that in the future might help solve some of the problems. I don't mean the world's problems, although I would hope for that, too. I am talking, of course, about the undergraduates in mining engineering who are over here from the University of Illinois, and I would like at this time to ask you men to rise so Mr. Swanton and the membership can have another look at you. (Applause)

I do think that the Institute has had some very happy listening today and I will take this opportunity of expressing the appreciation of the entire Institute to the authors of the papers today, and again to Mr. Swanton, for making our day so interesting and successful.

And now, as my final act – it is not a duty, it is a privilege – I wish to introduce the incoming President of the Institute, William Bolt of Pawnee, Illinois, which is very close to Springfield, as you know. This man has some very deep-seated roots in the coal industry of this state. Not only has he been directly connected with a great deal of coal production but his father, Martin Bolt, was very important in some of the beginning and growing days of the industry here. From the early nineteen hundreds until 1925 he participated, first as Secretary, then as Assistant Director, and finally Director of the Department of Mines and Minerals here in Springfield; and it will be a surprise, perhaps, to some of you, I know it was to me, to learn that Martin Bolt preceded Bela Schonthal as Secretary-Treasurer of this very Institute, serving, I believe, from 1912 to 1925, the time of his death.

It is a great honor and a great privilege now to introduce Bill Bolt, the next President of the Illinois Mining Institute. (Applause)

Mr. Bolt: Mr. Ball, officers, members of the Institute, Executive Board members of the Illinois Mining Institute and friends:

I had a question that came to me this morning that it didn't take me very long to solve. That question was how on earth you fellows elected me, a cripple, as your President. The solving was this. It doesn't take much of a President to run this Institute for the coming year, because of the impetus and the momentum that it has gained through the past years because of the fine officers, Executive Boards, and the membership; and certainly when I considered that our Vice President is Professor Harold Walker, I knew I didn't have much to worry about. So I am very happy and very proud to be your President for the ensuing year.

I know it is traditional that the incoming President shall not make a speech and I do not intend to make one. However, I would be remiss in my duty if at this time I failed to honor a man whom a great many of you knew. I believe you respected that man the same as I did. I refer to my father, Martin Bolt.

Gentlemen, I am proud to be an officer of this Institute and I hope that I will be as well liked and as successful in this term of office as the man that I am very proud to honor as my father. Thank you, and I believe at this time if there is nothing more to come before the Institute, Mr. Secretary, this meeting will stand adjourned until our next Annual Meeting. The meeting IS adjourned.

(Final adjournment)

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WET ROOF DRILLING WITH ROTARY ELECTRIC DRILLS

By L. F. LUMAGHI
President, Lumaghi Coal Co.
St. Louis, Missouri

Our company is using roof bolts in one section of its mine near Collinsville, Illinois. The seam is 8 feet thick and lies nearly level. In this section all equipment is track-mounted; the coal is loaded by Goodman loaders and cut by slabbing machines making an eight foot cut. Entries are driven 14 feet wide and rooms and room cross-cuts 24 feet. Pillars are not recovered.

The roof consists of 5 to 8 feet of laminated black slate overlaid by a strong limestone. In rooms where the slate is good, the top can be supported by 14 ft. bars set 4 feet apart with a prop on each side between the end of the bar and the rib. When the slate is bad, bars must often be set at half this spacing. It is necessary to set heavy collar bars at turnouts, sometimes as big as 18 ft. long and 8 in. at the tip.

Bolting Procedure with Wet Drilling

Bolting is done with a Jeffrey roof drill which pulls a trailer carrying a 300 gallon water tank and a rack for the bolts. There is a small turbine pump at the rear of the trailer for forcing the water to the drill. The drill steel is a plain steel tube $\frac{15}{16}$ in. diameter with a .30 in. bore. The drill bits are $1\frac{3}{8}$ in. Kennametal attached to the drill steel with a cotter key. The water is directed to the point of the drill and also comes out through the holes for the cotter key. The $\frac{3}{4}$ in. bolts are 48 in. long, with rolled threads and square flashed heads. Ohio Brass shells are used with pal-nuts to hold the shell in position when inserting in the hole. To bear against the roof we use an oak block 3x6x18 in. with a $\frac{3}{4}$ in. malleable iron washer over the head. (See Fig. 1)

After a place has been loaded out, the roof is examined and safety props set if needed, but this is rarely necessary. Then the track is laid up to the face and the roof drill comes in. The operator swings the head to the left rib and positions it 2 ft. from the rib and 4 ft. in-by the last bolt. He drills the hole, then swings to the right 4 ft., drills another hole, and so on along the arc of the swing until he gets to within 2 ft. of the right rib. Meanwhile his helper has been assembling the bolts and putting them up into the holes.

When the last hole is drilled the drill steel is removed and an extension wrench is placed in the tightener socket of the machine. The bolt is pushed up by the drill arm until the wood block is seated and then turned by the machine until it is so tight that the hydraulic motor in the head stalls, due to the opening of the relief valve. After the last bolt is set in the row, the machine is trammed forward 4 ft. and another curved row of bolts set against the face. This is the only roof support provided in the entries, but in the rooms a line of props 8 ft. apart is carried on each side of the track. The last cuts in rooms and cross-cuts are propped, not bolted. (See Fig. 2)

The socket holding the drill rotates at 413 RPM and the tightener at 206 RPM. At this speed it develops approximately 225 foot-pounds of torque with a hydraulic pressure of 1300 pounds. A torque wrench is kept in the section and the bolts are tested periodically by the foreman. The bolts when tested average about 170 pounds. We have noticed that the older bolts have lower torque and believe this comes from using unseasoned oak blocks which tend to shrink. We are now arranging to season the blocks before using them.

Operating Results

Coal is produced in this section on two shifts, but the roof drill is operated on all three shifts. The drill usually gets behind by the end of the second shift, and the third shift is spent in catching up on the working places, putting in extra bolts where the slate or top coal has broken around a bolt, tightening old bolts, and similar work. The third shift also loads the trailer with water and bolts, greases the machine, and gets everything ready for the next day. There are six men each day on the

Fig. 1. Water applied to electric rotary drill eliminates dust

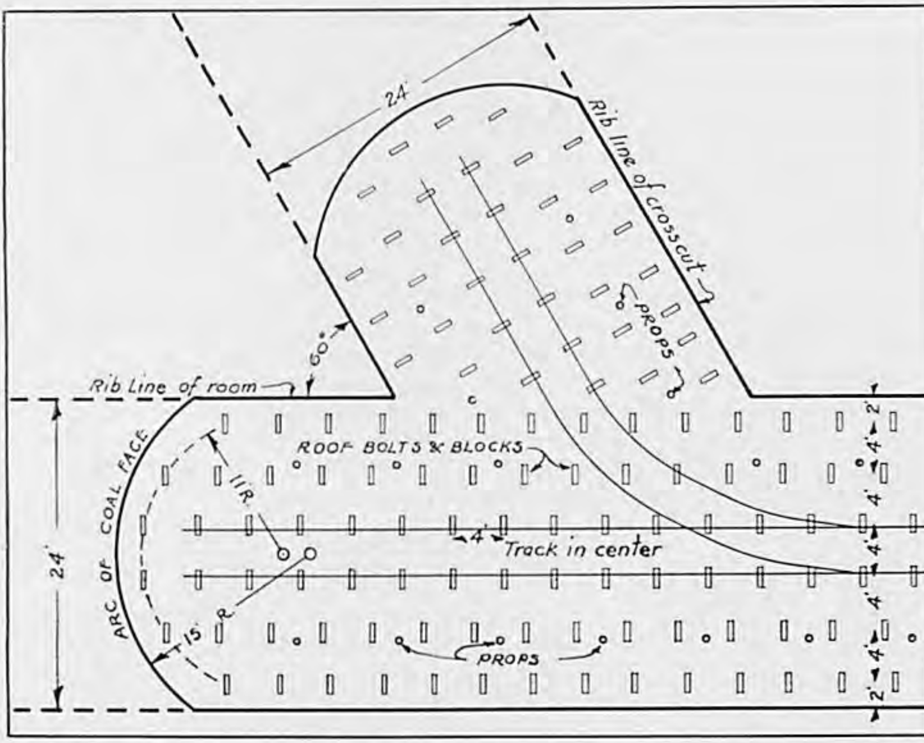

Fig. 2. Sketch showing roof bolt pattern in rooms

drill and the equivalent of one man setting props for the two producing shifts, or a total of 7 men. These replace an average of 12 timbermen. In February the bolted section averaged 982 tons of washed coal per day, with an average of 213 bolts per day, or 4½ tons per bolt.

This section has been on roof bolts since July 1951. We had some difficulties in the beginning, the most serious being the tendency of the cuttings to form a mud which would stick the drill steel in the hole. This was overcome by using bits which had grooves in the shank to carry the water down and out the bottom of the hole and by reducing the drill speed from the original 825 to 413 RPM. Occasionally the shell will fail to grip in a soft spot in the slate, and another hole has to be drilled. We carry a few 60 in. bolts on the machine which are useful here, as a bolt of the same length near the bad bolt will probably not grip either. We also use the longer bolts where the top coal sticks to the roof, cutting down the effective length of the bolt. In the beginning we used 3/8 x 6 in. square steel plates against the roof, but changed to the oak blocks because they give a better bearing on the roof. It is also easy to hang cables to them by driving nails.

Favorable Roof Action

We have had one roof failure in the bolted area. The first indication was the appearance of cracks in the slate between the blocks and when tested the roof sounded drummy. The place was allowed to stand idle for observation during 10 days; we then doubled the number of roof bolts and set 9 cross-bars and 1 collar bar over a 32 foot length of the room. In spite of this the place continued to show excessive weight and 13 days after the bars were set the roof caved to the limestone. The slate here was 58 in. thick. The action was identical with that in timbered places, which always cave to the limestone eventually, and frequently fail before they are finished. We expect that as the slate weathers, the bolted places will also cave, although with this one exception none has yet done so. We have had other failures with bolts experimentally installed in another section, and in each case had at least as much warning as we get in timbered work. The bolts have been very successful keeping the top tight at the working face, as there is never more than 8 ft. of roof span open.

This type of installation was selected because we had successfully used rotary drilling in sinking our slope, which went through several hard limestones as well as shale. We installed some roof bolts around the slope bottom installed by the same drills, but found that dry drilling produced a bad dust nuisance. The cuttings on analysis showed from 11 to 52% free silica content, indicating a serious health hazard which is removed by drilling wet. The water also keeps the bit cool and increases its life. We use a little less than 2 gallons of water per hole. The drill bits average 14 holes before getting dull, and can be re-sharpened 15 or 16 times.

This summer we will put another section on roof bolts. This is a trackless section, the coal being loaded by a Joy 11BU into shuttle cars. The same type of drill arm as described above will be installed on a Joy timbering machine, which is large enough to carry a water tank and a supply of bolts. It will be necessary to alter the cycle in this section, because the fire clay underlying the coal is soft and porous and if it gets wet it makes a mud through which shuttle cars cannot be operated. We intend to cut the places before bolting them. The cut is made about 1½ ft. above the bottom leaving the cuttings spread under the area to be bolted. We believe that the water from the roof drilling will be largely absorbed by the cuttings and not enough will get in the clay to hurt.

Operating Advantages and Lower Costs

In this mine we also have a producing section with identical equipment and conditions where the roof is supported with conventional timbering. In February, the labor cost in the timbered section was 6¢ higher than in the bolted section, but the timber cost was 15.4¢ as compared to a cost of 24.9¢ for bolts, drill bits, drill parts, and props in the bolted section. This made a cost differential of 3½¢ in favor of the timbered section. However, the daily tonnage in the timbered section was 34 tons higher than the bolted section, and on an equal tonnage basis, the differential would have been only 6¢ per ton in favor of timbering.

There are other savings in using bolts, which are not shown in the above figures. The cost of delivering from the surface to the face is lower. There is no loose coal lost behind the timbers, which decreases the work of coal preparation, increases extraction, and makes it easier to do an effective job of rock-dusting. To produce the same tonnage as in the bolted section it is necessary to clean up one more place each shift in the timbered section. There is plenty of room to store rails and props and ample clearance around the cars and machinery. Against this must be figured the cost of power, water, and amortization of the first cost of the drill.

Finally there should be a great saving in accident costs. Since we started we have had two reported injuries with 2½ hours lost time on the drill and none by falls of roof in the bolted area. In the corresponding timbered section we have had 17 reported injuries from timbering or falls of roof, of which two were lost-time with a total of 42 days lost.

Although we have not yet been able to show much saving in cost we feel this installation has been successful on the whole and it is our intention to extend roof-bolting over the whole mine.

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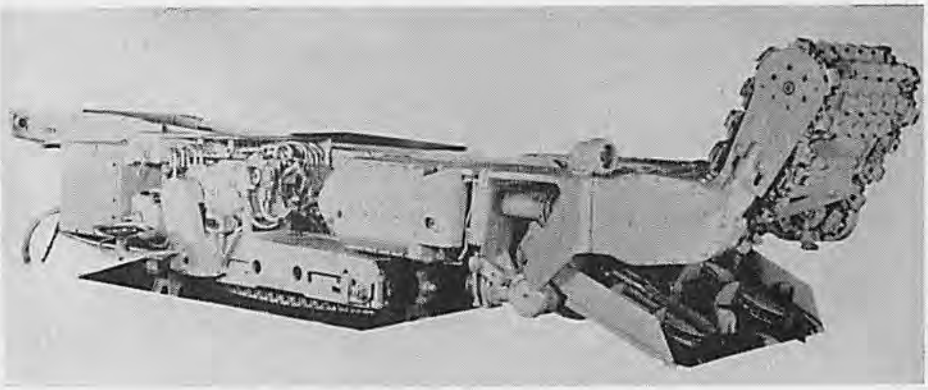
THE GOODMAN MINING AND LOADING MACHINE

By H. C. McCOLLUM
Consulting Engineer, Chicago, Illinois

One of the newer entrants into the so-called continuous mining field is the Goodman mining and loading machine. Like other machines of its type, it combines into one operation the breaking out of coal from the solid face and loading it into the haulage unit which starts the transportation to the surface. Also like others of its type, it is an assembly of cutting and conveying elements of known performance abilities and characteristics, arranged in a special design and employed in a novel form. It consists of three main parts; a caterpillar chassis, a conveyor and a mining head.

The chassis and conveyor are similar to those on a conventional mechanical loader but the mining head is entirely new: This consists of a revolving cylinder 42 in. wide held between two parrallel arms and driven by two cutter chains; it is the digging element which cuts the coal out of the face. The cylinder has five cutting discs spaced on 6 in. centers and each containing eight cutting bits. Conical shaped roller wedges rigidly mounted on the discs between the bits, break or wedge out the coal cores 3½ in. wide that are left between the cutter chain kerfs. (See accompanying illustration.) In this way approximately 50 percent of the mining is accomplished by cutting and 50 percent by wedging, which is designed to prepare a maximum of coarse coal sizes. The cutting cylinder can be raised and lowered and cuts downward from top of the seam to the bottom. The coal falls directly in front of a gathering or loading head which is similar in design to those used on the Goodman conventional mechanical loader. This head normally floats along the mine bottom but can be raised or lowered by hydraulic power for tramming.

In its operation, a complete cycle consists of sumping the cutting head to a depth of 18 in. at the top of the seam, then cutting downward to the mine floor, withdrawing 18 in. and swinging over 42 in. and upward to complete the cycle. The cutting cylinder is sumped hydraulically while the main chassis remains stationary. The machine can be operated so as to follow the irregular contours of a mine floor and cross-cuts can be turned at right angles in a place 14 ft. wide. The cutting head is hinged so as to swing 45 degrees to the right or left of the chassis. This also



Low model of the Goodman Mining & Loading Machine

applies to the conveyor loading boom. With this arrangement, the machine can cut a face 18 ft. wide without maneuvering on the caterpillar. It can operate in low coal as it is 34 in. high.

Trial Operations in Illinois and Pennsylvania

The first model of the machine made a trial operation in 1951 in the No. 5 seam of Southern Illinois. This is a hard dense coal with no regular line of fractures and, in general, is considered a difficult job for the present types of continuous mining machines. The test continued over several months and was made to prove the machine's possibilities and also to develop any weaknesses which might exist in the first model. On the whole, the test was satisfactory. There was no excessive strain or high power consumption and no mechanical or electrical failures occurred to the main motors or to the mechanical parts driving the head.

As had been expected, however, the test showed that several improvements could be made, noticeably in having a better cleanup from the mine floor. The machine was returned to the factory for rebuilding and has recently been placed in a mine in Western Pennsylvania, operating the Sewickley seam which has a height of 42 inches. As this article is written there has not been a sufficient operating time to warrant the posting of the results. However, it can be said that the mechanical failures have been very low. Some trouble has been encountered by sulphur balls in the seam which always impose a cutting difficulty. Experiments are now being conducted with various types of bits and no doubt this source of delay will be reduced.

The rated capacity of the machine is 3 tons per minute and the trial operations show that this is a reasonable rating when cutting on the down cycle in a coal comparable to the Sewickley seam. An average of two tons per minute should be maintained for a complete cycle of sumping, cutting, pulling out and swinging up the head. No tests have as yet been run on size consist but as the bits cut a 2½ inch kerf leaving a 3½ inch solid coal core to be broken out by the wedges, it would seem that a desirable size consist is possible. The redesigned machines place the gathering head much closer to the face, which has greatly improved the floor cleanup. The operator is in a position of safety, 15 ft. back from the face.

The general specifications are as follows: overall length 27 ft., height 34 in., overall width 90 in., width of mining head 42 in., approximate weight 20 tons, speed of loading boom conveyor 6 tons per minute, total number of motors 6, total hp. 180.

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THE LEE-NORSE MINER

By E. M. ARENTZEN
President, Lee-Norse Co., Charleroi, Pa.

The first experimental machine that was on exhibit in Cleveland in 1951 has gone through a number of tests beginning about June 1951 and ending in December. During this time it cut and loaded approximately 10,000 tons of coal and we gained considerable experience on the new Lee-Norse method. The first machine was designed to cut what we call "full entry" approximately 12 ft. wide, but we soon found out that it was difficult to cut full entry on rubber tires. Therefore, as soon as we had sufficient experience with the cutting mechanism, the machine went back to Charleroi where it is being completely rebuilt for further tests.

In the meantime, we undertook to build a small model called the "Junior Miner," for low coal, 36 to 48 in. The experimental design was actually built on a 14BU Joy chassis. It has been working in a mine in Eastern Kentucky in coal 44 in. high and has demonstrated remarkable ability to cut coal. However, there are corrections to be made from the mechanical and electrical standpoint.

The Junior Miner is only 32 in. high and about 6 ft. wide and about the same length as a loading machine. It has a swinging rear conveyor similar to a conventional loading machine. The cutter head is considerably different in design from the original machine because it only cuts approximately 8 ft. wide and only four cutters are used, two on each head. The cutters are only 24 in. in diameter but are able to cut and load coal at a rate of approximately one ton per minute with a total of 50HP. This type of machine has now been redesigned and will be built on a Lee-Norse caterpillar chassis where all the necessary speeds and special features can be incorporated.

Based on the above two experiments, we are now designing a new machine for high coal which will be installed in one of the coal mines south of Pittsburgh in the Pittsburgh seam. It will be approximately 48 in. high, 6 ft. wide and 27 ft. long, and will make a cut 8 ft. wide in a seam height of 60 to 96 in. That means that the conventional width entry will be driven in two lifts. The machine will have many of the features developed in the Junior Miner but, of course, it will be heavier and have the necessary structure to work the higher seams.

Our method of cutting coal by the so-called intersecting diagonal kerfs has definitely proved its great advantage in mining at a satisfactory production rate, with low power consumption and improved size consist.

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THE MECO-MOORE CUTTER-LOADER

By A. B. CRICHTON, JR.
Mining Engineer, Johnstown, Pa.

Everyone in the coal industry, without exception, is interested in production costs—or, more important, reduction in production costs. It is also everyone's duty to be interested in coal recovery—or, more important, an increase in percentage recovery. If these two factors can be coupled together, reduction in costs plus greater percentage recovery, everyone will be more than happy. As mining men, we realize that it would be pointless to expect a private operating company to attempt 100 percent extraction by any method, if the attempt results in bankruptcy. At the same time, we must certainly recognize the obvious fact that privately operated industry, which must be self-liquidating, is in pitched battle with government-operated non-liquidating enterprises paid for by you and me—the taxpayers.

Importance of Coal Conservation

This paper presents certain reasons why a change from the room and pillar mining system should be considered—perhaps why, in certain regions, a change is imperative. I again refer to better recovery at less cost. It is not claimed that such a system could operate universally; neither is this proposal offered as a panacea for coal mining. I do feel, however, that a retreating longwall system has a very definite place in American coal mines and its possibilities should be thoroughly explored and carefully considered. It is the enormous job of the professional mining engineer to sell to the industry this idea of an economical method for better coal recovery.

If present mining systems make a low recovery, if our technology lags, it should be our desire, as well as our duty, to attempt a correction, even though corrective measures involve a radical departure from present systems. We recognize the fact that the economy of the United States is based primarily upon the geologic accident of abundant energy deposits. Coupled with this has been our extraordinary technical and business ability for using them. However, to explode the 2000-year coal reserve myth, in the area of the United States termed the "Eastern Province" from whence has come about 85 percent of the coal so far produced, and where greater than 90 percent of coal energy is now consumed, accurate estimates reveal a supply for less than 100 years. Reserves of coking coals for metallurgical purposes in the Pennsylvania area, of thickness considered "minable" today, will last but a scant 20 years at present production rates. The Broad Top field is finished for any sizable tonnage. In the Uniontown-Connellsville region, the high volatile coking coals are all but exhausted. The huge New River and Winding Gulf regions of West Virginia have approximately 10 to 12 years. Some individual companies may have 30 years' life. There are but a handful of companies still producing coal from the thick Pocahontas No. 3 seam in West Virginia.

Conserving our coal reserves in seams between three and eight ft. in thickness is a matter of serious concern. The loss of coal in pillars is technically avoidable, but, because of the system of mining in practice in this country today, much pillar recovery is economically impractical. When coal finally becomes so valuable that it would pay to recover what is being lost now, it will be too late. Improved methods of recovery will apply only to mines operating then. Most of what is left behind now is forever gone. We are all familiar with the reasons for these irretrievable losses.

Longwall Offers High Coal Recovery

It behooves us, then, to consider a new system of mining which will enable us to approach 100 percent recovery. The subject of longwall in American coal mines involves more than a study and discussion of possible results with a particular machine. If we are to seriously consider longwall systems, we must immediately embrace an entirely new concept of mining vastly different from anything we have known in the past.

Of prime importance in this consideration are its present economic possibilities. Will the capital investment required be justified by results? Following that, would some new system be practical? From a technical standpoint—a mining standpoint—would it operate? We know that the average depth of present underground coal workings in the United States is about 200 feet. We also know that the cheapest coal to mine, other things being equal, is that which is not too deep or not too shallow. Seams under less than 75 ft. of overburden are within the economic realm of the strip operator. Some few coal measures in the United States are covered by 1000 ft. of overburden. The deepest vertical shaft in the United States to a coal bed is less than 1000 ft. In Great Britain, however, the average depth of all shafts is greater than 1000 ft., and many of them penetrate to 3000 ft. or more.

If the British and Continental European engineers are able to operate mining systems by which almost 100 percent recovery is achieved, such systems are worthy of consideration in this country from both an economic and a technical standpoint. Let me say right here that American mining companies have become "conditioned" to the expenditure of hundreds of thousands of dollars for equipment for one working section.

In this paper, but slight attempt will be made to set forth principles and formulas for the design of mine workings. Primarily, the attempt is to stimulate thought and interest toward a radical departure from the room and pillar system, which we know, and to state what are believed to be some well established facts in connection with longwall mining. With intensive planning and study of factual information available as a result of research conducted by engineers here and abroad, perhaps our industry will be on its way to a better solution for complete recovery of our coal. There are certain fundamental facts concerning the extraction of coal and the control of the strata which must be accepted if we are to start.

Roof Control Is the Key to Longwall Mining

It is admitted that efficient control of associated strata, both roof and floor, is of fundamental importance to successful mining. This, of course, is elementary. However, because of many variable factors involved, there has been a tendency on the part of most American mining engineers to

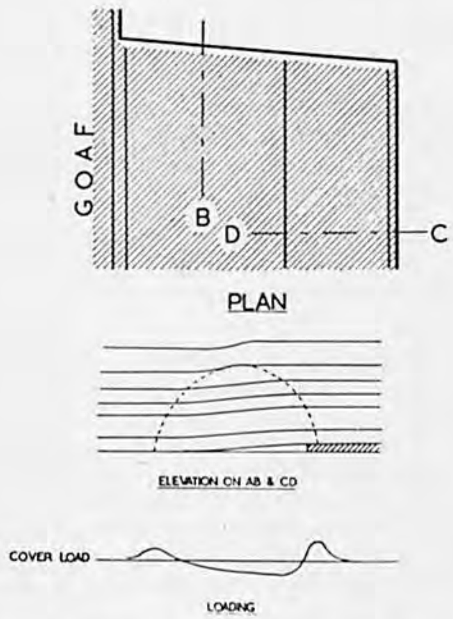
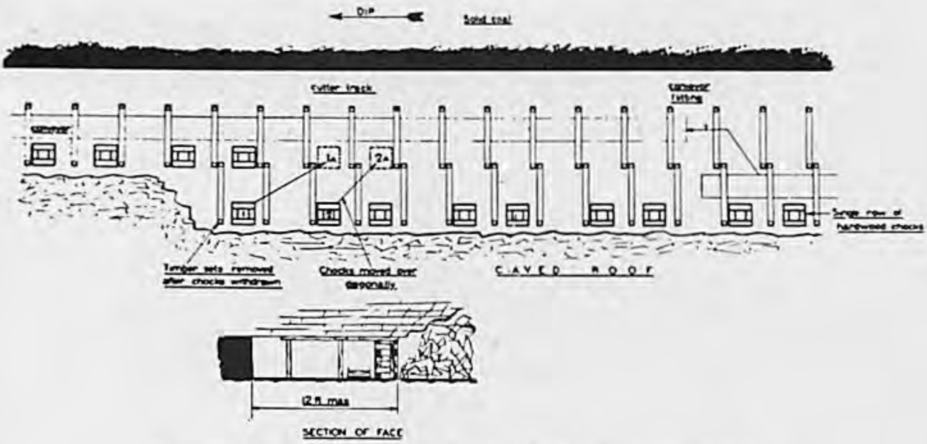


Diagram showing area and width of maximum pressure arch

believe that the behavior of strata is unpredictable—that this behavior can only be discovered in individual cases, largely by means of trial and error. As a result of research, sufficient information has been collected and evaluated, and there are certain guiding principles which will eliminate much costly experimental work and enable us to launch a new system of mining with maximum safety afforded both the underground employee and the operator. In connection with the study of strata control, certain basic results are apparent immediately.



Typical longwall face showing method of setting and moving cribs

1. When coal is completely extracted over a sufficiently large area, it is inevitable that subsidence of the strata will occur right up to the surface. This is true regardless of the depth of the workings, the thickness of the seams, or the method of mining.

2. The result of partial extraction may be limited to the movement of the surrounding strata and the extent of such movement, in turn, is affected by the width of the working places and the size of the coal pillars left in place.

3. The weight of the strata above a mining excavation is approximately one pound per square inch for every foot of depth. At considerable depth, the weight of the strata is greater than the carrying capacity of any practical form of artificial support, such as, props, cribs, or even steel timbers. At a depth of 1000 ft., for example, the weight of the strata overlying each square foot is about 72 tons. Therefore, mining at such depth is possible only because the greater portion of the load is transferred to the sides of an excavation as abutment load. These abutment loads must rest either on solid coal, on pillars, or in mined-out areas.

4. The object of strata control is to reduce the loads in the working areas, so that these areas are safe for both men and equipment, and at the same time to provide sufficient space for maneuvering. To do this, it is necessary to maintain the strength of the subsiding roof mass over the face, and to keep breakage of the roof beds to a minimum, in the working area.

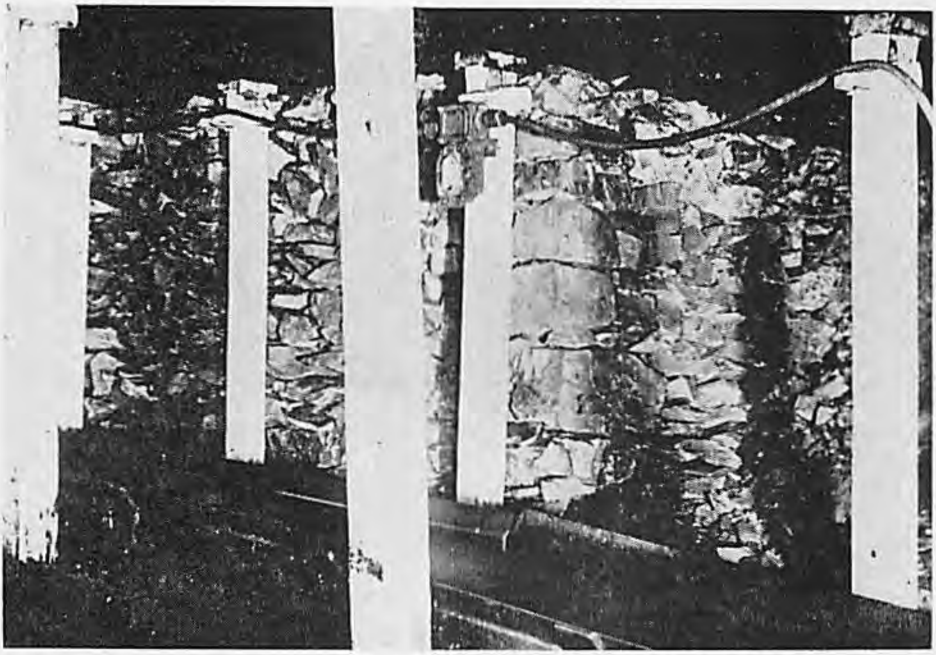
5. Artificial supports reinforce the strength and control the movement of the immediate roof beds and maintain space in the working area, but are completely inadequate to carry the enormous weight of the overlying strata. Therefore, it is essential that the workings be so designed that concentration of the main roof load is avoided in the working area.

These loads must be accommodated as concentrated abutment loads on the coal or in the excavated areas clear of the roadways.

Studies on the Pressure-Arch

Transfer of roof loads to abutments, to accomplish the above object, is the next step. When roadways are driven, the immediate roof beds bend downward to free themselves of the weight of the beds above. To prevent excessive bending and breaking of these beds, we set props or, in recent years, pin the roof. The result of any excavation is the development of a pressure arch, the abutments of which rest on solid coal beyond each side of the excavation. Since the advent of roof pinning, we are familiar with terms such as, bending, shearing, lateral compressive, and vertical compressive forces, which operate within and around the pressure arch. The distances over which the abutment pressures act depend upon the magnitude of this transferred weight, and the strength of the coal acting as an abutment or pier, and the strength of the adjacent strata.

As the width of an excavation is increased, there will also be an incr ase in the dimnsions of the pressure arch. When a width is reached which is greater than the beds are able to bridge and a fall of the overlying strata occurs, the width of the maximum pressure arch has been exceeded. Then the distribution of the load is more complex. In addition to the abutment pressures which act on the coal when the roof is intact, certain corresponding abutment zones are established in the exca-



Typical hand longwall pack

vated area as a result of the fall of roof. The width of the maximum pressure arch varies with depth. This width is influenced but slightly by local strata conditions.

As proof that a definite pressure arch exists, and the fact that its width can be predicted, consider, for example, conditions which exist on entries or roadways leading to advancing longwall faces. Roof conditions generally are good in these roadways for some distance back from the face. Beyond this distance, the roof begins to disrupt and disintegrate. As the face advances, the point of disintegration commences to move forward along the roadway in the same direction as the advancing face. This point of disruption indicates the position of the back abutment of the pressure arch which spans the face. The distance between the location of the back abutment and some point beyond the face in the solid coal is the width of the maximum pressure arch. The face, itself, is actually in a decompressed zone.

From observations made on longwall roadways, the following figures are submitted as conservative estimates of the width of the maximum pressure arch for various depths of cover. Notice that the width of the maximum pressure arch increases 30 ft. for every 200 ft. of depth.

Depth Feet	Width of Maximum Pressure Arch Feet
400	120
600	150
800	180
1000	210
1200	240
1400	270
1600	300
1800	330
2000	360

Keep in mind that the pressure arch exists not only from a point in the caved area to a point in the solid coal beyond the advancing or retreating face, but also to the solid coal on the rib side or to an excavated area. Therefore, the main roof load can be transferred over a distance not exceeding the width of the maximum pressure arch, and this furnishes us information for the design of mine workings. It is necessary to touch upon the behavior of coal pillars if we are to consider longwall retreating faces, which appears to be a practical solution for a new mining system in the United States. We know that the compressive strength of coal is infinite if lateral movement is absolutely prevented. It is axiomatic that when a coal pillar is formed, the sides of the pillar commence to fracture or spall and tend to move into the excavated area.

Friction between the coal in place and the roof and floor tends to oppose the movement and sets up lateral constraint. This constraint increases toward the center of the pillar. In any pillar sufficiently large, there will be complete constraint near the center, and the pillar will support any load which may be imposed upon it. It is evident that a large coal pillar will carry a much greater load than a number of small pillars of the same total area. It is also true that a square pillar will carry a much greater load than a rectangular pillar of the same area. Consequently, it follows that the width of a pillar designed to carry a particular load is a function of the maximum load, and, therefore, its dimensions can be determined by the widths of the adjacent rooms or entries.

Retreating and Advancing Methods

In a retreating longwall system, definite calculations can be made for the length of the face, for the width of entries driven to open the block of coal, and for the size of the entry pillars to support those roadways. In other words, we can design it, like an engineer designs a bridge.

In most British and European coal mines, longwall retreating faces are not practical, unless huge areas on either side of this face have been previously excavated by advance longwalling. Roof pressures are so great at their depths that it is next to impossible to prevent the collapse of entries driven into the solid. It is this difference in the depth of our coal seams and theirs which in our country makes longwall retreating systems practical.

In retreating longwall, trouble resulting from the back abutment pressure is eliminated—that trouble is behind us. It is true that the front abutment, which not only rests on the large block of solid coal, but also spans the roadways in advance of the face, may cause some trouble. The development of yield-pillar techniques will handle this and, in most instances, front abutment pressures can be transferred to the ribs.

On advancing faces, the coal must be transported through the wastes and the roadways must be supported by hand-packed walls. The roadways must be protected, in most instances, with steel arch girders. Pres-

View of Meco-Moore Cutter Loader

sures are so great in most of those workings that not only must the roadways be dug down several times a year, but a row of timbers must be carried within three ft. of the face. In fact, this is mining law in Great Britain.

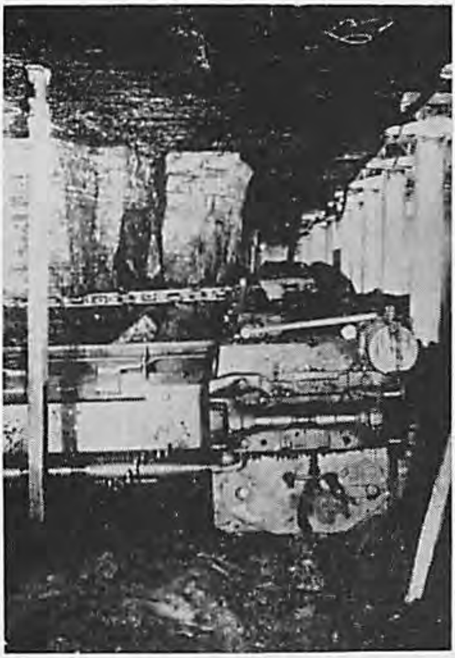
In all advancing workings where snaking-type conveyors, such as the German Panzer or the British Python, are not employed, the face transportation equipment must be "broken down," passed through the timbers and reassembled on the new face. All such manipulations account for the enormous amount of deadwork required on advancing faces, and for the dissipation of high face tonnage to relatively low tonnage per man in the working sections. I would judge that this ratio of nonproductive to productive labor on advancing faces is about 8-to-1. We have the opportunity in this country of reducing this ratio by the use of a retreating system to 2-to-1. This reference to ratios covers the work force in connection with longwall mining with machinery. I have given no considration in this paper to hand-loading longwall systems.

A Longwall Operation in West Virginia

There is operating today in the Crichton No. 4 mine of the Johnstown Coal and Coke Company in Nicholas County, West Virginia, on a 550-ft. face retreating, an Anderson-Boyes Meco-Moore cutter-loader. Operations commenced over a month ago. However, we had been preparing this section for three months and high falls had been effected immediately behind the crib row. This is the first machine of its kind in the Western Hemisphere. To my best knowledge, ours is the longest face (over one-tenth of a mile) on which any type of cutter-loader machine is operating in the United States. The development of the Meco-Moore has been a great pioneering effort in longwall working and the success achieved has established the value of mining and loading coal in one simultaneous operation from a longwall face. Seventy-nine of these machines are in operation in British mines as of this date, mining approximately 115,000 tons weekly and producing an average of 7.3 net tons per man shift on the section. The highest output per man shift the first four months of this year is approximately 13 net tons. Keep in mind that this latter result comes from a unit operating a longwall advancing face under more than 2000 ft. of cover. The output from the actual loading phase of the cycle is about 100 tons per man shift. The machine does not depend on coal cleavage or induced roof pressure on the coal face to assist it in producing coal.

The unit we are operating in the 38 to 42-in. Sewell seam in West Virginia produces at a rate of 80 tons per hour and production on the loading shift, if normal, is between 100 and 133 tons per man. We are just now training our crews for 24-hour operation, planning for four 6-hour face shifts with two loading shifts per 24 hours. Our goal, momentarily, is 25 tons per man overall on the section, which includes the entire crew of machine men, timber resetters, electricians and mechanics. We have continued to improve each day, but it is not possible at this stage to discuss the machine's application or operation with finality.

However, we do know that with a huge block of coal—some 1800 ft. long by 600 ft. wide—"opened" by conventional entry driving or American continuous miners and with long face chain flight conveyors for transporting to conveyor belts in the panel entries, we can establish a longwall retreating face. With such a system, our ventilation is greatly simplified over any system of room and pillar mining. Intake air is coursed up one set of entries, across the longwall face, and return down the entries on the opposite side of the block. Drilling and shooting is eliminated.



View of face directly behind cutter loader

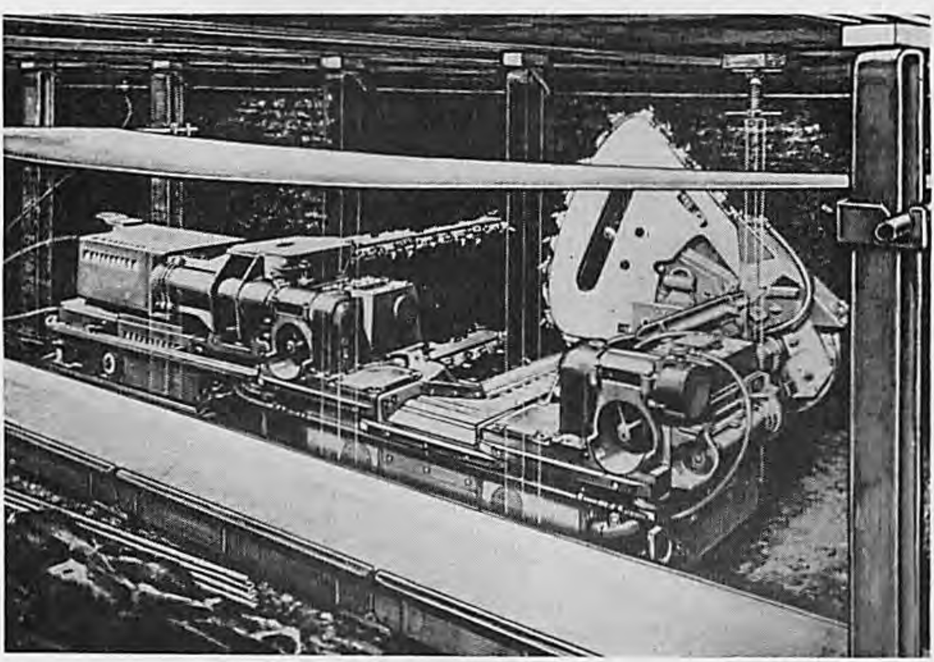
Roof Support and Face Conveyors

All timber used on this face is recovered. Hardwood crib blocks are placed on steel crib releases welded to a steel framework measuring two ft. square. All of this material is constantly reused. For added protection during our preliminary period, we are using 4- and 5-in. steel H columns, rounded on the bottom for easy removal with a sledge. A steel plate with crimped edges is welded to the top of the H column for softwood capping.

Our plans include a snaking-type conveyor discharging at one end only, so that we will need but one belt conveyor in the future to transport coal from this face. At the present, we are using two standard chain flight conveyors, tail pulley to tail pulley, which discharge at either end to another conveyor in the entry adjacent to the side of the block. From there a crosscut conveyor, one entry pillar length removed from the face, places the coal on 30-in. belt conveyors. In other words, half the face tonnage goes out one side, the remainder goes out the other. We are not disturbing the small entry stumps which act as yield-pillars to protect our roadways. Perhaps much of this appears overdone. No doubt we are over-designed and unduly cautious, but until a simpler and just as secure system finally evolves, we are taking all possible steps to safeguard our men and our equipment.

Our cribs are set approximately 6 ft. from the solid face and are on 5-ft. centers. This leaves a space of 3 ft. between the individual 2-ft. cribs, in which is placed a rigid steel H column. Our roof and floor are strong sandstone. The machine, which takes off a 5½-ft. web of coal, can advance along the face at a feed of 24 to 30 in. per minute. At maximum speed, the Meco-Moore produces coal at a rate of about 2 tons per minute. The machine pulls itself with rope drums in the same manner as a shortwall cutting machine, and a jack is set and reset every 40 to 50 ft. The only time lost on the face, except for periods when bad top is encountered which may require additional timbering, is for the resetting of the machine jack. Bad top conditions today are in the gob tomorrow.

One man operates the machine, another man precedes the machine to handle the power cable, and a third man places steel timber behind the machine on an exact line to which the face conveyor is moved preparatory to the passage of the cutter-loader on its return trip. Once the



Artist's view of loader in operating position

A longwall face after cleanup ready for new cut

conveyor is moved over to its new track and the cribs are drawn toward the face behind the conveyor the distance of one cut, the steel timbers are removed and reset on the gob side of the face conveyor. No timber is contained in the area between the crib row and the face, which is open to permit travel space for the Meco.

The Machine and Its Operation

This machine is powered by two 60 h.p., 440 volt, A. C. motors. It consists of two horizontal cutting bars, one at floor level and the other at approximately mid-seam level, which is adjustable to greater height by a hydraulic jack. A third bar for vertical shearing, in the form of a triangle, around which passes a cutting chain, cuts a 3 in. kerf at a distance of approximately 5½-ft. from the face side of the machine. This vertical shearing bar makes the new face. With the exception of the two 5-in. kerfs cut by the horizontal bars and the 3-in. kerf cut by the shear, very little fine coal is produced.

A fourth man may be needed in some coals to break up the large lump sizes produced between the two horizontal bars or between the top bar and the roof. In certain seams, it may be necessary for him to dislodge coal which clings to the roof.

Actually, what the machine is doing in its cutting operation is opening three sides of a cube of coal between the horizontal bars and two sides of a cube of coal above the top bar, a cube with two sides already open—the face and the end into which the machine is advancing. The weight of the cube of coal itself breaks it loose from the coal ahead in that portion of the seam between the two bars, and the top coal usually separates from the roof above and is held only by the coal ahead. As the coal falls to the floor, it is gathered by a rotating shaft containing teeth or picks. The shaft revolves adjacent to an inclined, slotted bar resembling a pocket comb, and the teeth of the rotating shaft turn through the teeth of the slotted blade. This causes the coal to be moved on an angle, upward, and is deposited on a slat-type belt conveyor about eight ft. long, which operates at right angles to the face. The face conveyor end of the slatted conveyor is elevated so that the coal can be discharged over the side of the face pan line. Two bugduster units gather the fine cuttings and elevate them for discharge, also, onto the face conveyor. The machine is equipped with water nozzles for wet cutting. But little dust is generated by the machine in operation.

Our tonnage results to date are inconclusive, although they are very gratifying with about 400 tons on some loading shifts. Against this tonnage must be charged about 25 men for 16 tons per man shift on the haulage. We have every reason to believe our labor force will be reduced to 12 men for the same tonnage, when our crews are trained, and when the cycle pattern is finally established. As to size consist, the face is producing a product which is 70 percent coarse over a $\frac{3}{4}$-in. round hole screen. We have already experienced a reduction in non-labor mining costs through the elimination of timber, drills, augers, explosives, brattice cloth, etc., which will exceed 30 cents per ton. The repair and maintenance cost of numerous conventional face equipment units is ended.

Acknowledgement

I would be very remiss not to mention and give fullest credit to the late M. S. Moore, the machine's inventor; to Mark A. Higgins, managing director of the Mining Engineering Company, Ltd. of Worcester, England, and his most able staff; to Forrest Anderson and Anderson-Boyes and Company, Ltd. of Motherwell, Scotland; to Robert Lancaster, Angus Duncan, Robert Snedden, Robert Colbert, William Rowell, engineers all, who have given valuable council and much needed encouragement; and to James A. Hayes, now assistant production director of the East Midlands Division of the National Coal Board of Great Britain, who contributed so much in making this machine a production reality.

In presenting this paper I humbly submit a new mining philosophy, a fundamental mining system, and a proved, trustworthy machine, all of which I hope will help further the interests of the American coal mining industry.

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SLOPE SINKING AT PEABODY NO. 10 MINE

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Planned methods and timing materially accelerated the completion of the initial development period for the shaft and slope sinking at the new Mine 10 of Peabody Coal Co., near Pawnee, in the western part of Christian County, Illinois. As a result, the mine will be in full scale operation before the originally scheduled date.

At the above location the Illinois No. 6 coal seam approximately 7 ft. 6 in. thick, under 350 ft. of cover, consisting of: 64 ft. of soil, sand, gravel and clay at the top; then about 8 ft. of limestone, with shale and rock down to the Herrin limestone immediately above the coal.

Set Goals

Specifications by the management for the mine and facilities included the following:

Capacity—13,200 tons per day from two-shift operation at the rate of 1000 tph.

Slope—16° incline with a 6-ft. wide belt compartment and an 11-ft. wide manway and track space, both 8 ft. high in the clear, 1242 ft. long to the coal level and an additional 260 ft. to the bottom of the lower hopper; a total length of 1502 ft.

Air Shaft—Vertical 15-ft. diam circular, concrete lined shaft 350 ft. deep.

Surge Hopper—1000 tons capacity at the foot of the slope.

Coal Haulage—All belt, consisting of 36-in. room panel belts, 42-in. sub-main belts, 48-in. mother belt, 60-in. shuttle belt over the hopper, and a 48-in. steel cable reinforced belt up the slope.

Bids were obtained and a contract was awarded to the Dravo Corporation to sink the air shaft and to construct the concrete portion of the slope from the surface through the unconsolidated material and upper limestone to a vertical depth of 80 ft., or a slope distance of 314 ft. From past experience, it was decided that the coal company forces could drive the rock portion of the slope most economically.

A view of surface plant showing portal location and tipple construction

The contractors estimated time for sinking the air shaft was four months, while the time required for the concrete portion of the slope was 9½ months. This schedule would delay production 5½ months if the slope were driven only from the top down. Consequently, it was planned to drive in coal from the bottom of the air shaft to the slope

Accurate surveying insured exact meeting points

Slusher bucket drags rock into loading machine which in turn discharges into shuttle car

and work the slope both up and down from that point until driving in the rock could be started at the top. Thus, the slope was worked from three points.

Sinking the Air Shaft

The work was planned and performed so sinking the air shaft was started in January 1951 and it was taken over by Peabody in June. After the shaft was completed, temporary skips and hoist were installed. Development was started with three six-man crews driving toward a 26-in. drill hole which had been sunk previous by a contract oil drill rig. This hole was approximately 300 ft. west of the air shaft. It was cased and grouted so that it would be dry. On the surface blowing fan was installed temporarily and a stacker cage rigged up; this provided the second escape-way prescribed by Illinois State Mining Laws when more than 20 men are working coal mine development. After the development period, when this hole is no longer needed for ventilating purposes, an exhaust fan will be installed over it to remove dust from the dump hopper.

The coal produced during this period was hoisted in two counterbalanced 2½-ton drop bottom skips with rope guides which dumped the coal directly into railroad cars on the surface. In this manner 1500 tons per day could be mined. It was possible, thus, to mine out an area adjacent to the slope bottom sufficiently big to gob all of the slope and bottom hopper rock. This eliminated the expense of rock hoisting, which would have been a large item, and also permitted marketing the development coal.

View during construction showing track and belt compartments

Rope guides were used in the shaft so that they could be easily removed when lowering large equipment, like loading machines and shuttle cars.

Entries driven from the air shaft reached the point where the coal and slope intersected on August 25, 1951. A two-drum 75 hp electric hoist was installed at this point to raise and lower material and equipment up and down the 16° slope.

Slope Driving Up Grade

Driving the slope upward was then started. The rock face was drilled with three hand-held Sullivan air hammers and shot with 60 percent dynamite, using eight different types of delay caps.

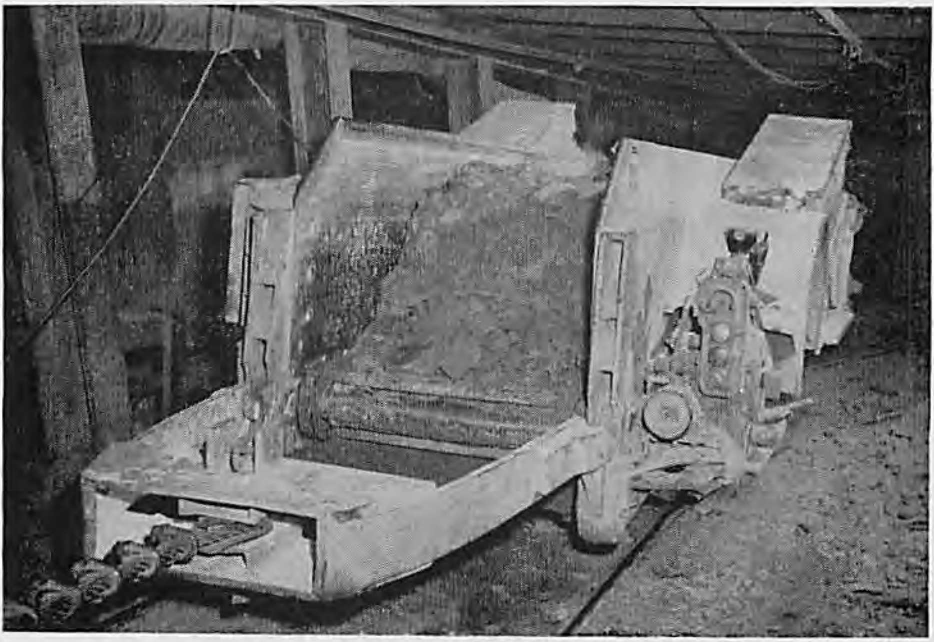
Broken material in the first 40 ft. of the slope from the coal intersection up was loaded by a Joy machine into a shuttle car. Here it was found that this equipment could no longer be used, so a Joy three-drum slusher mounted on a loading machine head was placed in the slope. The slusher bucket dragged the rock into the loading head which served as a surge bin for the shuttle car. By this time 30-lb. track had been laid behind the slusher so that a car could be run up and down the track pulled by the 75 hp hoist. The car was made from a battery driven shuttle car with the rubber tires replaced with 12-in. track wheels. The slusher was anchored each time it was moved toward the face to four 2½-in. pins sunk 3 ft. into the bottom.

Roof Support

It was found that legs could not be used to support the 120-lb. railroad rail cross bars which were set on 24-in. centers for timbering the slope, because they interfered with the slusher. Consequently steel pins were placed in two 2½-in. holes drilled three ft. into the rib. Across the top of the pins were placed four by four-in. pieces of oak board on which were set the 120-lb. rails. When the face advanced 100 ft., the slusher was moved up and temporary center props placed under the steel rail cross bars behind it.

Permanent timbering consists of 10 in. H-beam stringers on each rib and another line of 10 in. H-beam stringers six ft. from the north rib of the slope. This separates the belt and track compartments of the slope and adds to the center support of the cross timbering. Under these stringer beams are legs made up of two 120 lb. steel rails placed back to back; these are set on eight-ft. centers and welded to the stringers. To keep the legs from cutting into the bottom, a half-in. steel plate, one foot square, is used as a mud sill. Two 2½ in. holes are drilled through this plate and into the bottom three ft. deep for steel anchor

Shuttle dumps into the glory hole



Track mounted shuttle car hauls material to top of glory hole

pins to keep the mud sills from moving down the slope. Then all of the stringer beams, steel legs, mud sills and pins are welded together.

After the slope had advanced 75 ft., it was decided that hauling the muck to the bottom was too slow a process, so starting from the coal level a glory hole was driven up to the bottom of the slope. This glory hole was six ft. in diam and 18 ft. deep. Track was then placed across the top so that the shuttle car could dump into it as a storage bin. Mucking operations could then move along more continuously. At the bottom of the glory hole, a counter-weighted gate was installed. A shuttle car could open the gate, receive its load of muck, which was then taken into gob rooms and dumped.

On the first and second shift there were two eight-man crews and on the third a four-man crew for maintenance.

After the beam timbering was completed, the first two-in. flash coat of gunite was applied. Tie-wires were placed in the flash coat and the gunite allowed to harden. Then a reinforcing wire of four by six-in. mesh, six ft. high, was placed along the sides of the slope and covered with a three in. coat of permanent gunite. This was done to keep the shale ribs from air-slacking. The gunite machine was a jet-crete type. Its nozzle could be operated some 400 ft. from the machine. It took three men to perform this operation, one at the machine preparing the mix and feeding the machine, one at the nozzle, and one cleaning.

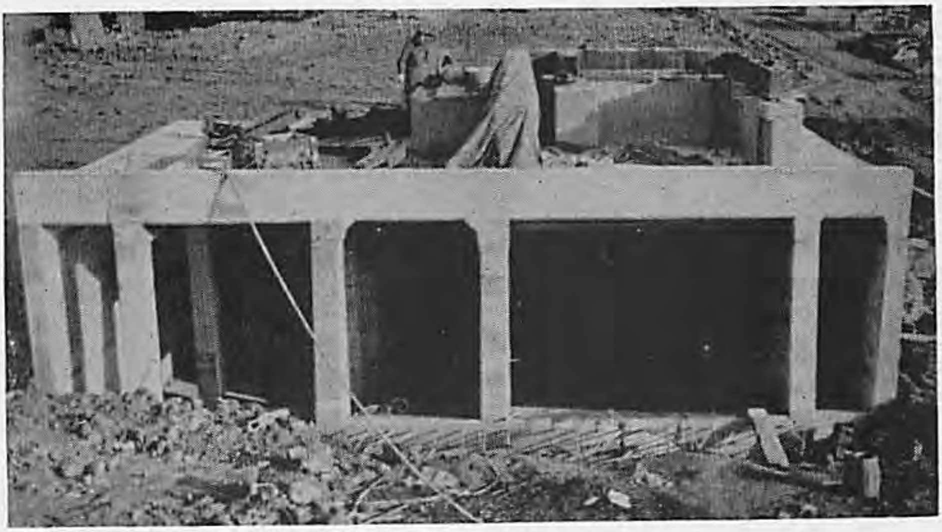
By this method, the slope was driven up grade at an average of 7.34 ft. per day.

Top Caissons Sunk

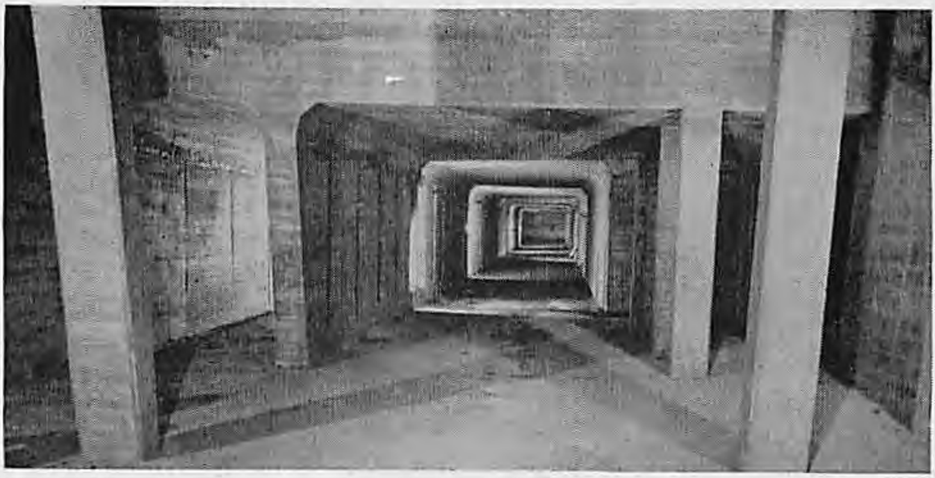
In the meantime, Dravo Corporation proceeded with their proposed method of constructing the upper concrete portion of the slope. Through the soft surface strata they sank three reinforced concrete caissons so arranged that the slope would be concreted into the base of these structures.

Merits of this method of construction are: (1) the surface ground was disturbed very little beyond the width of the slope. Nearby buildings were constructed on simple spread footings and were built while caisson sinking was still in progress. (2) The exact break-under location did not need to be determined until satisfactory rock was located within the test pit. (3) Strata of wet, running sand encountered during the sinking were cut off as the caissons dropped and caused no further trouble. (4) The large caisson, firmly seated upon rock, protects the transition section of the slope from earth pressures which might otherwise be excessive.

The first caisson, 107 ft. long and 28 ft. wide, was sunk at the brow-under point until its cutting edges bore uniformly on rock. Inspection of the underlying rock from a test pit excavated beneath the caisson disclosed a satisfactory location for making the transition from open cut to tunnel construction. Working from the end wall of the caisson downward to this point in short sections, excavation was made and the concrete floors, walls, and roof of the slope poured. Using steel beams to support the rock overhead, several feet of tunnel were driven and lined with concrete.



View of portal looking down slope



The completed slope is thoroughly modern in design

With location of the slope thus established, work on the other two caissons, closer to the portal, each 38 ft. long and 26 ft. wide, was started. These caissons were formed so the slope passed through them near their bottoms and each was sunk to a pre-determined elevation. To prevent any future settlement, a concrete seal three ft. thick was placed under each of these caissons.

The three caissons were separated by four-ft. spaces and, after all sinking was completed, steel sheet piles of arch-web sections were driven between the corners of adjacent caissons thus closing off the ends of the four-ft. wide openings. The small cofferdams thus formed were excavated to a depth of three ft. below the slope floor, the sheet piles being braced as excavation progressed. Short beams spanning recesses were left in the caissons. Holes slightly larger than the slope were blasted through the end walls of the caissons and the concrete construction of the slope within the first caisson was extended through both smaller caissons and closure cofferdams. From the last caisson to the surface, a short section was built within steel sheets and the remainder in open cut. Incorporated in the portal section was a mantrip loading platform and foundations for the main hoist and motor-generator set.

The design and method of building the concrete caissons were generally similar for all three. Each was rectangular in plan with the outside surfaces made as smooth and true as practicable. Steel cutting edges were provided at the bottom of, and flush with, the outside surfaces. The lower six ft. of the outside walls were wedge-shaped, the inside faces sloping upward and inward from the cutting edge. As a result of this shape, earth, sheared off by the cutting edge as the caisson sank under its own weight, was rolled towards the center of the six-ft. high "work chamber." Vertical holes—approximately 10 ft. in diameter and spaced

Construction Summary

	Length in Ft.	*Days*	*Average Ft. Per Day*
Air shaft	350	106	
26-in. drill hole	420	10	
Driving in coal	529	44	
Caisson work	314	224	
Driving slope up	778	106	7.34
Driving slope down	151	21	7.19

evenly—were left in the caissons. Through these holes (16 in the large and six in each of the smaller caissons) material was excavated from beneath the caissons by means of 1½ cu. yd. clamshell buckets handled by full-revolving cranes. Forms were fabricated to be usable in all caissons with only minor alterations.

Slope Driving From Top

The upper concrete portion of the slope (314 ft. long) was completed by the contractor on December 7, 1951, and Peabody crews started driving down by methods similar to those mentioned above to meet the slope being driven up. Loading of the muck was done with a Joy loading machine. To keep the machine from crowding into the face too fast a Brown-Fayro car puller was set 100 ft. back from the face with the rope tied to the bumper of the loading machine. The machine helper used a pull-cord switch at the face to operate the hoist. Muck was loaded into a track-mounted shuttle car, which was pulled to the outside by a temporary hoist with 100 hp motor. The muck was dumped into a 75-ton rock bin set so a truck could back under it to receive its load.

Timbering and drilling driving down the slope were done in the same manner as driving upward. In going down, roof bolts were used where there was good rock in which to ancher. The bolts were put on four-ft. centers, which made six bolts across the face. This prevented over-break in the top.

Immediately after leaving the caissons, a sump three ft. deep was dug on the south side of the slope and a concrete ditch poured across the slope to catch the surface water that came down. In driving up and down, very little water was encountered.

The upper and lower portions of the slope holed through on January 12, 1952, 778 ft. from the coal level and 465 ft. from the portal.

Plan Slope Belt

The 48-in. steel cable reinforced belt to move the coal up the slope will be 1729 ft. between centers, with a vertical lift of 476.5 ft. and a speed of 475 fpm. It was decided to use three 250-hp motors connected to a tandem drive placed on the ground surface at the portal, rather than one large motor drive for this belt. This would eliminate construction of a heavy support for the drive and also make installation and repairs more convenient.

A belt splicing and repair housing will be built along the belt structure just above the drive, to provide a convenient and safe place in which to work. To reduce belt abrasion the coal will be fed out of the bottom of the 1000 ton bottom hopper and placed on the belt with two Syntron feeders and a speed-up belt 48 in. wide, 47 ft. between pulleys.

By planning and timing so several phases of the work could be done concurrently, it was possible to complete the shaft and slope in 12 months; drive development entries and at the same time obtain revenue from coal mined during the construction period.

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BREAKING COAL AT FACE WITH CHEMECHOL

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One of the most healthy signs in the coal industry today is the keen interest shown by all operators in new ideas and developments. The present large attendance at the Coal Show is concrete evidence of this interest. Your ready acceptance of new things has led to aggressive and forward looking research by most manufacturers associated with the coal industry. As a result, tremendous strides have been made in recent years in the development of modern preparation plants, haulage methods, and new machinery and equipment used for mechanization of the mines.

The Du Pont Company likewise has conducted a comprehensive research program directed toward new and better products for breaking down coal. As a result of this program, a new nonexplosive device called CHEMECHOL has been developed to a point where extensive trials have been conducted during the past year. This product has a number of unusual safety features, yet so far as cost studies to date are concerned, should produce coal at an overall cost comparable with several other mining methods now in use. This paper gives the background on events leading to the development of Chemechol, a resume of results to date, and the future prospects.

History

The Du Pont Company decided during the 1920's to direct its development work on the breaking down of coal along two lines. First, to formulate permissible explosives which could give optimum breakage and yet have adequate sensitiveness and water resistance, and second, to investigate each suggested nonexplosive method of breaking down coal with the idea of selecting one worthy of extensive development and eventual sale. In following each of these lines, obviously safety was considered paramount, but it was recognized fully that safety alone would not insure a broad application of any substitute for permissibles. Such replacement must be adaptable to modern coal mining practices, must produce increased proportions of coarse coal, and must be little or no more expensive than permissibles.

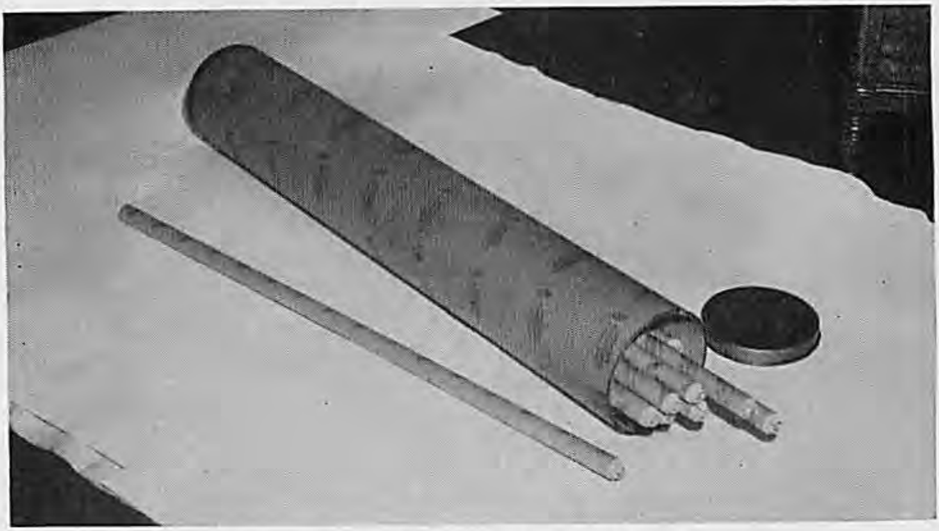

Fig. 1. A drum containing Chemechol units packed for shipment

Literally, thousands of permissible type explosives were formulated and tested, some on a laboratory scale only, and many others in the field. On the whole, the permissibles which have been developed and marketed over the past forty years have served their purpose very well and have provided the coal operators with an economical and a relatively safe means of producing coal. In this latter connection it should be emphasized that the United States Bureau of Mines' records show that during this entire period of over forty years, permissible explosives have never been responsible for a single underground gas or dust explosion when these explosives were used in the manner prescribed as permissible by the Bureau.

In spite of the foregoing, it must be admitted that during the period under review, there have been a relatively small number of underground gas or dust explosions involving permissible explosives, the investigation of which established that in each instance there were one or more violations of permissible usage regulations. During this period also there have been reports of mine fires involving permissibles. Most of these mine fires have been due either to insensitive permissibles or to improper methods of priming and charging. We have been able to virtually eliminate the first of these two causes by improved formulation, but progress in the second involves a program of education which has been and will be slow to bear fruit.

Considering the above limitations of permissible explosives, all concerned recognized the desirability of finding a nonexplosive method of breaking down coal which would produce the required breakage, present the maximum in safety, but at the same time, taking all facts into consideration, be economical for the operators to use. It appears to be a foregone conclusion that because of the high efficiency of permissible dynamites there are many coal operations where, due to the nature of the operation, no satisfactory substitute is likely to be found.

Studies on Non-Explosive Devices

The first non-explosive product developed by Du Pont was called "The Hydraulic Mining Cartridge" and this device was given extensive trials in the late 1930's. Essentially it consisted of a heavy rubber tube enclosed in an expandable steel wire braided casing with special end closures. The tube was placed in a drill hole and expanded by oil pressure. Although this method was outstanding from a safety standpoint, it proved to be impractical because (1) the maximum pressure was about 3,000 pounds per square inch, thus necessitating an excessive number of boreholes, (2) drilling and breaking difficulties were encountered in mines with a rock top, and (3) the coal, in many instances, was too large to be handled properly by the loading machines.

Combining our studies with investigations of other well known methods utilizing carbon dioxide or compressed air, we arrived at the conclusion that the ideal method of breaking down coal would incorporate the following requirements:

1. The product to be non-explosive in all respects, and to eliminate the use of electric squibs or electric blasting caps.
2. The method should eliminate high pressures in tubes or lines outside of the borehole.
3. The reaction should not emit a spark or a flame.
4. The gaseous products of the reaction to be non-noxious.
5. It should eliminate any possible disaster hazard, even if the product was misused.
6. It must produce the breakage desired in modern mines.
7. The device should be economical and convenient as compared to other methods.
8. The device would have to meet the legal requirements of certain states for on-shift use.

Our laboratory undertook in 1945 a special fundamental investigation of the decomposition of a series of chemical compounds in the hope of explaining certain phenomena which had occurred from time to time during manufacture of these chemicals. This investigation was broadened and intensified in 1947. The results of this fundamental study and our determination to develop a method of breaking down coal involving as nearly as possible the eight requirements listed above brought about a broad research program leading to the product now known as Chemechol.

Description of Chemechol

This method breaks down coal from the mine face by the force of compressed gas generated by a chemical reaction within a steel tube and released through a rupture disc. There are three main components to the device:

1. The Chemechol unit itself, which is decomposed to furnish the gaseous products which do the work.
2. The steel tube in which the reaction takes place.
3. The battery controller by means of which the chemical reaction is started.

The unit consists of somewhat over 1¼ pounds of a chemical mixture packed in a rigid paper shell 1 in. in diameter by about 40 in. long.

Fig. 2. First step in assembling the unit

These units are packed in fiber drums and shipped in the category of ordinary chemicals. Storage may be in any convenient place with two limiting conditions. First, the storage should be dry and well ventilated. Second, the units should be stored in a separate room or building from other material since Chemechol can be rendered worthless by being mutilated by heavy objects or contaminated by grease or oil, etc.

A single unit and a drum packed for shipment are shown in Fig. 1: This unit contains a Nichrome wire embedded in the mixture towards one end. When a current of 6 to 9 amperes is passed through the Nichrome starter wire, the chemical reaction is initiated. The two ends of the wire are fastened to an adapter plug which closes one end of the paper tube. This adapter is so constructed that when the unit is thrust into the steel tube it not only automatically makes the desired electrical contact but it is also held firmly in position by a novel seating device.

The gaseous products produced when a unit is discharged consists of approximately 50% steam, the remainder being substantially nitrogen and carbon dioxide. The noxious gases produced are only about one-fifth of the upper limit of Class A permissible explosives as defined by the United States Bureau of Mines, and are substantially less than any permissible explosive our company has yet been able to produce.

Fig. 3. Attaching the discharge end of tube

The steel tube used thus far is approximately 54 in. long and $2\frac{5}{16}$ in. in diameter. One end is closed by an electrical plug equipped with terminals through which the electrical current is supplied to the Nichrome starter wire. The other enclosure is the steel shear disc which is held in place by a head provided with parts for discharging the gas. The over-all length of the assembly, less electrical cord, is about 5 feet and the total weight is about 35 pounds.

The original model of the tube has undergone many successive design changes which have been made to increase the life of the various parts and facilitate loading and servicing. Shear discs of various materials have been tried. At present a steel shear disc 1.72 in. in diameter and 0.135 in. in thickness is preferred. These discs shear at a pressure of 18,000 to 22,000 pounds per square inch, the shear pressure depending upon the particular lot of discs and upon the sharpness of the inside edge of the discharge head. If desirable for certain coal mines, the discharge pressure can be varied within wide limits by using shear discs of different thicknesses.

Initation of Chemechol

The battery controller used to initiate the reaction consists of a 36 volt lead acid battery together with a controller for regulating the current flow. A current of about 6 to 9 amperes for a duration of approximately 7 seconds is required to start and to insure completion of the chemical reaction. Low voltages or amperages are incapable of starting the reaction, thus making initiation by stray ground currents virtually impossible. Ignition by conventional type blasting machines is impossible because of their short current duration. Furthermore, the chemical reaction cannot be started by high currents caused by high voltages, such as 250 volts D.C., commonly used for mine haulage and machinery because the Nichrome wire burns through too rapidly to impart sufficient heat.

The battery controller unit was designed with safety as the primary consideration. The following features are included:

1. The proper range of current is delivered to the unit.
2. The voltage and current are automatically cut off from the leading lines before the disc ruptures, and hence before any fall of coal.
3. The voltage and current are automatically cut off in the case of an overload or short circuit in the leading lines.

In actual practice underground the miner usually first assembles sufficient tubes for all of the holes in the face and then places a tube in each hole. The discharge end of the tube is located about 6 in. from the end of the hole. The miner then makes an electrical connection from one tube to the leading wire from the battery controller. The tube is then initiated at the controller station located around two corners from the face. The leading line is always unplugged at the controller when the miner is at the face. As a matter of convenience we have found it possible to make multiple connections and discharge several tubes in proper sequence one at a time before returning to the face. The operations of assembling the unit and placing it in the hole are shown in Figs. 2, 3, and 4. Fig. 5 shows a typical coal fall.

Trials and Tests Underground

Most of our experience to date has been conducted at several mines in Illinois, at a property of the Freeman Coal Mining Company, and at properties of the Peabody Coal Company. Our principal experience has been in the Lida B Mine of the Franklin County Coal Corporation, where Chemechol has been continuously used since March 1951. We have had wonderful cooperation with these companies and we wish at this

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DENSE MEDIA SEPARATION BY TROMP PROCESS

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The initial installation of Tromp bath equipment within the United States was placed in operation during December 1951 at mine No. 22 of the Old Ben Coal Corporation, Valier, Illinois. It consists essentially of five McNally-Tromp bath units for preparation of the 6 x 2 in. and 2 x $\frac{5}{16}$ in. sizes with the $\frac{5}{16}$ in. x 0 fine coal cleaned in Rheolaveur launders. The American adaptation of this process is known as the McNally-Tromp Heavy Density Cleaning System, due to its development by the McNally Pittsburg Manufacturing Corporation.

The preparation plant was designed to accommodate a raw feed of 800 tons per hour. Hoisting or foreign coal delivery may provide a total of 850 tons per hour. The surplus will normally be retained in the blending bin to avoid need of suspending washery operation in event of limited interruption in delivery. Raw coal input may be delivered by skip hoisting from No. 22 Mine with the opportunity of providing a part or all of the feed from other mines. Foreign coal is received in railroad hopper cars and delivered to a dump pit equipped with a car shaker, feeder and belt conveyor extending to the hoist shaft tipple.

The first step in the preparation process is to reduce the primary feed to a 6 in. diameter top size. The 6 in. x 0 raw coal is delivered to an 800 tons capacity blending bin, divided into four compartments with control facilities for optional delivery to any section. Protection is afforded by automatic change in event of filling any sectional compartment. Withdrawal feeders from each of the four bin sections, are equipped with individual vari-speed drives. Controlled removal provides a blended assembly for delivery to the preparation plant.

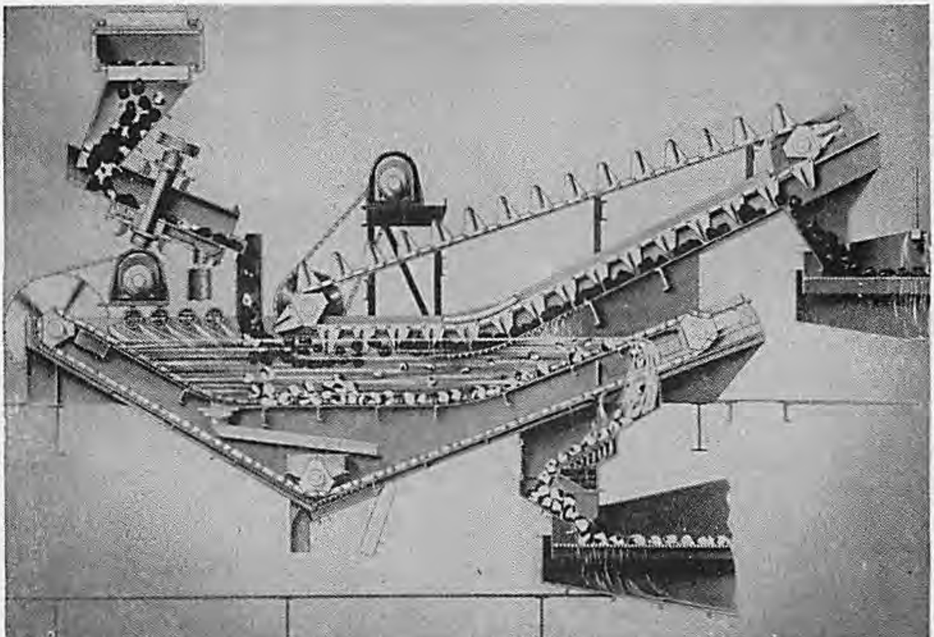
General Flow Plan

Primary separation is made within two coarse and two small coal bath units. Secondary separation of the primary sink material is made in a single bath unit. It provides a float product or middlings as crushed and recirculated. Raw coal screening can provide 312 tph maximum of 6 x 2 in. coarse coal with subsequent delivery to the two, 8 ft. wide McNally-Tromp bath units. Primary separation of the coarse coal is made at 1.36 Sp.G. of heavy density media within each bath. The cleaned coal is rinsed, drained and classified for continuous loading as 6 x 3 in. and 3 x 2 in. Facilities are available for optional reduction to provide 2 or 1½ in. crushed screenings. The general arrangement of the heavy density bath units is shown in the accompanying sectional view.

Four vibrating screens remove the $\frac{5}{16}$ in. x 0 and provide 2 x $\frac{5}{16}$ in. raw coal in the approximate amount of 256 tph. Crushed middlings are recirculated and increase the division to a maximum total of 286 tph. Cleaning follows in two, 8 ft. wide, McNally-Tromp bath units. The 2 x $\frac{5}{16}$ in. feed to the small coal bath is separated at 1.43 Sp.G. The cleaned coal is rinsed, drained and classified before delivery to the washed coal bins. Measuring feeders under these bins enable blended assembly for prescription loading.

The 1 x $\frac{5}{16}$ in. portion of the sink material is delivered to the refuse surge bin. Low ash coal adhering to bony material does not suffice to warrant separation of the middlings product from this size division. The 2 x 1 in. portion of the small coal sink material is assembled with the 6 x 2 in. sinks from the coarse coal bath units. The 6 x 1 in. assembled sink material is delivered to a single, 6 ft. wide bath for recovery of a middlings product. Heavy density separation is made at 1.60 Sp.G. with the sink material passing to refuse.

The float or recovered middlings is crushed to 1½ in. x 0 to free the salable coal from adhering bony material or shale. Recirculation is provided by assembly with the raw coal passing to the blending bins. The $\frac{5}{16}$ in. x 0 fine coal is prepared in duplicate, parallel Rheolaveur launders.



Sectional view of McNally-Tromp heavy density bath unit

Each unit consists of four launders, the top decks of which are divided into three 14 in. lanes.

Variation from the usual arrangement is provided by inclusion of a secondary return to supplement the primary regulation material. Advantage is provided by the resultant opportunity of improved separation and delivery of a more uniform product. The plus 1 in. refuse is crushed to 1¼ in. x 0 and assembled with the 1 in. x 0 refuse for hydraulic disposal.

Heavy Density Performance Data

General interest appears centered to a considerable extent in the separating performance provided by the McNally-Tromp heavy density bath units. A summarized comparison is available with respect to earlier hydro separation of similar raw coal from the same source of supply in a Baum

Cleaned Coal		Primary Sinks	
Sp.G.	%	%	Sp.G.
+1.46	0.01	0.0	-1.26
1.46 x 1.44	0.01	0.0	1.28 x 1.26
1.44 x 1.42	0.04	0.03	1.30 x 1.28
1.42 x 1.40	0.02	0.10	1.32 x 1.30
1.40 x 1.38	0.64	0.43	1.34 x 1.32
1.38 x 1.36	2.24	0.93	1.36 x 1.34
	2.96	1.49	
-1.36	97.04	98.51	+1.36
Total	100	100	Total
Approx. R.C. Ratio 70.2%		29.8 %	
Total Misplacement = 2.52% of Raw Feed			

Table I—Coarse coal bath misplacement curves 6 x 2 in. Separation at 1:36 SP GR, April 3 through April 21, 1952 jig washer. Heavy media separation in the small coal bath units has provided a cleaned product with around 1.5% less ash, together with a small increase in recovery. Operation in December 1951 was limited to four part days as followed by raw coal input with a 3 in. top size throughout January and February 1952.

Delivery to the coarse coal baths consisted of 3 x 1½ in. raw coal during early operation. Washability tests indicate 82.6% of this material to be within ten points above and below 1.36 Sp.G. where separation was desired. Gravimetric analyses of the cleaned coal showed an average of 5.90% sink material from 59 tests during January and February 1952. Occasional tests proved the misplaced product to be near gravity material. Ash analyses confirmed this indication by the average finding of 7.46% on a dry basis. Washability data show slightly less ash in the raw coal float at 1.36 Sp.G. where separation was intended.

Delivery of mine run coal to the new plant began in March 1952. Subsequent feed to the coarse coal baths consisted of 6 x 2 in. material. Detail washability data are not available for the plus 3 in. material. Progressive increase through the smaller sizes and the trend shown for adjacent mines, insure increase over the ratio of near gravity material in the 3 x 1½ in. division. Gravimetric tests showed an average of 5.22% sink material in the cleaned coarse coal during the first month after change in the top size. Improved operation has accompanied later changes and adjustment.

Operation during the period April 3 through April 21 disclosed 2.96% average sink material in the cleaned coarse coal when the under product or primary sinks contained 1.49% of float. Total misplacement amounted to 2.52% of the raw feed. Table I presents detail data relative to the character of misplacement within a coarse coal bath unit as shown to be near gravity material for the most part. Misplaced material with a specific gravity above 1.40 and below 1.32, as beyond a four point range from the intended division, provide a total of (0.095% or) less than one tenth of one percent of the raw feed input.

Operation of the small coal bath units during the first two months of the current year was accompanied by 121 gravimetric tests for plant control and adjustment. The cleaned coal carried an average of 5.32% material sinking at 1.43 Sp.G. where separation was intended. Misplacement during the same period totaled 5.06% of the raw product delivered to the small coal bath units. Raw coal input within this size division contained 33.9% of material within ten points above and below the gravity of intended separation. This ratio would be increased by recirculation of crushed middlings. Changes and adjustment enabled reduction of misplacement in the small coal bath units with a total of 3.19% in March 1952, when the clean coal sink material averaged 2.04%.

The average ash content of the cleaned product from the small coal baths during the months of January, February and March varied between 0.46 and 0.53% above that of the raw coal float at the gravity of intended separation. Extent of this increase is due in part to change in the character of product delivery when including the recirculated crushed middlings.

Table II applies to the period April 2 through April 21 and shows detail data regarding the character of misplacement in both the cleaned coal and primary sink material from the small coal baths. Misplacement amounted to 3.85% of the raw coal feed with concentration of error in close proximity of the intended gravity of separation. Exception is alone provided by misplacement in the 1 x $\frac{5}{16}$ in. portion of primary sink material. This finding appears characteristic of heavy media separation wherein the range of misplacement is increased within the small sizes. Early reduction of coal loss is expected.

Product Control

Detail performance data are not available for separation in the middlings bath. Daily operating tests have been limited to finding the ratio of float loss in the final reject assembly from the heavy media circuits. Exclusive of the $\frac{5}{16}$ in. x 0 material, we found 4.13% of the crushed refuse to float at 1.43 Sp.G. during the period from April 3 to April 21. Product control warrants a moderate loss of coal adhering to the sink material from the middlings bath. Recovery would otherwise increase the ratio of high ash bony material passing to the Rheolaveur launders from recirculation after crushed reduction.

Cleaned Coal		Primary Sinks		
Sp. G.	%	% 2x1	% 1x$\frac{5}{16}$	Sp. G.
+1.53	0.13	0.11	3.26	-1.33
1.53x1.51	0.12	0.05	0.81	1.35x1.33
1.51x1.49	0.29	0.12	0.99	1.37x1.35
1.49x1.47	0.52	0.22	1.05	1.39x1.37
1.47x1.45	1.11	0.55	1.12	1.41x1.39
1.45x1.43	1.17	1.21	1.99	1.43x1.41
	3.34	2.26	9.22	
-1.43	96.66	97.74	90.78	+1.43
Total	100	100	100	Total
Approx. R.C. Ratio 80.3%		9.3%	10.4%	
Total Misplacement: 3.85% of Raw Feed				

Table II—Small coal bath misplacement curves 2 x $\frac{5}{16}$ in. Feed and separation at 1.43 SP GR, April 2 through April 21, 1952

Heavy density separation in the McNally-Tromp bath units show sufficient improvement over hydro cleaning to necessitate revised thought regarding the difficulty of division. Consideration of the raw feed volume within a range of three or five points from the specific gravity of the intended separation, appears pertinent in evaluating the attendant difficulty. General thought in the past anticipated separating performance on the basis of material ratio within ten points of the intended division. This range appears to extend well beyond the limits which are applicable to the equipment under review.

European development of the Tromp bath was principally directed toward a three product separation. Six units of this type were inspected by the writer in France, Belgium, Holland and England during the early part of 1950 when a total of 23 units were reported in operation.

The McNally-Tromp heavy density cleaning unit is, instead, designed for a two product separation which has also received some attention in Europe. Initial operation was attended with those difficulties normal to a new development. Improvements found to be needed or advantageous have been incorporated in each of the five units under review.

Heavy density of the separating media is provided by the use of fine magnetite. Local grinding provides reduction with around one or two percent plus 80 Mesh and near 70% of 200M x 0. Magnetite recovery from the rinse water is secured by hydraulic classification. Operation parallels the European practice in connection with Tromp bath separation, in contrast to general use of magnetic recovery in the United States. The washed coal, middlings and refuse are rinsed successively by a mixture of dilute media, clarified water and fresh or makeup water for removal of magnetite. The assembled drainage provides a dilute media as recirculated in part for subsequent rinsing.

The major portion of the dilute media is delivered to a revolving screen and a circle throw vibrating screen for separation at 80 Mesh. The oversize material is assembled with the fine coal and delivered to the Rheo launders. The 80M x 0 through product is passed to duplicate 18 ft. diameter settling cones for a classified separation of magnetite from the coal and slimes. The gravity differential between the 5.0 to 5.2 Sp.G. ore and the expected average of around 1.50 for the coal and slimes, facilitate acceptable separation.

The solids content in the water overflow passing to waste, averaged 2.61, 2.54 and 2.61% during the first three months of 1952. Daily tests show operation within narrow limits of the average findings. An optimum solids ratio will afford protection against undue loss of magnetite in the recovery circuit. Additional experience is required to determine the basis of operation for maximum economy. Pneumatic lifts control the rate of thickened magnetite withdrawal from the apex of both recovery cones. A limited amount of fine coal, approaching an 80 Mesh top size, is normally included in the concentrate without evidence of handicap. Media recovery with a density of 1.50 and 1.60 Sp.G. is returned to the bath circuits with the heavier portion being directed to the Middlings bath. Media with a lower weight is returned by the automatic regulators to the recovery cones for further thickening.

Initial operation entailed an excessive magnetite loss due to accident and other difficulties. Usage amounted to 2.20 pounds per ton of raw coal input during the succeeding period through February 29. Allowance for the approximate tonnage of recirculated middlings would provide an average loss of 2.00 pounds per ton delivered to the primary separating bath units.

The top size of raw feed delivery to the heavy media units was increased from 3 in. to 6 in. throughout the month of March. Magnetite loss during the month was reduced to an average of 0.89 pounds per ton of raw coal delivered to the bath units. Allowance for the estimated volume of recirculated middlings would provide an average magnetite loss of 0.81 pounds per ton of feed input to the coarse and small coal bath units. Reduced magnetite loss appears largely due to change in the surface area of the raw feed when including the 6 x 3 in. with the plant input. Changes and improved operation provide contributing factors. Plant input amounted to 46,370 tons to insure acceptable accuracy of the indicated data.

Magnetite Handling and Recovery

Magnetite ore is purchased as an approximate 20 Mesh top size product. Bulk shipment is made in open top cars. A monorail mounted traveling crane equipped with a clam shell bucket is used for unloading and for movement from a 300 tons capacity storage bin. Grinding facilities include a batch hopper, feeder, ball mill, centrifugal and cross flow classifiers, together with pumps and ground magnetite storage facilities. The latter need was met by installation of a cone similar to the pump sump located under each bath unit.

The mill capacity is more than double the amount required for plant operation. It affords opportunity of accumulating a reserve supply in the 50 tons capacity ground magnetite storage cone. Protection is thereby afforded against possible need of mill repairs or emergency supply in event of accidental loss from any one of the heavy media circuits.

A daily record is maintained to show the amount of magnetite added to the operating circuits. A stock inventory is made at the end of each month by cross sectioned measurements of the storage bin supply. Advantage is provided by segregating material in the last car lot delivery, from the balance of coarse magnetite on hand. Care has been exercised to insure reasonable accuracy in arriving at the unit consumption data listed above. Past determinations have included adjustment for variations in the amount of heavy media within each of the five bath circuits. Variation in the amount of magnetite lodged within the facilities or remaining within the recovery cones is disregarded.

The favorable separation described is due in part to maintenance of uniform gravity of heavy density in the bath units. Automatic regulators are provided to govern withdrawal from bath recovery cones and to govern density control within each of the five bath units.

Specific Gravity Regulation

Automatic control frequently limits the daily variation within a range of 0.01 from the intended specific gravity of separation. Density within each of the bath circuits was originally checked every half hour by weighing one liter of the media. Review is presently made on an hourly basis with prospects of further reduction being warranted.

Each regulator consists essentially of a hydrometer element within a tube or well, wherein constant flow provides duplication of the density within the circuit. The hydrometer is suspended from the end of a scale beam carrying a sliding weight on the opposite end for adjustment. The weight carrying end of the control beam terminates in a pole operating within two parallel coils. Measured impedance activates a Modutrol motor for movement of a splitter gate to govern the disposition of overflow from each bath regulator cone.

The constant supply of clarified water, available to replace the moisture loss on the washed products, is similarly controlled. Delivery is directed to the bath circuit or to dilute media as required to maintain the desired gravity for separation. The regulators for control of recovered media, govern delivery to the bath circuits or return to the recovery system in event of additional thickening being required. They include provision to vary the amount of compressed air available for the pneumatic lifts and the consequent rate of withdrawal from each recovery cone. An optimum ratio of fine coal and clay slimes is preferred within the heavy density circuits. Stability of the media or retarded settlement of the ground magnetite, is provided by this material. An excess of fine coal or slimes will provide sufficient viscosity to retard separation of the raw coal feed to an objectionable extent. A conical viscosimeter with a tubular extension from the apex aperture, has been used for testing. The findings provide the governing basis for purging to avoid an excess of slimes in a circuit. Heavy media stability requires a limited ratio of slimes to retard settlement of the magnetite and provide acceptable uniformity throughout the depth of the bath. Variation between the average in a circuit and sample collection adjacent to the surface of a bath unit, can be held within a maximum range of two points from 1.36 to 1.38 Sp.G. being cited as example.

Plant operation includes routine daily performance tests and analyses to insure acceptable product control. These data are tabulated with average figures provided for each month. Convenient comparison is enabled by listing those data for the preceding month and for the year exclusive of the current month. Normal practice will provide later inclusion of similar data for the preceding year.

The data listed in this review have been taken largely from the average monthly performance figures. Individual tests have shown sufficient uniformity to enable using the average data for evaluation of the system and to govern opinion with respect to future need.

Heavy density separation enables performance beyond the capacity of early preparation facilities. The McNally-Tromp bath unit affords opportunity of usage which warrants consideration, as demonstrated by the initial American installation under review.

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FROTH FLOTATION FOR RECOVERY OF SLURRY

By S. M. PARMLEY
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The recovery of a salable coal slurry is a timely subject and of interest and considerable importance to the coal operator at the present time. High production costs, increased ash and sulphur in the raw coal, and stream pollution laws have instilled new thinking into the recovery of fine coal slurries. Although froth flotation has been in use in the coal industry in the United States since 1931, it has not been applied to the recovery and cleaning of fine coal slurry to any extent until recent years.

Slurry or dust is, and always will be, an inherent feature of the wet coal washing plants, no matter what their capacity or type, and irrespective of the size and characteristics of the raw feed. The quantity of fines and water pollution solids may be reduced but not entirely eliminated, so consideration should be given to the economics and advantages which may be derived by cleaning the slurry.

Slurry is a function of the water system, so full consideration should be given to the dimensions and type of water clarification, as well as to the slurry recovery and dewatering units, in an endeavor to install and operate the units with a reasonable capital expenditure and operating cost. The seriousness of the problem will determine how detailed the consideration must be.

It should be realized that the first cost is not the only cost, and that it is more expensive to rectify a trouble than to prevent it. Effort should be made in the design of the washing plant not only to obtain a maximum economical yield of recoverable coal but to stabilize the washery system to prevent stream pollution and reduce the loss of salable coal slurry in the washery waste.

Possibilities of Froth Flotation

Until recently the froth flotation method of cleaning slurries has not met with much favor in the United States due to its high capital and operating costs, and its inherent temperamental operating conditions. In Europe and England, where it is necessary to obtain the highest possible recovery of combustible matter from coal preparation plants, froth flotation plants have been adopted to a very great extent. Gandrud, Fraser and Yancey (1) state that Western Germany has more froth flotation plants and treats a larger tonnage by this process than any of the other counties on the Continent. The Dutch State Mines, in the Limburg Province, Netherlands, has probably the largest single froth flotation plant in the world. It has a capacity to treat 70 tons per hour. In 1950 there were 43 operating plants in England, Scotland, and Wales, with an average capacity of 11 tons per hour per plant.

L. W. Needham states (2,1) that, generalizations are as dangerous in connection with coal preparation as with any other technical study. However, it would seem that until a cleaning method of equal range is found, froth flotation should be extensively applied where fine coal must be cleaned, and that it should be used for whatever fraction will give a good friable, well dewatered and easily handled filter cake.

In recent years, full seam mechanical mining has produced an increased tonnage of fine coal with an increased ash and sulphur content in the raw coal beyond consumer acceptance. To reduce the ash and sulphur and for economical reasons, plants producing metallurgical coal purposes are applying froth flotation for cleaning the slurries.

A study of the recovery problem should consider the economics of froth flotation, versus wasting to slurry ponds, and its periodic removal and disposal to banks. The value of the cleaned slurry, due to its improved quality may prove profitable, after deducting for operating labor and amortization of the possible high capital cost.

There are no general rules or empirical formulae that can be applied to the design of all froth flotation plants. The characteristics of the coals, washery performances and flow sheets, are all different and each presents its particular problem, not only due to the inherent properties of the coal but its utilization.

Froth flotation is rather temperamental from an operating standpoint. It is rather high in cost per ton of capital expenditure, and operating cost per ton of cleaned slurry.

In the design of a froth flotation plant, to obtain a high quantitative and qualitative efficiency as well as uniform results of products and operating conditions, consideration should be given to the application and control of the following conditions. Time does not permit a discussion of these items, but they are listed here as timely subjects for future papers and consideration.

1. Economics of treating the slurry by froth flotation.
2. Type of flotation unit.
3. Required number of cleaning units, so as not to overload the capacity of the cells.
4. Density of the feed.
5. Conditioning time.
6. Flexibility of the flotation cells for retreatment.
7. Breaking the froth to obtain the maximum capacity of the filters.
8. Type of filter units.
9. Disposal of the tailings.
10. Kind and quantity of reagents and application.

A froth flotation plant, under proper operation, will generally produce an acceptable clean coal and a white water tailings containing principally clays. The methods of tailings disposal is one of the problems connected with froth flotation. The following methods may be considered.

1. If quantity of tailings is small, disposal to ponds or waste bank, may be feasible and economical.
2. Nature of tailings may be responsive to thickening by rake thickeners or by cyclones with thickened underflow, disposed to ponds.
3. Tailings of high clay content clarified by flocculation and thickening.

Since the passing of stream pollution laws, more consideration has been given to clarification by flocculation of washery circulation water containing a high percentage of minus 325 mesh clays.

Experiments in Flocculation

Considerable research work has been accomplished in England and Europe on the clarification of washery circulating water by flocculation. Mr. J. O. Samuels (3) has published an article on the Investigation of Coal, Clay Dispersions Using Salt Starch Gel, consisting of the chlorides of Calcium, Barium, Magnesium and Zinc and potato starch.

The following table taken from the article gives the average settling velocity of the salt, starch gels, compared with that for boiled, swollen and sodium hydroxide starch products.

Mr. Samuels states that the quantity of salt starch gel required to obtain flocculation is considerably less than that required for other forms of starch. The salt starch gels increase the settling velocity four to seven times at the lower concentrations of solids (2% to 5%) in the coal clay dispersion, and twenty to eighty-eight times more at the higher concentrations of solids (5% to 10%) over that for starch alone.

At 2.5% solids in the coal clay dispersion, and with 0.07% of potato starch, the settling velocity in cm. per minute for boiled starch is 6.7, for swollen starch 3.52, and for sodium hydroxide starch 6.25, compared to 24.6 cm. per minute for salt starch gel containing 0.0024% of potato starch. A coal clay dispersion containing 10% solids and with a starch gel containing 0.29% of potato starch, the settling velocity in cm. per min. for boiled starch is 0.21, for swollen starch 0.05 and sodium hydroxide starch 0.81, compared to salt starch containing 0.0096% of potato starch of 4.4 cm. per minute.

The article contains considerable interesting and practical data and is recommended for your perusal.

The British practice (1) of froth flotation differs from that in the United States in that the British plants are usually operated on a closed system. There is no desliming of the feed or wasting of the slurry water. The flotation tailings are usually flocculated with reagents and settled. The thickened tailings are pumped to ponds or mine refuse piles. The clear overflow is returned to the washery circuit. In the British and European practice, cresylic acid and creosote are used universally as reagents, instead of pine oil and petroleum as used in the United States.

% Solids Grams/ 100 cm	% Starch as Gel (Potato)	Settling Velocity Cm/Min			% Starch Settling	
		Boiled Starch *2	Swollen Starch *2	NAOH Starch *2	Starch/Salt Gel *1	Velocity Cm/Min for Starch/Salt Gel
2.5	0.07	6.7	3.52	6.25	0.0024	24.6
3.5	0.10	5.3	2.70	4.44	0.0033	78.5
5.0	0.14	3.75	2.10	3.25	0.0048	14.6
6.5	0.19	2.70	0.85	2.71	0.0062	10.4
8.5	0.24	0.75	0.34	1.25	0.0081	8.0
10.0	0.29	0.21	0.05	0.81	0.0096	4.4

*1—Based on added starch.
*2—0.5% solution.

Froth Collecting and Breaking

D. H. Davis states (4) that at the Champion No. 1 Preparation Plant of the Pittsburgh Coal Co., a number of frothing and collecting reagents have been used and, while observations made may not be true for all circumstances, they represent the conclusions reached under existing conditions. Cresylic acid was found to be one of the best frothing reagents in respect to cleaning performance and together with kerosene and spray oil produced the best results in mill operation.

Breaking the froth to a liquid condition for satisfactory filtering on vacuum type filters is a problem connected with froth flotation. In the United States the following methods have been used:

1. Water sprays.
2. Vibrating screens.
3. Centrifugal impellers in a tank or froth breaker.
4. High speed belt elevator.

Davis (4) states that at the Champion No. 1 Plant of the Pittsburgh Coal Co. the best solution for breaking down the froth was found to be a bucket elevator operating at approximately 400 ft. per minute. By use of the bucket elevator, the filters operated without overflowing at pulp density of 30 to 35 percent solids. When filtering the concentrate without breaking down the froth, the production of the filter cake was at the rate of only 20 to 25 pounds per square foot per hour. The capacity was doubled by the use of the elevator. The other methods have produced only partially satisfactory results.

Western German practice (1) in the handling of froth flotation products usually includes a froth destroyer to condition the froth concentrate before it is delivered to the filters. The vacuum tank type of froth destroyer is used almost exclusively in the Western German coal industry (7).

P. J. Van Der Walt (5) has published a treatise on "A Study of the Operation of the Cyclone Washer and Its Application to Witbank Fine Coal." Mr. Van Der Walt states that the tests show that the performance of the cyclone washer treating fine coal, (½ in. x 100 mesh), is very nearly equal to that of the conventional types of heavy media washers treating coarse coal. In other words, the high efficiencies commonly associated with heavy media washers may be obtained in fine coal cleaning by applying the cyclone washer. Tromp distribution curves for the various size fractions of the feed show that the efficiency of separation is very high for particles ranging from ½ in. down to 48 mesh and that the efficiency begins to fall off for smaller particles, with quite satisfactory performance down to 100 mesh.

The cyclone not only effected remarkably sharp separations at very difficult specific gravities (1.35 to 1.41), but that the capacities were also phenomenally high for so small an apparatus in all cases. Tests were run on a 9½ in. cyclone, using barytes (BASO) as a medium. Tests on a ½ in. x 100 mesh feed gave efficiencies of 92% to 96% at specific gravities of 1.36 to 1.41 and with capacities of 9.5 to 12.5 tons per hour.

—*Discussion*—

John Griffen (*McNally-Pittsburg Mfg. Corp.*): I want to ask Mr. Parmley what he got on the German vacuum froth breaker as to the additional power required and increased filter capacity. I saw those two and a half years ago and they looked pretty good to me.

Mr. Parmley: From the information I was able to obtain in Europe, the filters were not giving any trouble. They were producing a cake from 1½ to 1¾ in. thick. The power was rather high on account of the vacuum.

Mr. Griffen: The other thing that interested me was the fact that in England and in Germany they used wire cloth as a filter medium rather than a fabric. I think that has a lot to do with the high capacity. As a matter of fact, we are beginning to use it in this country.

Mr. Parmley: In this country wire cloth has recently been used only in a few plants. It has been my experience that feeding the filter direct with the froth from the flotation units results in the filter operating with a reduced capacity and usually with an overflow. It appears that the air contained in the bubble effects the pick-up of the filter. In England it appears to be the general practice to run the froth direct to the filters without breaking; while in France I saw one installation where the froth was run direct to the filter. The filter cake was soft with a high moisture content and did not have a cake as thick as with the filters operating with the vacuum froth breaker.

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OVERBURDEN BLASTING TECHNIQUES

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In discussing explosives it is easy to get involved in questions that are difficult to prove with factual evidence. Thoughts on blasting procedures are quite often so firmly fixed that even with an overwhelming amount of evidence, ideas may not easily be changed. However, evidence may be had through the use of the so-called machine-gun type camera on blasting practices and it is appropriate that we examine the tool before proceeding into the details of overburden blasting technique which it has disclosed.

Description of the Camera

The new tool is the fast-action, large-negative sequence camera, developed by the Army Air Force during World War II to record bombing results. Through its use it is possible to "stop" blasting action at regular timed intervals during the blast for detailed study and interpretation. Until this type of camera was developed, the only way to judge blasting action was the small-negative movie camera, which could not catch the details of rock movement. It is, of course, possible to take a photo sequence by using several still cameras with electric solenoids to activate the shutters, but such a complicated procedure is too formidable for general use. With the machine-gun camera, which is neither expensive nor complicated, stripping operators may trace the action of their blasts and thus judge the efficiency of their blasting practice.

Briefly, the machine-gun camera is a battery-powered machine which takes 5 x 5 in. photos at the rate of three a second. Exposure time for each photo is 1/450 of a second, which is fast enough to stop the action of each fragment of the blast. Since the film is over 30 times larger than the largest motion picture film, it is possible to produce sharp, clear prints which are easy to arrange and are adaptable to study. The technique of taking the machine-gun photos hinges mainly on synchronizing the timing between the blaster and the photographer so that the camera is running a few seconds before the blast is initiated and kept running during the discernable action.

Camera Studies Reveal Blasting Action

This type of camera was first used on a stripping blast some 18 months ago. Results of this trial were so gratifying and informative that it was

Fig. 1. A perfect blast at the height of its movement

decided to use it regularly for studies of all types of overburden blasting. The object of all studies with the camera has been to trace blasting action, whether this action was desirable or undesirable. None of the blasts on which the camera has been used were specially set up. Pictures have been made of so-called good blasts and so-called bad blasts as the opportunities presented themselves.

As a result of study of machine-gun photographs, it has been possible to arrive at a tentative definition of a "good" blast. Fig. 1 demonstrates this. The blast is at its height, but it can clearly be seen that there is no flying rock, no escaping gases and that the burden to be moved is completely displaced and fractured as indicated by the swelling action.

Besides taking pictures of blasts, the machine-gun camera has done some blasting itself, because it has exploded many hazy theories regarding explosives action. Three important conclusions which may be drawn from the visual evidence of the camera and which may be at odds with some older theories are:

1. A column of explosives does not detonate instantaneously.
2. The point of initiation of a charge of explosives is important.
3. The proper use of milli-second delays can do far more than previously supposed to gain increased blasting efficiency and advantageous action of the overburden.

With the photos as visual evidence let's examine these conclusions.

Movement of Overburden

Despite the fact that the velocity of detonation along a few inches of dynamite can be accurately measured, it is often contended that, for all practical purposes, the wave of detonation along a column of explosives in a drill hole can be considered as instantaneous. If this were true it would make little difference at which point the explosives column is initiated. However, study of the machine-gun photographs gives visual evidence that the movement of rock or overburden definitely responds to the wave of detonation along the bore hole.

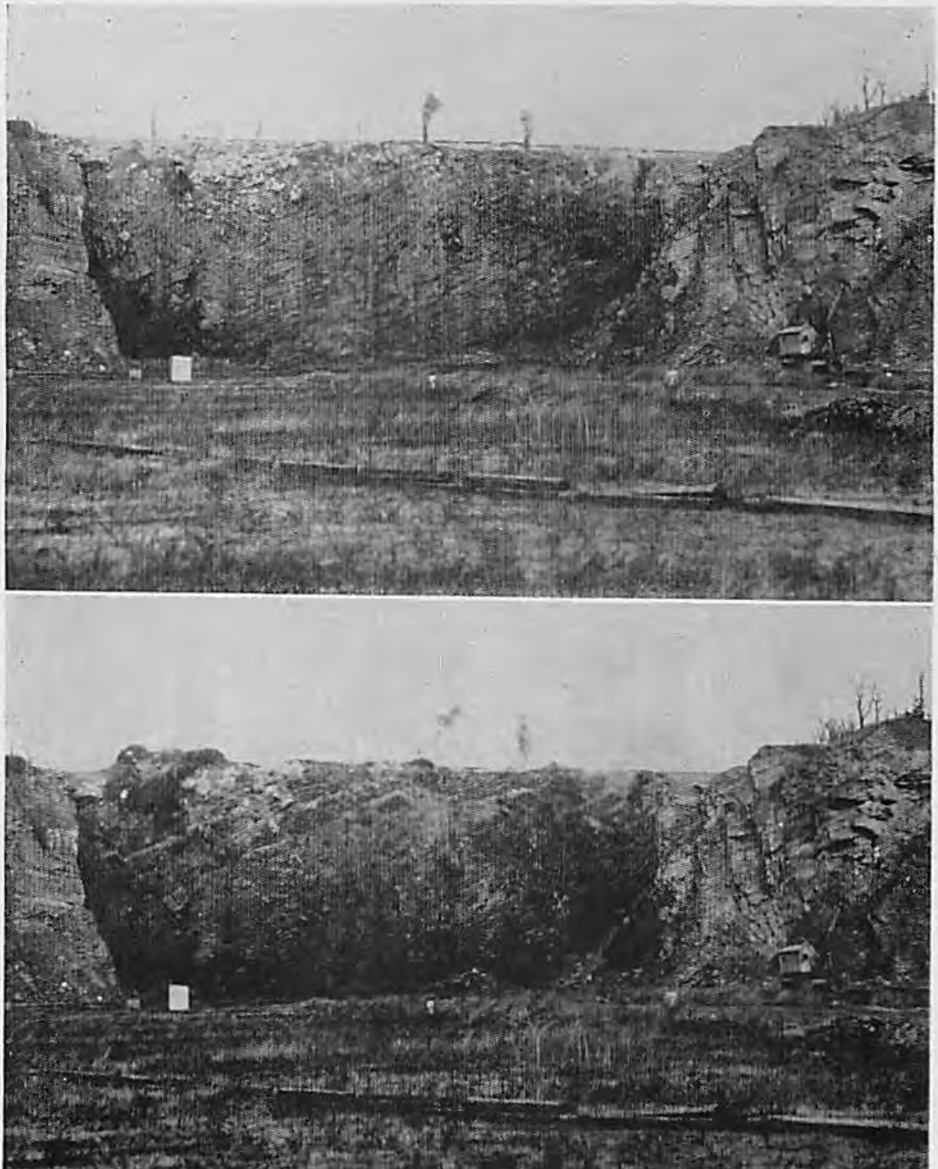

Fig. 2. Two views at 1/3 second intervals show progress of detonation

In the past it has not been possible to be sure of this when viewing blasts, because the movement is so quick and the cloud of smoke and dust follows so fast upon detonation that no positive evidence was gained. However, with the machine-gun camera as many as ten individual photographs are obtained from the moment of detonation until the blast is obscured by smoke and dust. So we can now examine thoroughly the progress of the detonation of explosives along a column and see that it is reflected in the movement of the rock.

This movement is shown in the photograph in Fig. 2. These views are of a quarry face 130 ft. high. This type of shot was chosen as an illustration because it lends itself to examination of action along a column of explosives.

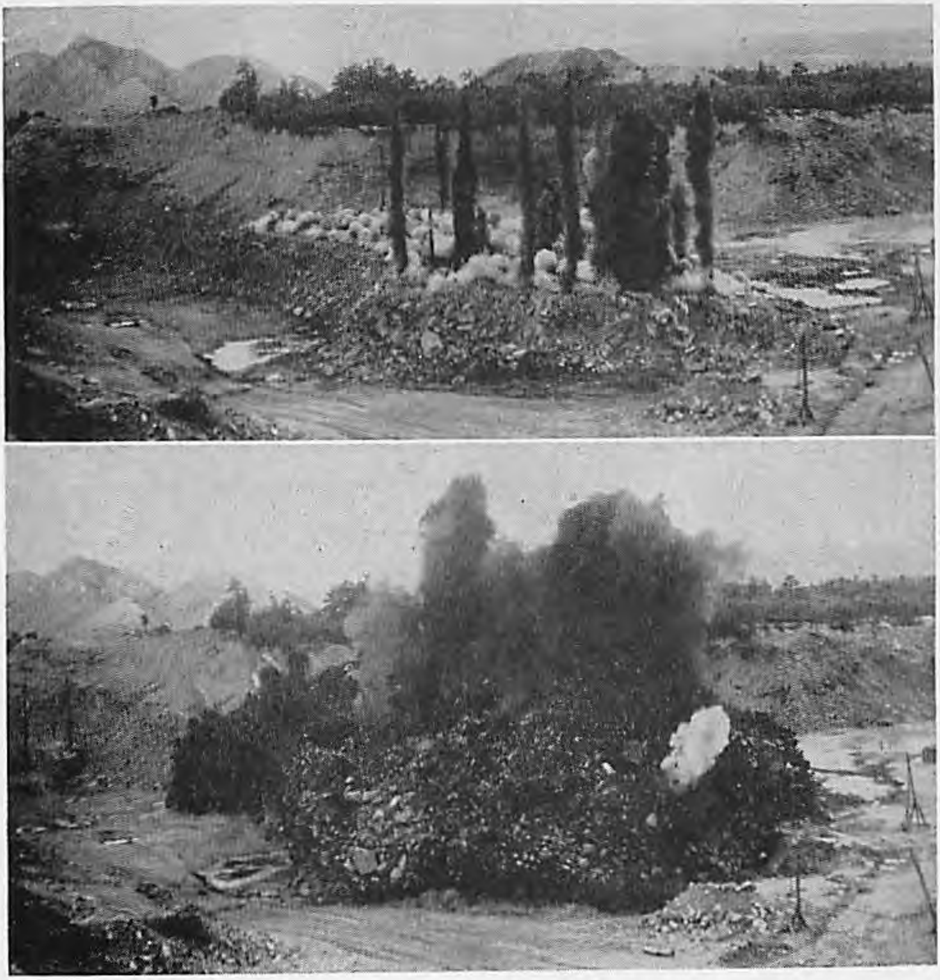

Fig. 3. Sequence views of a typical blast initiated from the top of a vertical hole

Fig. 4. An anthracite blast detonated with milli-second delays at the bottom of the holes

The detonation is started from the top by means of milli-second delays attached to detonating fuse. The holes were fired progressively from right to left. The first picture in the sequence, which is taken 1/3 second after the blast has been initiated, shows movement of the rock only in the top third of the quarry face. The next picture (1/3 second later) shows movement in the entire face. When detonation is initiated from the bottom of the holes, the bottom of the face moves out first. Abundant photographs are available to bear out this point.

Importance of Point of Initiation

Having determined that a column of explosives does not detonate instantaneously, it becomes obvious that the point where the explosive is initiated is of major importance. Explosives force follows the lines of least resistance, and these lines are established at the first instant of

Fig. 5. The results of inadequate stemming

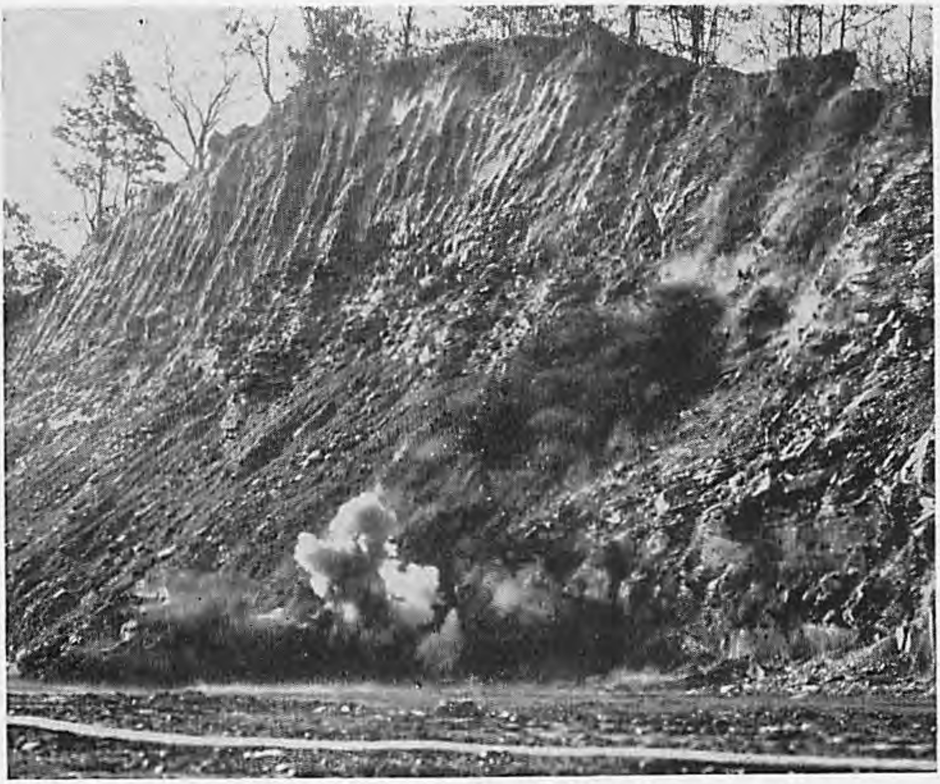

Fig. 6. A single shot detonated at the back of a horizontal hole with adequate stemming

detonation, setting the pattern for the release of force as the wave of detonation proceeds along the explosives column.

In strip mining, following the practice of vertical hole drilling, there is usually a marked difference in appearance of blasts when the comparison is based on top versus bottom initiation of the charge. In most instances bottom initiation affords better confinement of the explosives force and thus gives the explosive more opportunity to work in displacing and breaking the overburden. Naturally, with confinement of the explosive gases, the air blast or air vibration caused by these gases is generally lessened. Fig. 1 is an example of the control and efficient use of gas possible when bottom detonation is used.

Blasts initiated from the top or front of the hole generally show less confinement as evidenced by geysers of escaping gases. This, of course, means more noise, and it can be attributed to the fact that an extra free face is provided by the movement of the material just above or in front of the detonating explosives column. Fig. 3 shows, in sequence, a typical vertical hole stripping blast initiated from the top.

The blast shown in Fig. 4 involves the combined use of detonating fuse, initiating some holes from the top, and milli-second delay electric blasting caps initiating other holes at the bottom. This method started movement of the overburden at the logical point. The portion of the blast initiated at the top is at left of the photos. The resulting lift provided space for the remaining material to be moved so that proper relief was given to prevent excessive degradation of the coal. The blast was similar to removing material from a v-shaped formation. The coal in this area pitched downward and at a certain point reversed itself and pitched upward. So in this case top detonation was desirable.

In horizontal blasting it is harder to show marked differences by means of the machine-gun camera. However, certain fundamental differences may be seen when a comparison of the two ways of initiating a blast is observed.

Proper Stemming is a Necessity

One notable fact, apparent with both methods, is the absolute necessity of having sufficient stemming in the holes. It appears that more and better stemming is needed to confine the charge and thereby get the most efficient use of explosives force. A little extra time used in providing adequate stemming can easily be proved to be time well spent.

Regardless where the charges are initiated, a lack of stemming is easily detected. The photograph in Fig. 5 was taken ⅓ second after the charges were detonated. In this case only 6 to 7 bags, or 8 to 9 ft. per hole, of stemming was used. The jetting action extends from the high wall to the spoil bank. This blast consisted of two staggered rows of holes 65 ft. deep. The top row had an average charge of 150 lbs. per hole and the bottom row had an average charge of 220 lbs. The powder factor ranged between 6 and 7 cubic yards per pound of explosives. The top row was detonated by instantaneous E. B. caps and the bottom row by a combination of Nos. 1, 2, 3, and 4 milli-second delays. The delay periods are apparent in the varying lengths of the jets. The height of the bank ranged between 50 and 60 ft.

Fig. 7. In contrast with Fig. 6, this view shows the result when a horizontal hole is detonated at the front

To provide severe conditions for checking on stemming, a single horizontal hole drilled in the tight in a 75 ft. bank was photographed. (See Fig. 6.) The 133 lb. charge was detonated at the back of the hole by an instantaneous E. B. cap. There was 15 ft. of stemming used. One-third second after detonation, there was no evidence of explosives force being lost. There was ample evidence of complete confinement and definite action throughout the height of the overburden. Fig. 7 shows another shot in the same pit using like conditions with the exception of the point of detonation. In this case five holes were shot (not in the tight), and detonation of each hole began at the front. Two features are obvious —loss of explosives force and less displacement of overburden.

Getting the Most from Milli-second Delays

Improvements in the techinque of using milli-second delays in overburden blasting are developing steadily. As a result the trend today shows startling increases in the practical application of this modern method of detonating explosives force. But full utilization of this method or any other improved methods will depend on how much attention and study is given to their proper application. An active interest in blasting techniques and results is important and should be followed closely.

It has been definitely established that, properly applied, milli-second delays can provide the following advantages:

1. *Better fragmentation.* This not only means faster digging but also less wear and tear on equipment.

2. *Improved displacement.* It is not uncommon to get reasonably good fracture and not have sufficient displacement. The lack of displacement may result in slower digging.

3. *Reduced vibration and noise.* This has been documented by seismograph tests and is equally true of either progressive or alternate methods of milli-second-delay shooting.

4. *Controlled throw.* Both the extent and direction of throw can be influenced by the delay periods used.

5. *Reduced backbreak.* Reduction of backbreak in vertical hole shooting permits starting the next row of holes in the desired area.

Firing holes in sequence has been said to result in decreased blasting vibrations. In the past this has been widely accepted. Recently a study on blasting vibrations in Sweden has indicated that less vibration may occur when fast delay electric blasting caps ure used alternately.

It is hoped that these advantages, constantly being proved in pictures by the machine-gun camera, can be accepted as a challenge, to all of us, to get the most out of explosives energy in all types of mining. Increasing attention to overburden blasting technique can bring this goal nearer.

time to express our sincere appreciation for the help that we have had in carrying out our development work.

In August 1951 the tests at the new Farmersville mine of the Freeman Coal Company was primarily for development work and extended for 12 days on a triple shift basis. During this period they advanced 2,493 feet of headings 14 feet in width, averaging 8 feet in height. The total tonnage mined was 14,000 tons gross with 33% of the material broken rock. There were 2,200 Chemechol units used which calculates 6.3 tons of material per unit. This work was carried out during the earlier days but was discontinued because we were not able to supply sufficient equipment for the rapidly expanding operation. The trial, however, did show excellent results in this type of work.

In September 1951 Chemechol was used to a limited degree in the No. 10 mine of the Peabody Coal Company, near Ellis, Illinois. It was obvious almost from the beginning that the existing equipment was not suited to the mining conditions. The coal was center cut 9 feet deep and it was soon found that the breakage of the bottom coal, and particularly the recovery of tubes, presented a major problem. Difficulties were encountered with breakage of our electrical connections as the coal broken from the bottom holes covered up the tubes. The problems involved in this type of breakage are being given further study and it is expected that one or more changes that have been proposed in the tube design will in due course solve them.

Fig. 4. Placing the assembled tube in the shot hole

Fig. 5. Face fall shows the excellent breakage by Chemechol

We would also like to mention a few tests made in Pennsylvania. After seeing a small scale demonstration of Chemechol in an experimental mine which showed its non-explosive properties and method of use, the Secretary of Mines of the State of Pennsylvania, the Honorable Richard Maize, granted us permission to make tests in one section of the Montour No. 9 mine of the Pittsburgh Coal Company at McAdams, Pa. We are very grateful for the excellent cooperation received in these tests from the State of Pennsylvania officials and the Pittsburgh Coal Company.

The work at the Montour No. 9 mine was done in relatively narrow places with the coal undercut to a depth of 9 ft. Here again recovery of standard length tubes was a serious problem. However, by using tubes approximately 8 ft. long the difficulty was largely corrected.

Operation in Illinois

As mentioned before, Chemechol was introduced into the Lida B Mine of the Franklin County Coal Corporation, Royalton, Ill., in March 1951, and continued there on an expanding basis so that at year end all of the coal produced was being broken with Chemechol. During the period up to January 1, 1952, the production amounted to 188,000 tons. The seam is undercut and some of the places are sheared as well. The coal produced has been of uniformly excellent quality and in percentage of coarse coal and minimum quantity of fines has been appreciably superior to permissibles. Loadability has been excellent. The number of holes required per place has been equivalent to those needed for permissibles.

In a typical room at the Lida B, 20 feet wide by 6 feet high with a bottom kerf, and 6 foot holes, the number of holes required with Chemechol varies from 6 to 8 depending upon the degree of bug dusting and the placement of the holes. An additional 7 feet of room width can be handled with two extra holes. Six holes are usually necessary in room and entry widths less than 20 feet down to about 12 feet. For widths less than this, the coal can be broken satisfactorily with four holes. Where the coal is both sheared and bottom cut, it is possible to eliminate one or two additional holes.

The tons of coal produced per Chemechol unit usually vary from 4 tons to 6 tons per discharge depending on the various mining conditions encountered as mentioned previously. As shown in small scale screen tests, the minus 8 mesh fines of the coal broken with Chemechol was 9.8% as compared to 21.7% achieved previously with permissible shooting.

Installation and Operating Costs

The investment required by the operator will be for the purchase at the start-up of a quantity of complete tubes per operating unit approximately equal to three times the number of holes used in any one face. This will run about 20 tubes per unit at a total cost of approximately $1500. It is also well to have on hand a few spare parts so that repairs can be made quickly without taking a complete tube out of service. For convenience it is desirable for the operator to furnish some kind of buggy for transporting the tubes from place to place within the operating unit of the mine. This buggy is used to transport the tubes, carry the supplies of discs, gaskets, etc., and also provides a clean working place for recharging the tubes. In some mines the battery controller has been fastened to this buggy. The alternative to providing a buggy would be to purchase sufficient tubes to be left in each room. It is quite apparent that the cost of providing a buggy would be more economical.

From our experience to date in undercut coal, it seems probable that one unit will replace from 1½ to 2 pounds of permissible explosives. This would include, of course, the replacement of one electric blasting cap necessary with the permissibles. As previously mentioned, this experience has been confined to very limited operations in one state, so that it is still too early to make an accurate forecast. Another large item of mining coal is the cost of drilling. We have found in undercut coal that the number of holes required is about the same as used with permissibles, so there is no increase in cost in this operation.

Our development work to date has demonstrated that the life of the equipment is of sufficient magnitude so that the cost per ton is only a minor factor. Estimating these costs on a very conservative basis, we believe that the figure for replacing equipment will be less than 2 cents per ton.

Chemechol today is available only in limited quantities and its use will be confined in the immediate future to a very few mines where further experimental and development work will be carried out. The greatest difficulty at the moment in expanding is procurement of the special alloy steels in the tube assemblies and also materials used in the battery controller units. These items are currently in very short supply and we are having the same difficulty as everyone else in securing an adequate amount for our needs. We anticipate that this situation will show a great deal of improvement in the latter part of 1952.

Permissibility by U. S. Bureau of Mines

The United States Bureau of Mines is actively studying the performance of Chemechol in its equipment designed to evaluate the permissibility of coal breaking devices. At present the Bureau is establishing the background on our product so that a schedule may be written for official testing from a permissibility standpoint. In this connection, the Electrical Section of the Bureau has cooperated with us in arriving at a design for the battery controller unit which will bring it in line with the standards set for permissible electrical equipment.

Face prepared for the shot

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STRIPPING IN HEAVY OVERBURDEN

By ARTHUR F. LEE
District Engr., Truax-Traer Coal Co.
Pinckneyville, Ill.

There are many mines in the bituminous fields that are successfully and economically stripping overburden that is 50 to 90 ft. and more in depth. Various types of equipment are used, various pit layouts and methods of excavating and spoiling are employed to meet the different classes of strata and geological formations that are encountered. In preparing the paper presented here, attention was given to the diversification of stripping plans and practices in conjunction with single units or with combinations of different units and the descriptions given here cover six general method-conditions as listed below. Acknowledgment and gratitude are expressed to the personnel of these companies for their splendid cooperation in furnishing the information as well as their time and help in obtaining the plans and photographs.

OPERATIONS DESCRIBED

1. Tandem Units, Shovel & Dragline, on coal;
   Overburden—Surface, shale, rock;
   Truax-Traer Coal Company—Burning Star Mine—near De Soto, Ill.
2. Tandem Units, Shovel & Wheel-Excavator—on coal;
   Overburden—Surface, shale, little rock;
   United Electric Coal Cos.—Buckhart Mine No. 17—near Canton, Ill.
3. Combination Units, Shovel on coal, & Dragline helper on spoil;
   Overburden—Little surface, mostly shale and rock;
   Enos Coal Mining Co.—Enos Mine—near Oakland City, Ind.
4. Dragline only—On prepared bench;
   Overburden—Surface, shale, rock;
   Maumee Collieries Co.—Chieftain Mine No. 20—near Riley, Ind.
5. Dragline only—On prepared bench;
   Overburden—Surface, hardpan, little shale;
   Fairview Collieries Corp.—Harmatten Mine—near Danville, Ill.
6. Shovel only—Little surface, mostly shales and rock.
   Hanna Coal Co.—Georgetown Mine No. 12—near Cadiz, Ohio.

In addition to the above typical methods a few rare cases may be encountered as for instance the hydraulic method of washing and pumping away the sandy surface above the shales, as operated by the Shasta Coal Corp., near Bicknell, Ind., a few years ago. Such types are not covered in this paper.

TANDEM METHOD—SHOVEL AND DRAGLINE ON COAL

Truax-Traer Coal Company—Burning Star Mine

The tandem operation of both stripping shovel and stripping dragline located on the coal is very familiar to all of us, having had to use at that time the tools we had in order to survive. From fifteen to twenty years ago most big stripping operators possessed a ("then") large dragline of dipper capacity of ten to twelve cu. yds. and boom from 140 to 160 ft., as an aid in opening box-cuts of 40 to 50 ft.; together with the hope that with its aid, further stripping depths could be obtained by helping the stripping shovel. Occasionally it stripped to coal in isolated spots where there was no rock and the shales required little or no shooting.

It was during this period of the draglines aiding the shovels in disposing of the greater overburden that a depth was reached whereby further deeper stripping was prohibitive. This maximum stripping depth varied at different mines depending on the overburden strata and thickness of coal, or yardage ratio.

At the Burning Star No. 1 mine, the overburden averaged about 50 ft. deep in its latter months, until it was abandoned as noted on the

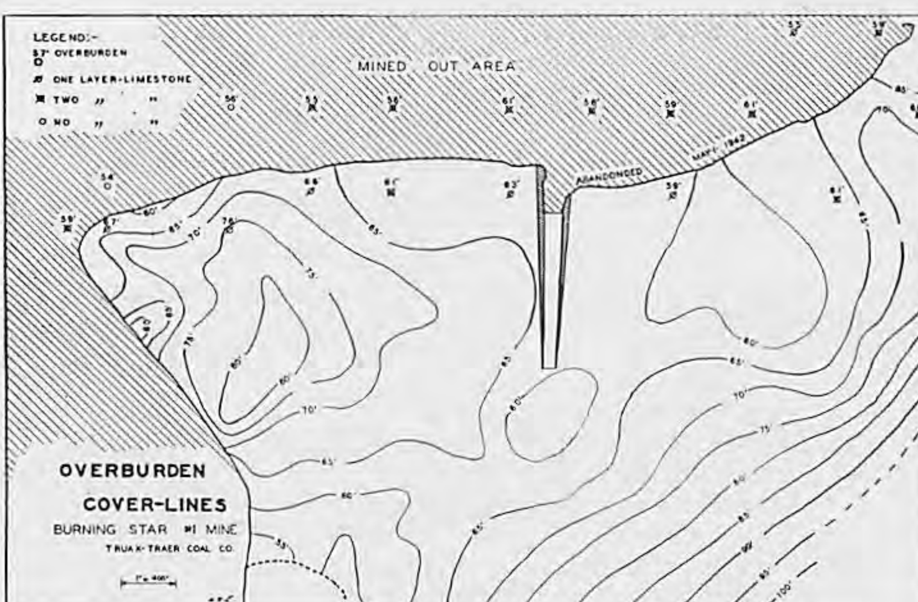

Fig. 1. Overburden contour at Burning Star Mine

portion of map where a maximum depth of 55 to 60 ft. was encountered (Fig. 1). At that depth the surface material taken by the dragline varied from 5 to 15 ft., hence a very inefficient operation and decline in combined yardage of the two units resulted, caused by too much lost operating time by the two units passing, as well as the extra low dragline yardage, caused by too slow a digging cycle and with bucket partially filled at too high a digging range.

The units were a Bucyrus Electric 750 shovel with 95 ft. boom and 17 cu. yd. dipper, and a Marion Electric dragline with 150 ft. boom and 10 cu. yd. bucket. Monthly tonnage ranged from 50,000 to 55,000 tons washed coal in the maximum overburden. By this time both the Marion and Bucyrus companies were making larger shovels and the tandem shovel and draglines operations were being replaced by the larger machines, so the tandem operations above have ceased.

The Truax-Traer Company, since abandoning its tandem operation at No. 1 Mine, has two draglines, one of which has recently replaced a bad condition of tandem operation at 56 ft. overburden at its Pyramid Mine near Pinckneyville, Illinois. This operation will not be discussed here as a similar operation of deeper overburden is explained elsewhere in this paper.

TANDEM UNIT—SHOVEL AND WHEEL EXCAVATOR

The United Electric Coal Cos.—Buckheart Mine

This operation in Fulton County, Illinois, has three stripping units; one Marion dragline with 175 ft. boom, and two units working in tandem consisting of a Bucyrus electric shovel, 105 ft. boom, 30 cu. yd. dipper, and the wheel-belt excavator.

The dragline will not be discussed here as a similar operation is mentioned elsewhere in this paper.

The wheel-excavator was described in detail in a very interesting paper by Mr. John Huey, presented at the Mining Congress 1950 Coal Convention in Cincinnati. This machine was an idea of their own, de-

Wheel excavator—United Electric Coal Cos., Cuba No. 9 mine signed and constructed by their own organization, combining both the revolving wheel ditch digger and the belt conveyor. It was used for taking the upper strata from the surface down to a desired depth and carrying it across the pit and discharging it far enough over in the spoils that spoil slides are eliminated.

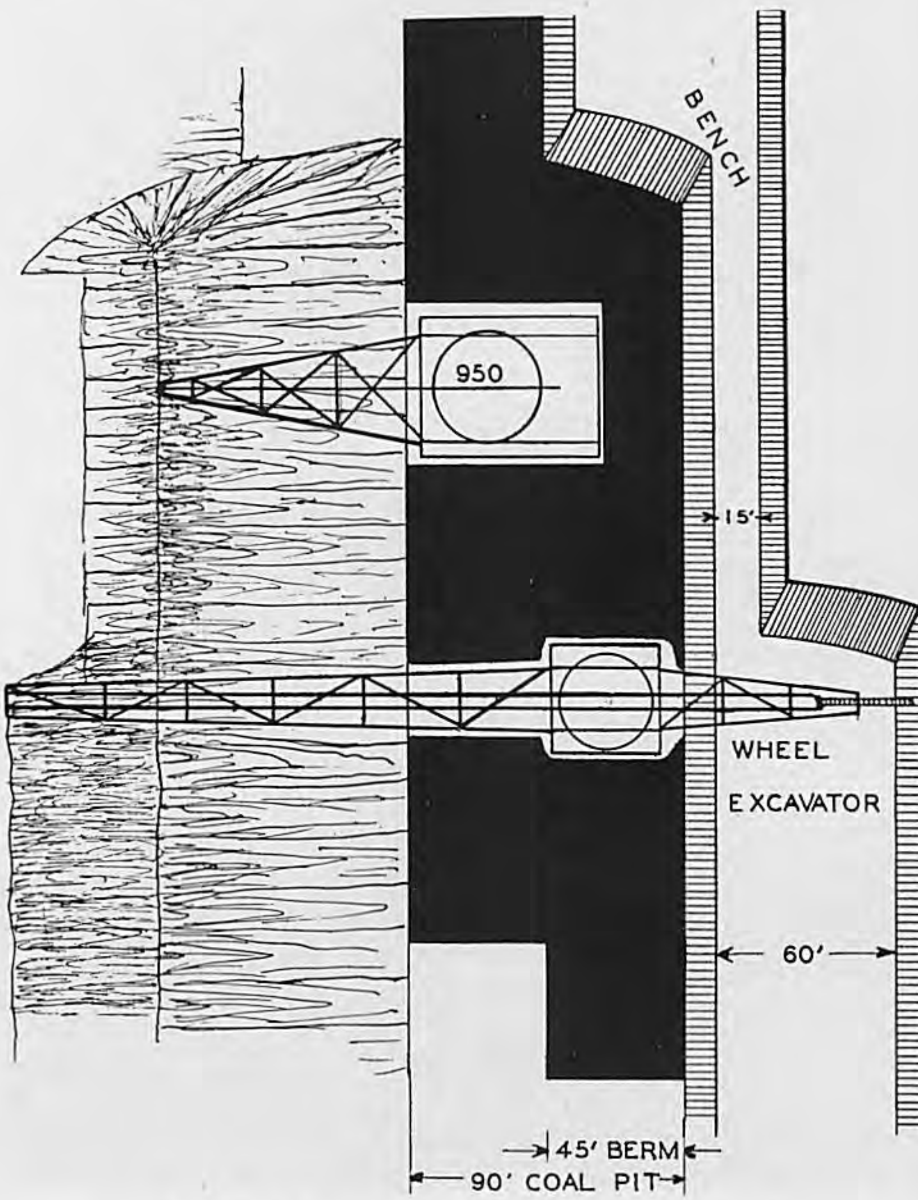

Fig. 2. Plan of working tandem units—United Electric Buckheart Mine

In the area the No. 5 Illinois coal seam averaging about 4 ft. 8 in. is mined. It is overlain with a rather consistent sequence of strata throughout most of that area. Immediately over the coal is about two ft. of black slate, above it two ft. more or less of white limestone. The surface consists of yellow rotten sandy clay varying from 5 to 15 ft. Then between this yellow clay surface and the white limestone is a light gray shale of varying thickness, the greater the total depth to coal the greater the thickness of this shale, and the less the depth the less the shale thickness between surface and limestone.

The characteristic of this shale lends itself to an ideal combination of the wheel-excavator and the shovel, working in tandem, as there particularly are no boulders. Very seldom the limestone has to be shot, if so, a sidewall drill is used.

Method of Working Tandem Operation

The general layout of the mine operation follows the circular haul plan whenever possible, which means that the haulage trucks have to pass the shovel, and also that there is approximate 40 ft. coal berm. The shovel travels rather close to the berm rib so as to spoil its maximum shale and rock as a retaining wall for the surface or bench dirt

35 yd. Marion shovel at United Electric in deep overburden

that is thrown beyond the shale and rock spoil by the wheel-excavator following the shovel. The wheel-excavator as far as mechanical construction and operation *can if necessary* remove all the strata from the surface down to within 23 ft. of the coal. Also the nature of the shale is such that the wheel-excavator can dig it to within 23 ft. of the coal if necessary.

The shovel digs a width of approximately 50 ft. (Fig. 2). The wheel-excavator following the shovel also takes a minimum width of 50 ft. plus 10 ft. extra. This leaves a safety shelf of 10 ft. on the highwall between the time the shovel strips and before the wheel makes its new cut or bench. The width of the wheel-excavator bench remains about 60 ft., unless extra soft surface material necessitates a wider bench to overcome a local dangerous condition. The depth of the bench is variable between 5 and 30 ft., depending on the surface topography. When the shovel reaches the end of its pit, it returns but stripping in opposite direction, and below the bench made by the wheel. The wheel-excavator follows making a new bench for the shovel when it reaches other end of pit and then returns. The pit being 90 ft. wide, the two units on the coal pass each other near each end of the pit before the coal is removed. The management tries to keep the 950 shovel depth as near consistent or a uniform depth as possible to conform to that depth which the shovel performs at its greatest efficiency by obtaining its maximum yardage; being understood that it has to deviate from the above rule when extra deep cuts are encountered.

Performance

In tandem operation the monthly performance of these two machines are:

950	700,000 cu. yd.
Wheel	500,000 cu. yd.
Total	1,200,000 cu. yd.
Maximum 950	831,000 cu. yd.
Maximum Wheel	698,000 cu. yd.
Total	1,529,000 cu. yd.

The average depth excavated during the past several months was about 63 ft.; equivalent ratio of solid highwall being 12.3 cu. yd. to 1 ton solid coal, or 16 cu. yd. to 1 ton of recoverable washed coal, at 77%. The maximum depth stripped being 80 ft., a ratio of 15.6 cu. yd. to 1 ton solid coal or 20 cu. yd. to 1 ton recoverable washed coal, at 77%. The mines production including the two units in tandem and the 7400 dragline ranges from 75,000 to 125,000 tons washed coal per month. Slides are nil.

At their Cuba mine, same county, the tandem wheel-excavator and shovel under similar overburden conditions has averaged 70 ft.; a ratio

Shovel and dragline—Enos Coal Mining Co.

of 13.7 cu. yd. to 1 ton solid coal or 18 cu. yd. to 1 ton washed recoverable coal, at 77%. The maximum depth is 85 ft.; a ratio of 16.6 cu. yd. to 1 ton solid coal, or 21 to 22 cu. yd. to 1 ton washed recoverable coal, at 77%. The operation produces from 65,000 to 70,000 tons washed coal per month. Slides are nil.

COMBINATION UNITS—SHOVEL ON COAL—DRAGLINE ON SPOIL

The Enos Coal Mining Company

The mine is located approximately nine miles southeast of Oakland City, Indiana. The No. 5 coal seam varies from four to five ft. in thickness, and is overlain with intermittent layers of hard shales, some limestone and two sandstone strata, 20 and 22 ft. thick. The overburden reaches a depth of as much as 90 ft. It is drilled by combination of vertical drills of the "Joy" rotary-air type on the highwall, and also by the sidewall auger type, drilling both horizontal and diagonal holes. Both type of holes are shot by LOX (liquid oxygen & carbon).

The stripping operations consist of two independent pits, each pit having a Bucyrus electric shovel of 113 ft. boom with 64 ft. dipped sticks and 36 cu. yd. dipper to strip the overburden. The surplus overburden in the pit observed is rehandled by a Bucyrus Monighan Diesel dragline of 100 ft. boom and 6 cu. yd. bucket. This helper dragline is on the second or third spoil approximately, being in a position about opposite the stripper. The road-bed height of the dragline is maintained 15 ft. higher than the elevation of the highwall opposite that that is then being stripped. This 15 ft. higher road-bed for the dragline helper was found by many years of experience in combating this problem; the main benefits to the dragline are:

1. As it is dragging the surplus shovel spoil away, its bucket is pulled up diagonally along the previous spoil to the height that makes the road-bed for the next spoil.
2. When the above operation (1) is completed, its drag cable is released, and it is lowered out for another cycle, etc., thereby eliminating many swings of 130° or more, to dispose of surplus spoil.
3. When the surplus spoil exceeds the next road-bed requirements the necessary swing rarely exceeds 130° to dispose of this surplus. Also the extra hoist is not excessive.
4. For consistent deeper overburden, it is necessary to use larger bucket.

Method of Stripping at Enos

The accompanying diagram (Fig. 3) shows the pit layout. The maximum length of one pit is a short mile. Truck haulage ways are maintained through spoils and vary from 1200 to 1600 ft. depending on several factors;—depth of overburden, topography, etc.

In the operation, the 1050 stripping shovel advances, leaving a 30 ft. berm, and excavating approximately a 50 ft. width, placing it to the spoil. The spoil dragline takes the surplus away by rehandling; making a roadway for the next cut. The highwall ahead of the shovel is shot, and as it is practically vertical a great portion of it is thrown over on the 30 ft. berm and probably a third the distance across the open cut, the latter being overburden yardage the shovel does not handle. The shovel does not clean up berm for haulage trucks thereby increasing its efficiency and yardage.

Sidewall drillers immediately follow the shovel advance, but if drills cannot keep up with shovel, they have the 30 ft. berm left to work on and catch up in case the coal has been loaded.

The coal is loaded retreating, so as not to interfere with the shovel operation. If shovel is about halfway between haulage roads and advancing, then the coal loader "sumps in" back of the shovel, and loads in the opposite direction until it reaches the haulage road it is approaching. The empty and loaded haulage trucks meanwhile have an 80 ft. wide solid block of coal between loader and haulage road to pass each other. As the empty truck nears the loader it turns around and backs into loading position on the 30 ft. berm. This little loss in loading efficiency is more than compensated by stripping yardage gained in stripping efficiency. By the time the loader has loaded out to its haulage road, the stripping shovel has excavated to the next haulage road to which it has been advancing. Having excavated beyond the haulage road, the loading shovel now dead heads up to where it first "sumped in" and then it loads following the stripper; but as the stripper has passed the next haulage road, the trucks go out this new haulage road, which is back of the stripper, the stripper being in the next adjacent tract.

When the stripper has reached one of the haulage roads its efficiency is cut somewhat in casting the spoil back of it for the dragline to reach, in order to keep the haulage road open—although that haulage road at that time is not being used. In crossing this haulage road then the dragline leaves the shovel and deadheads back over its path that it has previously made, then down its incline to the level of the haulage road, across the haulage road, up the incline on the other side of the haulage road, then over to the spoil at the shovel to again help it spoil the surplus. This operation repeats each time a pit haulage road is crossed. The present dragline incline and crossing of haulage road was about 500 ft. back of the present cut. These crossings are moved ahead, to shorten deadheading distance, when desired, as circumstances require.

With such layout as described above and with the synchronized operation of the shovel and dragline, the shovel has the last year averaged about 800,000 cu. yd. per month, and a maximum of 1,000,000 cu. yd. per month; ratio of 12 to 14 cubic yards overburden to 1 ton raw coal.

Average over burden for year was a little over 60 ft. The record depth of stripping was 93 ft. for about 100 ft. of advance, through a knoll. Last year's annual production was about $1\frac{1}{3}$ million tons of coal for the two strippers. Spoil pile slides were practically nil.

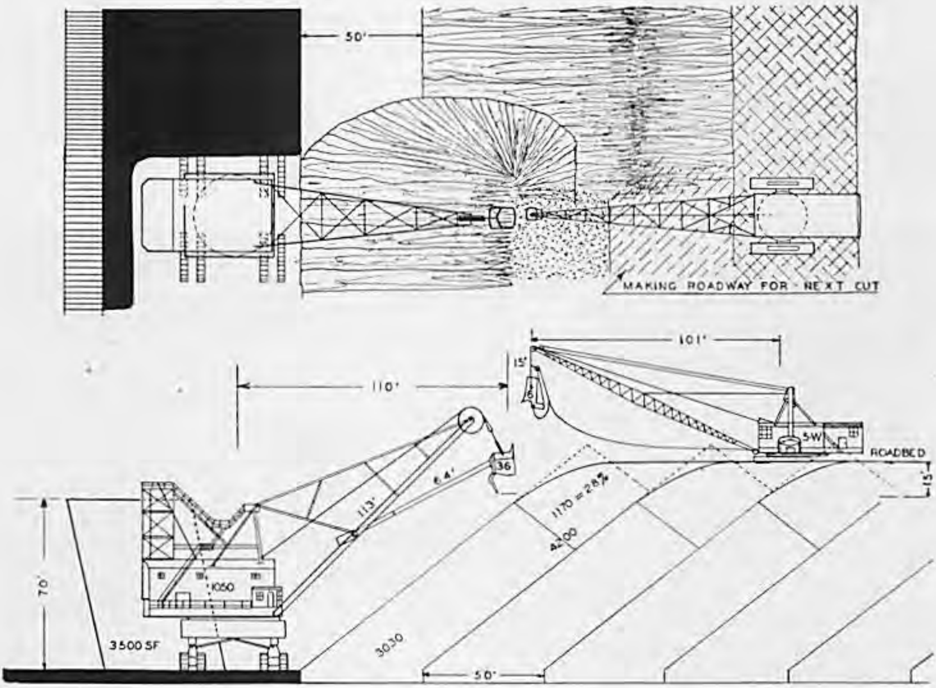

Fig. 3. Enos digging and spoil plan

DRAGLINE ONLY—ON PREPARED BENCH—SHALE AND ROCK

The Maumee Collieries Company—Chieftain Mine

The Chieftain Mine is located in Vigo County, Indiana. The No. 5 vein is about 4 ft. 5 in. thick here and overlain with alternating strata of shale, sandstone and limestone—reaching a total depth of 85 ft. in the stripping area. The two 6 ft. strata of limestone and one 6 ft. of sandstone are rather uniform and consistent throughout this immediate area of stripping; the greatest variation in any strata being the sandy clay surface, which varies according to the topography.

The mine consists of two stripping operations or pits, a Bucyrus electric dragline, 215 ft. boom, 25 cu. yd. dipper in one pit, and a Marion shovel, 96 ft. boom, 18 cu. yd. dipper in another. The Marion shovel is aided by a Lima dragline, 85 ft. boom, 2½ yd. bucket. Working only two shifts, with its companion dragline working three shifts in order to catch up, it has stripped an area varying from 57 to 73 ft. Both pits are served by one truck haulage road, located between them. The road is advanced as the two strippers approach it, and starting again new cuts, as noted on diagram plan.

Dragline Operating Plan

As shown in Fig. 4 an open pit of 90 to 105 ft. is maintained. This necessitates loading the coal out in three parallel strips, and following the dragline, taking all the coal from spoil to highwall, leaving no berm. The dragline advances the pit in one direction only, excavating from the haulage road until it reaches the end. The length of pit is seldom more than one half mile. As it advances excavating, it makes a bench on its highwall side, from 180 to 200 ft. wide, its depth varying from 5 to 15 ft. On this bench the dragline returns deadheading to the

Dragline at Maumee Collieries, Chieftain Mine

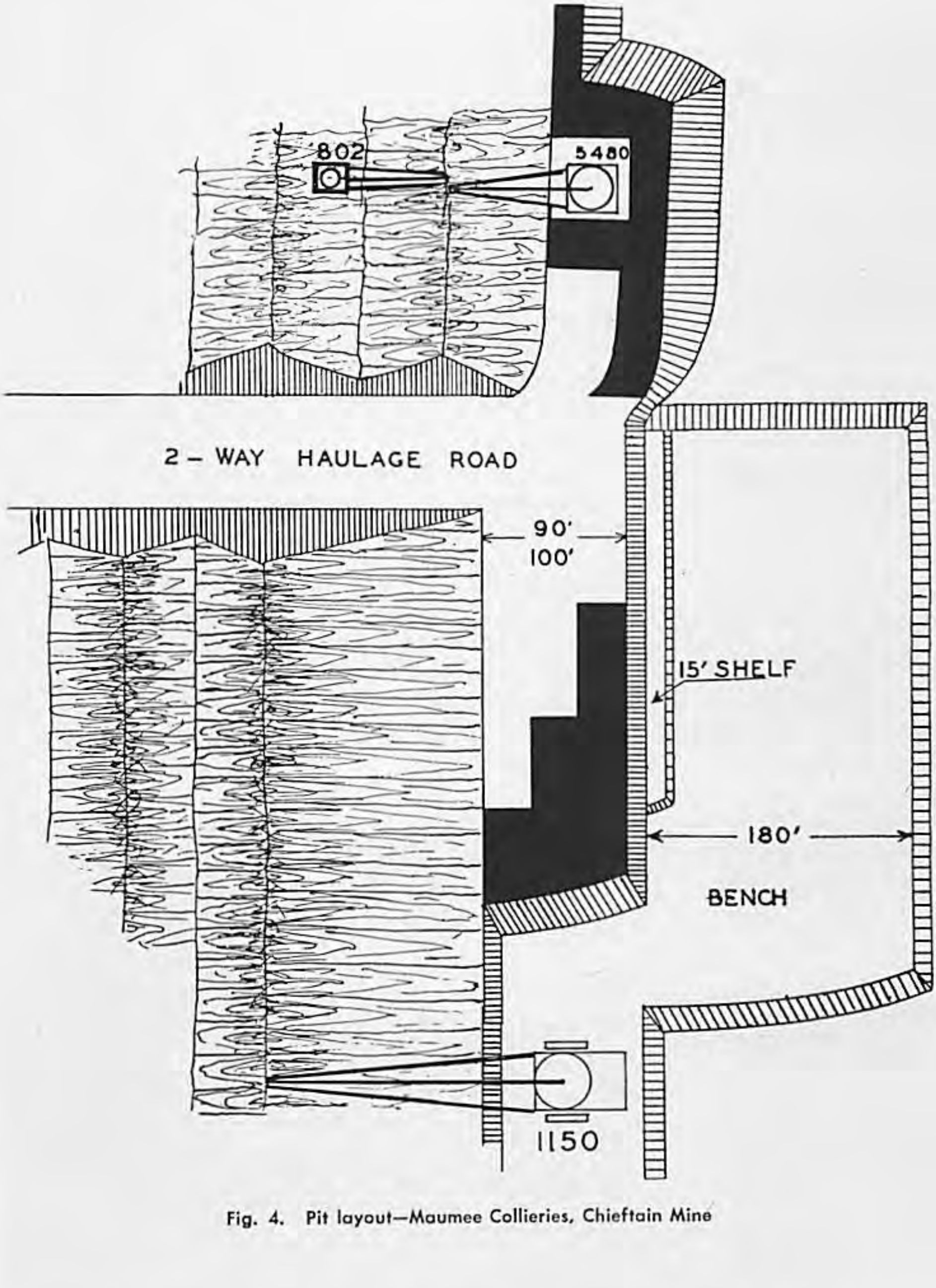

Fig. 4. Pit layout—Maumee Collieries, Chieftain Mine

haulage road, to again start excavating from the road to the pit's end. On the bench also three churn drills work for blasting the overburden by Hercules dynamite. On the open side of the bench at the highwall, a recess or shelf is made above the hard strata by deepening the bench to the rock strata, for a width of approximately 15 ft. This shelf acts as a safety factor in that it acts as a catch basin for the loose dirt or small slides of the bench from sliding into the pit onto the coal before it is removed.

Performance

The average depth of the 1150 stripping for last few months was about 75 ft.; a ratio of 16.3 cu. yd. to 1 ton solid coal, or 19.7 cu. yd. to 1 ton washed recoverable coal at 82%. The maximum depth was 86 ft. for a distance of 500 or 600 ft.; a ratio of 18.7 cu. yd. to 1 ton solid coal, or 22.5 cu. yd. to 1 ton washed recoverable coal at 82%. The average monthly yardage of the 1150 was about 800,000 cu. yd. the maximum being 900,000 cu. yd. The combined washed tonnage from both the dragline and the shovel pits varied from 58,000 to 65,000 tons per month.

DRAGLINE ONLY—ON BENCH—NO ROCK

Fairview Collieries Corp.—Harmatten Mine

This operation is in Vermilion County, Ill., approximately 4 miles west of the center of Danville, Ill. An odd coincidence is that the present Harmatten coal field is less than two miles from the historic "Pioneer Workings," which were the beginning of the present-day huge strip operations. The seam now being stripped is the Illinois No. 7, averaging about 6 ft. 1 in. thick and fortunately underlaid by an extra hard fireclay, permitting the coal haulage trucks to travel on this fireclay

Dragline—Fairview Collieries, Harmatten Mine

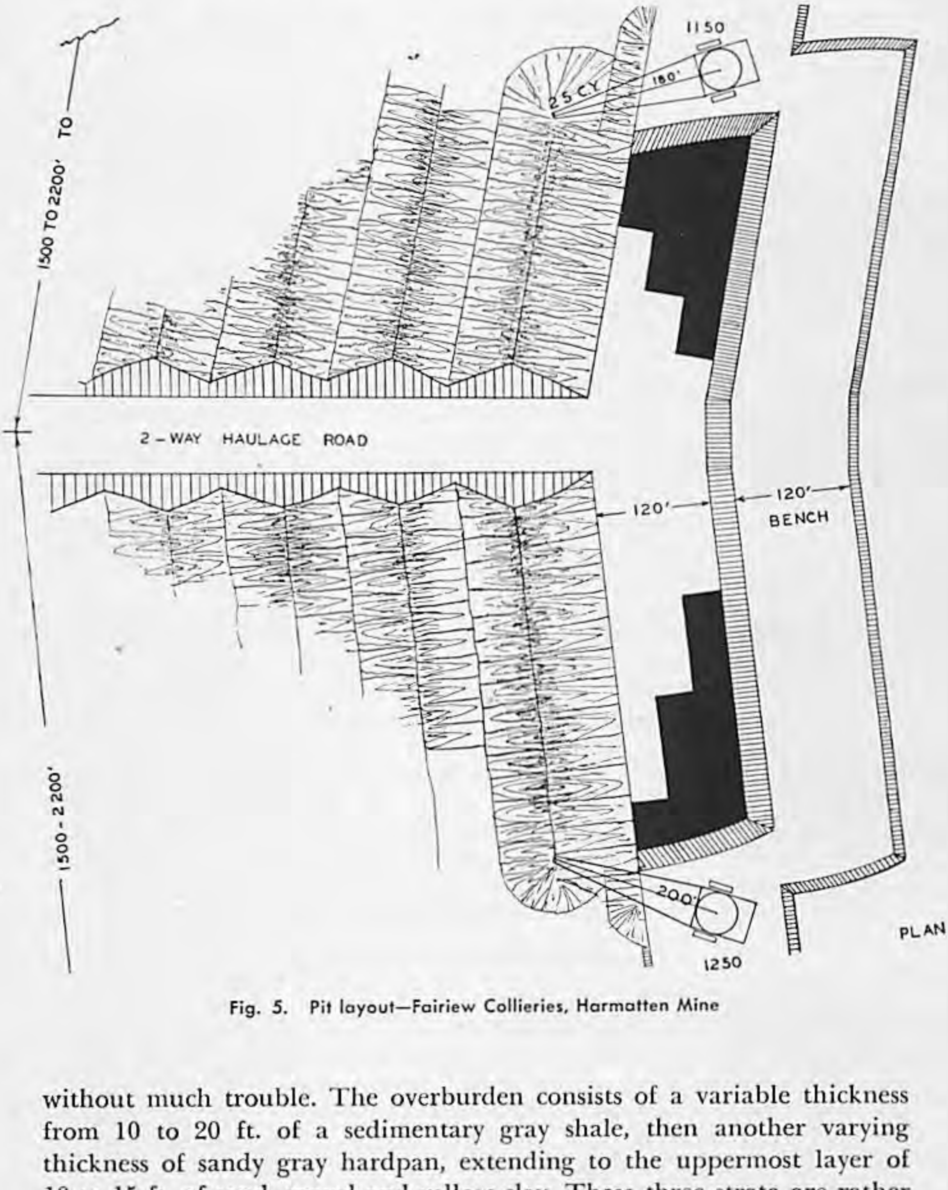

Fig. 5. Pit layout—Fairiew Collieries, Harmatten Mine

without much trouble. The overburden consists of a variable thickness from 10 to 20 ft. of a sedimentary gray shale, then another varying thickness of sandy gray hardpan, extending to the uppermost layer of 10 to 15 ft. of sand, gravel and yellow clay. These three strata are rather consistent through the field, regardless of depth, the hardpan varying greater in thickness as total depth increases. The upper portion of the overburden is rather soaked with water, and it is common for streams of water to be bleeding from the highwall. There is no limerock nor sandstone. The shale directly over the coal does not require shooting.

Hence overburden stripping to 90 ft. and over with no overburden shooting is practical.

Pit Layout

The diagram in Fig. 5 does not show the entire layout of the property, but only that portion or tract now being worked. The equipment consists of a Marion electric coal loading 7½ cu. yd. shovel, and two electric Bucyrus draglines; one 180 ft. boom, 25 cu. yd. dipper; the other a 200 ft. boom, 30 cu. yd. dipper.

There is one two-way truck haulage road from preparation plant to pit. This haulage is maintained on floor of pit, being kept open, and advanced as each of the two draglines make their cuts on each side of and at approximately right angles to this road. Each dragline, one on each side of the haulage road, starts at the road, stripping in opposite directions. Each excavates an open cut 120 ft. wide at bottom on coal, at same time taking 15 to 20 ft. depth of the soft surface overburden for a width of 120 ft. off the highwall side. This makes a bench for the dragline to travel on in its return trip to its starting place at the haulage road, after it has completed the full length of the pit. The pit varies from 1500 to 2200 ft. in length in that particular tract; the variable length pits depending upon several factors.

Meanwhile the draglines stripping is being followed by the coal loader going in the same direction. The 120 ft. width of coal from spoil to highwall is loaded out in three parallel cuts, each 40 ft. wide by 150 to 175 ft. long, and leaving no coal berms. The first of these cuts was on the spoil side to preclude slides. The highwall is loaded last. It is very noticeable how much coal loss from spoil rib coal is eliminated by the three 40 ft. cuts of coal. The 120 ft. wide coal cut gives greater maneuverability for the trucks, coal drill and loading shovel. Depending upon operating conditions relative to breakdowns, slides, etc., the loading shovel shuttles back and forth between the two pits to keep itself in coal. It always has a clear road, never being obstructed, nor does it interfere with the two dragline strippers by its loading operation.

Excavating Cycle of Stripping

The excavating cycle is as follows:

(1) The dragline digs the key cut and spoils this lower or harder material at the toe of the spoil bank, thus helping to prevent slides. (2) While still in position it removes the berm material, depositing it into the V-cut and beyond. (3) The dragline moves to the next position and makes the regular dig of the harder material lying directly over the coal, and deposits it beyond the V and well into the spoil pile. (4) Then moving to the third position it rehandles the V-dirt. Being close to the spoil bank, it can deposit this dirt easily with possibly 50° or 60° swings.

Two basic decisions were made following a study and discussions of the operating and engineering departments, namely: (1) The V between highwall and spoil to be filled to preclude any chance of the dragline sliding into the pit. (2) The bench be carried approximately 20 ft. deep so as to get below the water bearing strata.

Without going into how the 120 ft. width was arrived at, note the following advantages of the wide cut over narrow cuts: The overburden rehandled in V cuts is considerably less. The shorter total distance dragline deadheads back to haulage road, due to lesser number of trips. In percentage, the total dragline operating cycle of whole field is less. There is a decreased number of key cuts. In case of slides, the advantage is obvious. There is less amount rib coal loss. Three coal cuts make better maneuverability of loading machines. The overburden from bench at 180° swing is the same, regardless of width. Conclusion from above was that greater yardage could be moved by wide cuts; under conditions with no hard shales or rock.

Performance

Each of the two draglines are handling about the same amount of yardage per month. This varied from 500,000 to the record of 700,000 cubic yards of virgin overburden, which does not include the "V" cut or rehandled spoil. This rehandled dirt averages about an estimated 15% and would be added to previous figures for actual moved yardage.

The average depth of overburden for past several months varied from 70 to 80 ft., averaging about 75 ft.; or a ratio of 11.2 to 1 for raw coal or 14 to 1 for recoverable coal at 80%. The maximum depth stripped to date is 84 ft.; a ratio of 12.6 to 1 for raw coal @ 6 ft. 1 in. or 15.7 to 1 for recoverable coal at 80%. Some 90 ft. stripping is expected, if so a ratio of 13.2 to 1 for raw or 16.8 to 1 for washed coal. The monthly average washed coal ranges from 75,000 to 125,000 tons. Slides from both spoil and highwall cause some nuisance at this mine.

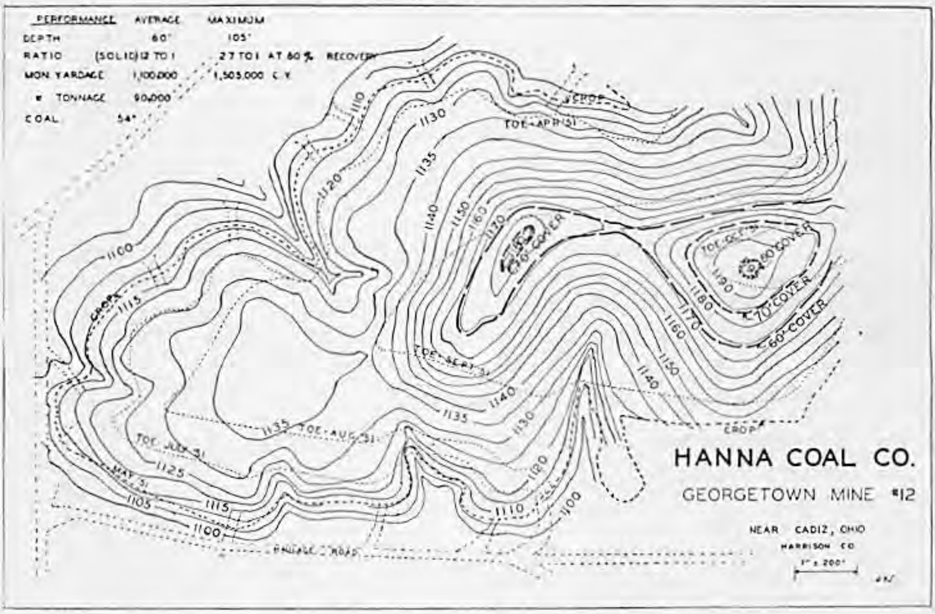

Fig. 6. Contour map of stripping area—Hanna Coal Co., Georgetown Mine

SHOVEL ONLY

Hanna Coal Company—Georgetown Mine

The Georgetown Mine is located in Harrison County, Ohio. The mine operations consist of one large central washing preparation plant, supplied by coal from several pits; four pits of which contain the Marion electric largest shovels. Three shovels use a 45 cu. yd. and one has a 50 cu. yd. dipper, 62 ft. sticks, and a 120 ft. boom.

The coal stripped here is the Pittsburgh No. 8 which is 54 in. thick. Where the coal is of 85 ft. depth it is immediately overlaid with 6 to 8 ft. of shale; above is the hard and white "Fishpot" limestone ranging from 20 to 25 ft., and the "Uniontown" shales from 30 to 35 ft.; then the yellow clay surface from 5 to 20 ft. The topography of this large stripping field is very irregular and very rolling, traversed by many deep valleys and steep hills. The coal usually is above the elevation of the valley and outcrops in the hillsides. The seam lies almost level.

METHOD OF OPERATION

As the stripping area consists of many ridges with projections branching off it is mined by the general method of contour stripping. A typical pit area covering about 60 acres is shown in Fig. 6.

The shovel opens the pit on or near the crop line, depending upon quality of coal, beginning at one of the valleys and stripping back and forth, following in general the surface contours, thereby maintaining an outside curve for the spoil. Haulage roads are made frequently and maintained in the pit so as to eliminate trucks passing the stripper. About 85 or 90 per cent of the haulage is maintained in this manner. As the pit is decreased in size the highwall is maintained on each side of the ridge almost parallel to the contour lines. Where the maximum depth is made in crossing the ridge, the pit is brought to an apex so as to gain spoil room in crossing the ridge. The depth of the stripping limit is planned about 85 ft. however, greater depths are sometimes made in crossing the ridge. The pit is maintained at an average width of 90 ft., 45 ft. for coal berm and 45 ft. for coal loader.

The overburden ahead of the Marion is blasted by LOX (liquid oxygen); the holes are drilled by the Joy Heavy Duty Rotary-Air drill. The one drill keeps ahead of the stripper most of the time, but occasionally aided on a swing shift by another similar unit. (Mr. J. S. Harmon, Gen. Supt. of Strip Operations, gives a complete description of this operation.)

PERFORMANCE

The combined yardage of excavation for the 4 large stripping shovels the last year was 49,081,000 cu. yd. or an average of 1,100,000 cu. yds. per shovel per month. The maximum for 1 shovel for 1 month was 1,505,000 cu. yds.

The average depth from the crop to the average present highwalls is about 54 ft. But excluding the shallow crop coal overburden, the average depth will be about 60 ft., or a ratio of 12 cu. yd. overburden to 1 ton solid coal, or 15 to 1 of recoverable washed coal at 80%. Average depth of each of 4 large shovels is 52, 54, 62, 64 ft. respectively.

The portion of map shown in diagram gives a good example of the method of working but does not show a great amount of deep stripping area. Of the 60 acres shown, only 6 acres were above 60 ft., or just 10%

SUMMARY OF DATA

AVERAGE OVERBURDEN

Thickness Coal Seam	*Mine*	*AVERAGE Ft Overburden*	*Maximum—Ft Overburden*
53 in.	Chieftain #20	75 ft	86 ft
73 in.	Harmatten	75 ft	84 ft
56 in.	Cuba #9	70 ft	85 ft
54 in.	Georgetown #12	60 ft	105 ft
56 in.	Enos	60 ft	93 ft

RATIO OF OVERBURDEN TO COAL
(Overburden given in cu. yds)
(Coal in tons)

Thickness Coal Seam	*Mine*	*AVERAGE OB To 1 ton Solid Coal @ 1770 ton per ft-acre*	*Maximum—OB To 1 ton Washed Coal @ 80% Recovery*
53 in.	Chieftain #20	15.5 to 1 @ 75 ft	22.0 to 1 @ 86 ft
56 in.	*Cuba #9	13.7 to 1 @ 70 ft	20.7 to 1 @ 85 ft
54 in.	Georgetown #12	12.1 to 1 @ 60 ft	26.6 to 1 @ 105 ft
56 in.	Enos	11.7 to 1 @ 60 ft	22.7 to 1 @ 93 ft
73 in.	Harmatten	11.2 to 1 @ 75 ft	15.7 to 1 @ 84 ft

CUBIC YARDS EXCAVATION PER MONTH PER UNIT

Thickness Coal Seam	*Mine*	*AVERAGE Cu. Yd. per Month*	*Maximum Cu. Yd. per Month*
56 in.	**Buckheart #17	1,200,000	1,529,000 950—831,000 Wheel—698,000
54 in.	Georgetown #12	1,100,000	1,505,000 Shovel Alone
56 in.	Enos	800,000	1,000,000 Shovel Dragline On Spoil
53 in.	Chieftain #20	800,000	900,000 Dragline Only
73 in.	***Harmatten	500,000***	700,000 Dragline Only

* Cuba #9 Mine used as similar operation and equipment, but had deeper overburden.

** Buckheart #17 Mine used as monthly record, has a larger wheel than at Cuba Mine. Each of the two wheels are used in combination with 950 shovel

*** Does not include rehandle yardage in "V" at spoil, which amounts to about 15%, making the dragline actually handling about 575,000 cu. yd. per mo.

of the area, but it contains 20% of the total yardage. If the total yardage on the 60 acres were considered, the average overburden from zero at crop line to 85 ft. at top of knoll would give an average stripping depth of 34 ft. for the 60 acres, or a ratio of 7 to 1 of solid coal. Thus with the 60 ft. average, it is noticeable that a much larger area of deeper stripping is encountered elsewhere than noted on this ideal tract.

A maximum depth of 105 ft. was obtained for about 100 ft. at the apex of a cut in crossing the ridge, which would mean a ratio of 21 cu. yd. to 1 ton of solid coal, or 26 to 1 of recoverable washed coal at 80%. Each of the 4 large shovels has maintained stripping approximately 90,000 tons per month of washed coal.

A modified stripping limit of 85 ft. is the present plan, having a ratio of 17 cu. yd. to 1 ton solid coal, or 21 to 1 of recoverable washed coal at 80%.

Conclusion

In last ten years with the advent of the largest stripping shovels and draglines that Marion Power Shovel Company and Bucyrus-Erie Company have produced, we have seen a remarkable increase of deeper overburden stripping in the bituminous fields of the midwest. Ten years ago stripping averaged about 50 ft. to a maximum of 65 ft. by the large strippers. Today the present stripping depth by large strippers averages approximately 75 ft. and maximum of approximately 90 ft. Ten years from tomorrow, what?

* * *

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NEW DEVELOPMENTS FOR COAL UTILIZATION

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Several times during this spring of 1952, after reading of river floods and spring freshets, I've thought of the story my father used to tell of the coal industry as he knew it as a young man on the Monongahela River in 1892. At that time the only outlet was by river shipment because no railroads had then been built into the area. Many of the barges used in transporting the coal were hastily constructed of green lumber cut from local hardwood forests. They were loaded with coal and shipped down river as far south as New Orleans where the coal was removed and the barges dismantled to salvage the lumber for local sale.

The market at that time was on a "coarse-coal" basis *exclusively*. Coal below about 1 in. was considered just plain, useless dirt; the miners were paid for *only* the plus-1 in. size they loaded into mine cars, and the customers bought *only* plus-1 in. One of my father's first jobs was to see that the coal skiffs placed on the river under the bar screens of the tipple were always emptied when full. This emptying job consisted of rowing the skiff into the middle of the river and dumping the screenings. I might add that this dumped coal was of the highest metallurgical quality ever produced in the U.S.A., and that today's best coking practice suggests that all coal fed into present-day coke ovens should be crushed to minus 1/4 in. This is something to give us a turn when we consider it in the light of the presently limited metallurgical coal reserves in the Pittsburgh district.

Coal was then sold by the bushel and a mutually satisfactory price was arrived at in this fashion: the mine owner stood on the edge of his river tipple exchanging arm signals, hand signs and wig-wags with the steamboat captain-owner, who usually stood on the pilot house of his vessel in the middle of the river. After a few minutes of haggling, if they had not come to terms on the price, the steamboat would push the empty barges on up the river and the captain would repeat the wrangling gyrations opposite the next mine tipple. If the steamboat owner had not been able to place all his empty barges at his price after passing the last up-river tipple, he would return and, relenting, make a deal at a slightly higher price and leave his last empties. The mine would then start operations to fill the barges, even if it were late in the afternoon. I wonder sometimes if our planning today in the coal industry is basically very much longer range: if in some ways we are not still standing on a dock and gesticulating when we should be moving with the current buoyed up with new concepts instead of bucking the current as the tide floods.

Market Demand for B.T.U.

One very definite trend in our present business, and it will become more pronounced in our future, should be clear to all of us: while my grandfather had no customers for coal finer than 1 in., we are rapidly coming to the time when we will have no customers of great national significance for coal coarser than 1 in. It is just a question of time before *all* coal must be sold on a heat-unit or analytical basis. When this time arrives, it will completely change around all our past concepts of how coal sizes play a part in coal mining and coal selling economics. Our growing markets are those that ignore coal sizes; they are those users that buy and consume only units of energy in solid form. Notably in this classification fall the electric utility industry and the steam generating stations of our expanding industrial system. Special uses for coal are growing, too, in the steel, electrometallurgical and chemical industries. Here again there is no particular premium for the size of the coal purchased. In almost all such cases the coal is crushed fine before it is used, and it is purchased for its chemical qualities only. The foregoing two general categories of our future customers are growing. All the others are shrinking: railroad fuel, the smaller hand-fired industrial and commercial customers, and the domestic household user.

What with the striking growth recorded in the number of coal customers that want only heat units or chemical properties regardless of coal sizes, any realistic examination of the possibilities for the future of coal must take this changing situation into account. Among other things, for example, we should inquire of ourselves whether this change in demand as to sizes doesn't call for some drastic reshaping of our thinking as it relates to production and pricing policies. I make this point because it seems to me that the decisions we reach on such matters may well shape our ability to sell, at destination, heat units at a price below that of competing fuels. This tide is very definitely turning and may sweep us hard aground in the shallows if we do not move boldly into the open sea on which we are now afloat.

Cheaper Transportation Needed

We have five great possibilities that could offset our large tonnage losses of the recent past and perhaps increase the overall demand for coal beyond any past records. The first and rather obvious possibility is to expand our markets under large boilers by replacing oil and gas now being used there. This can only be done on a long-term basis by reducing our delivered cost of heat units at these boiler locations. We must continue to do everything possible to reduce the mine-mouth cost of our coal, and from here on out we must begin to utilize all possible cheaper forms of transporting our coal from the mine-mouth to our markets.

In view of recent additional railroad freight rate increases, we should all review and carefully study all possible methods of getting our coal to market by trucks, by river, by conveyors, by aerial tramways, and by all possible combinations of these methods. We should review with electric power companies, the idea of making more power at the mine-mouth, or close to it, and moving the power to market via wires rather than railroad cars. If development work is necessary to prove up some of these different methods, it should be undertaken without delay and with the fullest cooperation of our industry.

In Pittsburgh Consolidation Coal we have high hopes that the pipeline method of transportation can be integrated into combinations of these different methods in order to give coal a new competitive advantage not now possible. Here again let me say that the pipeline development points in the direction of fine-size coal. As a matter of fact, our studies show that it is impractical to consider pumping coarse coal through long pipelines. Thus, it is just a question of cost per million heat units. It has been made demonstrably clear to all of us that the cost of moving coal to market by rail is ever increasing while at the same time the cost of moving gas and oil, our chief competition, to market through the use of newly developed techniques is decreasing. So coal must, and I believe will, find a way out of this dilemma. Coal placed under boilers now using gas and oil where coal is available, could increase coal's markets by 30 to 60 million tons a year.

Increased Electric Power

A second way of greatly increasing our markets is by promoting the development of methods of producing and distributing electricity from coal more cheaply. The electric power industry is expanding very rapidly, but we might stimulate that expansion and help make it even more rapid and far reaching if kilowatt-hours could be sold more cheaply. Many possibilities suggest themselves, including wires for transporting KWH's instead of coal from mine to market, and it is the real obligation of the coal and electrical industries to explore them all actively. It has been stated that if electrical energy could be sold for 20% less, its use would double in the U. S. A. If this were an accomplished fact, we could have had a present-year utility market of 220 million tons instead of 110 million tons, and a projected 1960 market of 200 million tons *more* than that now estimated for large power plants.

The prospects in the comparatively early future for expanded electrical energy uses are virtually endless. If we gear our business into this opportunity with effectiveness, there is really no telling how far we might go. I'd like to think our loud with you on what I believe to be some of these practical opportunities. Let us look at the cycle of expansion in aluminum capacity as one example. When the present cycle has been completed, the nation will have plants for a yearly production of about 1,500,000 tons of this metal. If still more capacity should be needed, and many in industry and government are convinced that it will, there is every possibility that coal will be the source of power required to produce it. As far as I know there are no figures available as to projected further expansions. Let us assume, however, that the present and planned capacity will again be expanded within a few years by just 10%, and that this increase will be based on coal power. How much coal will be required to meet this demand?

It now takes about 9 KWH's of electric energy to produce a pound of aluminum. Optimum efficiency in generating power from coal at the present time requires about 0.7 pounds of coal to produce a kilowatt-hour. The production of each pound of aluminum would thus require a minimum of 6.3 pounds of coal. Using these figures as a measure, an increase in the national production of aluminum by 10% or 150,000 tons, would provide a market opportunity for coal of some 950,000 tons annually. If, as we believe it might, carbonization is employed ahead of the power station, the annual tonnage here would jump to about 1,330,000 tons.

While this is hardly an astronomical figure to an industry used to dealing in millions of tons, it represents an application that has a pivotal importance for the future. If aluminum some day expands to four or five million tons per year—and most of the new capacity is based on coal-generated power—it could consume very significant quantities of coal annually. There is also magnesium which is produced through the use of considerably more power than aluminum requires. Also, now being considered for titanium production is a process that would consume about four times as much electric power as that needed in producing aluminum. Other promising new market opportunities for the use of coal-based electric power include the making of more chlorine, sodium and phosphorus.

Moving away from industry for a moment, there is on the horizon the dream of wide-spread electric home heating, the ultimate in automatic convenience, control and safety. The development of the heat-pump principle has moved this dream much closer to materialization. Although capital costs are presently rather high and some technical problems need to be solved, more applications of the heat-pump in combination with air-conditioning will be made in the near future. The first general applications will probably be in multiple dwellings and commercial buildings. Here again the basic cost of the electric energy units is the important factor in the ultimate success of this development. For this reason the question of how the coal industry can assist the power companies to produce cheaper electric power is a prime matter for us to be concerned with.

Frequently we are asked when discussing this potential growth in electric energy demand, whether the growth will not be counterbalanced by greater efficiency so far as the market for greater coal tonnages is concerned. Frankly I don't think so. This business of converting more and more power from a pound of coal has been going on for a long time. Meanwhile, electric utility fuel markets keep increasing. This means, and I feel it is important to emphasize the point, that improved efficiency in the burning of coal creates far more coal demand than it displaces.

Pipelines may lower coal transportation costs

Gasification and Liquefaction

The third prospect for new coal markets is in supplementing natural gas sources with gas made from coal. New processes and techniques now being worked on must be developed up to the commercial stage before this market becomes a reality. The possibilities here are enormous, and the technical potentialities are most promising. If the coal industry in 1960 should be required to supply only about 10% of the country's needs at that time for gas, the necessary conversion plants would consume around 100 million tons of coal a year.

The fourth and quite possibly the largest market opportunity for coal over the long pull is the conversion of coal into liquid fuels. As you know, this has been done in Germany and England for years. You also know that liquid fuels thus produced would not be presently competitive in this country with those from natural sources. In fact, the older coal conversion processes such as the direct hydrogenation of coal have been abandoned in all of western Europe and in England because they have been found to be no longer practical even in this area where no natural petroleum exists to any extent.

Further research and new concepts and processes will be required before the economic conversion of coal into liquid fuels can become a reality. There is more than a little promise here, however, and signs certainly indicate that this development is not simply an idle hope. There is ample evidence at hand to cause many of us to believe it will become economically feasible by 1960. If and when this hurdle is cleared, what does it offer in the way of a promise for the coal industry? Let us assume that by 1960 the demand for liquid fuels will be such that only 10% of that demand will be produced from coal. In that case the requirements would be about 180 million tons of coal a year.

By-Products and Low Temperature Carbonization

In addition to these four basic avenues to increased future coal markets, I visualize a fifth development that connects up with all four, while at the same time developing opportunities in the chemical market. This interim approach is involved in our company's research and development on the partial conversion of coal through a new form of low-temperature carbonization. Our idea here is to dovetail this development of coal processing with our overall objectives by advancing in the near future on all four of the fronts I have discussed.

In this process we squeeze out some special values from the volatile elements such as chemicals and gas and still can produce a more economical solid fuel that will be suited for firing under boilers. A portion of the distilled liquids not directly usable as chemicals could be converted into more chemicals, and when markets warrant it into liquid fuels. There is flexibility in this approach, since changes in the demand could be at least partially met by changing the yields thru process variations. Such a process will first be used to produce chemical intermediates from the distilled tar products. At a later stage in the evolution of coal-based synthetics, the demand-price picture will permit the conversion of some of these tar products into synthetic liquid fuels. As a larger demand for gaseous and liquid fuels develops, it could be accommodated by the gasification of the solid char produced and not used under boilers, as well as by using other processes yet to be developed for the complete conversion of coal. I believe that this step-by-step approach toward complete coal conversion will bypass many of the difficulties and certainly ease the capital requirements that would be involved if we pushed the now outmoded European processes for the complete conversion of coal.

Many good articles have been published lately about the future energy requirements of the United States. A lot is also being printed about future uses of atomic energy that will make electricity so simply and inexpensively. If you are worried about this, I commend to you the following story. A man who has been very close to all major atomic research since the United States started work on the bomb project about 10 years ago, is now telling this tale.

A Martian space ship lost its bearings and landed by mistake on our planet. Their time here was limited because their fuel was expending itself, so they asked to be shown only our method of providing energy for our people before they had to take off for Mars. When they returned home, the other Martians were naturally interested in their fleeting impressions of the planet Earth. The leader of the group said these inhabitants of Earth were the most fortunate people in the universe. He told them that whereas the Martians had had to develop and to depend upon nuclear fission to provide their sources of energy, these very lucky Earth-people simply dug holes in their planet and brought to the surface chunks of black stuff containing a high percentage of carbon. The Earth people merely pushed this material under boilers where it readily burned, releasing heat and making steam that drove turbines that drove generators that made electricity, just like that!

Summary of Coal's Future

To summarize I have outlined five possibilities for expanding coal's markets in the future:

1. By reducing the mine cost of coal and by finding cheaper forms of transportation, at least 30 millions of tons of coal a year can replace oil and gas under boilers.
2. By doing everything possible to help electric utilities reduce the cost of their power to their customers, we could pick up at least another 100 million tons a year more than present utility expansion plans call for.
3. By developing and promoting methods of converting coal into a natural gas equivalent, coal could have a market for at least 100 million tons a year at gasification plants.
4. By developing and promoting new concepts and methods for converting coal into liquid fuels, coal could have a market of 180 million tons a year in synthetic fuel plants.
5. By using a new form of low-temperature carbonization the coal industry could soon begin to accomplish on a partial basis the objectives as set out under (1), (2), (3), and (4) mentioned above and be moving step-wise in the right direction.

I cannot predict this morning how this industry of ours will meet the issues and problems projected here. But I feel keenly that delays in approaching the issues realistically can be a misfortune for our combined coal futures. Perhaps the great Bard had more than his immediate cast of characters in mind when he had Brutus say:

> "There is a tide in the affairs of men,
> Which taken at the flood, leads on to fortune;
> Omitted, all the voyage of their life
> Is bound in shallows and in miseries.
> On such a full sea are we now afloat;
> And we must take the current when it serves,
> Or lose our ventures."

DEATH IS SO PERMANENT!

In the month of April, 1952, six loading-machine operators and five loading-machine helpers were killed in the nation's bituminous-coal mines. These 11 deaths were 25% of the bituminous total for April. Furthermore, early returns indicate that more deadly haulage accidents will occur in 1952 than in 1951, unless the present trend is checked. From January through April, 1952, shuttlecar deaths accounted for 35% of all haulage fatalities, a proportion roughly three times higher than in any other year.

Such are current trends, as reported in the *Safety Newsletter,* Coal Mining Section, National Safety Council, by H. F. Weaver, editor, and D. S. Kingery, chief, haulage section, Coal-Mine-Inspection Branch, USBM. Messrs. Weaver and Kingery also report specifically on the circumstances surrounding the deaths of 23 loading-machine operators, helpers and shuttle-car operators. It is to be hoped that a recital of these 23 truly doleful case histories will provide you with knowledge of hazards that will help you prevent such occurrences in your mine or section. As you read, remember that because of human failures these men are dead—and death is so permanent.

How Six Loading-Machine Operators Were Killed

1. The victim was standing at the controls of the loading machine waiting for the arrival of a shuttle car, when a coal overhang, 16 ft. long, 2 ft. wide and 7 ft. thick, fell from the rib of the crosscut where the shuttle-car roadway was being cleaned. Roof bolts were used to support the roof in this place, but they were not involved in the accident. The cause was attributed to failure to square up the ribs during mining operations which resulted in many dangerous overhanging coal ribs throughout the mine.

2. The victim was operating a loading machine at the face of a crosscut when he was killed by a violent outburst of coal which resulted from (1) driving development places toward the core of an overstressed pillar within the abutment zone, (2) failure to maintain a straight, clean break line, (3) failure to make the pillars uniform in size during first development and (4) failure to extract all the coal from pillars in the adjacent worked-out area.

3. The victim was shoveling coal from along the rib so it could be picked up by the loading machine. He advanced in by the last permanent crossbar, which was 5 ft. from the pile of loose coal, and was struck by a fall of roof. The company rules prohibit workmen from advancing under unsupported roof, but in this case the rule was not complied with.

4. The victim was drilling blastholes in a large piece of roof rock that fell on the haulageway; he was standing on the fallen rock when a second fall struck him. The roof above the first fall had been tested and scaled with a tree limb about 18 ft. long, and temporary supports had not been set to warn of or prevent the second fall. A foreman had been assigned to supervise the job of cleaning up the fall.

5. The victim was struck by a fall of roof while operating a loading machine at a pillar face. The fall resulted from failure to maintain sufficient roof supports in the area where the machine was being operated. The foreman was in the place a few minutes prior to the time the fall occurred, but before leaving to answer a phone call had tested the roof (which sounded drummy) and instructed the operator to keep plenty of timbers close to the loading machine.

6. The victim was caught under a fall of roof rock that was 46 ft. long, 24 ft. wide and 16 in. thick. Most of this area, which included a crosscut, was unsupported. The cause of the accident is obvious.

How Five Loading-Machine Helpers Were Killed

1. The victim was crushed between the loading machine and rib when the machine was struck by a shuttle car that got out of control as a result of failure to repair the brake system, which was known to be defective. In fact, the shuttle-car operator had assisted a mechanic in making repairs the day before the accident but the job had not been completed.

2. The victim was operating the loading machine (it was customary practice to relieve the regular operator at various times during a shift) when the machine was moved too close to the posts. In backing the machine from the face, the victim's left foot was caught under the right tread, and to effect its release he stopped the right tread causing the machine to swing and squeeze him between the controller casing and a post. The victim was in such a position that he could not reach the safety switch, the tramming-control safety catch had fallen down and his body had the tramming-control lever fouled.

3. The victim was pulling the trailing cable ahead of a loading machine that was being moved from one room to the next when he was struck by a fall of roof in the room. Cause of the accident was failure to follow the adopted plan of roof bolting. The roof-bolting machine had broken down and when it was returned to service roof-bolting was started at the face instead of at the last row of bolts, leaving a 16-ft. length of unsupported roof. The fall occurred in this unsupported area.

4. The victim was caught under the same large fall that killed the loading-machine operator, as described earlier.

5. The victim was killed by a fall of roof 22 ft. long, 29 ft. wide and 5 in. thick in an entry. The set of four headings had been driven through an area that had a roll in the roof. The roll had been taken down in all but the one heading where the fall occurred. Despite the known dangerous condition of the roof in this roll area, it was virtually un-

supported. Many of the posts that had been set out by the fall were not capped properly. The seam was 56 in. thick but the posts provided were only 46 in. long, and the foreman had visited this place about 15 minutes before the fall occurred.

How 12 Shuttle-Car Deaths Occurred

1. The victim, a part-time operator making a fill-in trip for the regular operator, struck a crossbar while passing through a check curtain. The crossbar allowed only 3 in. overhead clearance and the chuck curtain obscured the abrupt clearance change.

2. The victim was killed when he was wedged between the roof and the shuttle-car steering wheel at the discharge point. Adequate overhead clearance was not provided and the shuttle-car was improperly maintained.

3. The victim evidently was standing up to operate the car and struck his head against a low crossbar or the coal rib.

4. The victim struck his head while raising to pass through a check curtain. Overhead clearance was abruptly reduced to 11 in., and the abrupt change was concealed by the check curtain.

5. The victim caught his head between the back rest and a half-header extending into the haulageway. Overhead clearance was reduced to 3 in. and it is assumed that the victim, who was operating a strange type of shuttle car, turned his head briefly to watch the rear of the car clear some suspended cables.

6. The victim, a man with no experience around shuttle cars, endeavored to turn a shuttle car around. Although he had many close escapes while maneuvering and his buddy begged him to stop, he persisted until he was killed.

7. The victim, a man with one day's experience, was killed while maneuvering the shuttle car at an intersection. The victim was 51 years old, had expressed fear of the shuttle car to fellow workers, and often had been helped out of dangerous situations by the other shuttle-car operators.

8. The victim turned right into the haulage heading and knocked out a check curtain attached to a 1-in. board. He evidently became excited, jumped out of the shuttle-car, and was squeezed between a post and the car.

9. The victim, a trainee, was returning with an empty shuttle car. He evidently was going too fast, turned the steering wheel in the wrong direction and struck an overhanging coal rib.

10. The victim missed a turn going into an intersection. Rather than back up and start again, he tried a sharp angle turn and was squeezed against the rib.

11. The victim, a loading-machine helper, was standing by the loading machine. When the shuttle car approached, the controller stuck and

the brakes failed to operate. The car struck the loading machine, causing it to squeeze the victim against the rib.

12. The victim was killed when his shuttle car was struck by another car barging through an intersection without stopping.

Lengthen the Odds in Your Favor

Whether your motives are selfish or otherwise, you have a perfect right to work toward the establishment of an enviable safety record in your mine or section. It's the record that counts, since it shows that accidents like the foregoing have been prevented.

But good safety records are not matters of luck. You have to stay one jump ahead of the next accident, and that takes forethought. In thinking ahead and applying definite preventive measures, you will be lengthening the odds in your favor. And the best way to lengthen the odds in your favor is to apply measures that will prevent accidents even though human failures occur.

In this regard, consider the machinery guards which are placed over exposed gears. If a workman's hand becomes caught in a set of gears, we say a human error was the cause of the injury. He should not have had his hand near the exposed gears or he should have stopped the gears before approaching them. You would think one such accident would present such a striking object lesson that the error would never again occur. But in the days before machinery guards, the error occurred time after time.

Machinery guards, when properly used, provide an answer to the problem because they will prevent the injury even though the human error is committed.

Let's examine the foregoing list of accidents to see if it contains an applicable parallel. Note that four of the shuttle-car operators were killed as a result of striking their heads against objects or getting caught in low clearance. These tragedies were caused by human errors, but the victims alone may not be responsible. The errors may have been committed by bratticemen who built curtains with insufficient clearance, or by machine operators who left overhanging ribs in place, or by bosses who failed to see the potential injuries in these conditions.

As in the machinery-guard example, the solution lies in removing the hazards to prevent injuries even though human failures occur.

Let's set up a hypothetical case to illustrate the point.

Assume that you are in charge of a mechanized section which includes two shuttle cars. Assume further that three check curtains hang across the shuttle-car routes. If each shuttle car makes 30 round trips per shift, from face to discharge point, your section contains 180 accident possibilities per shift, counting only those approaches from the blind sides of the curtains. And these accident possibilities are of the type that contributed to two of the shuttle-car fatalities. To lengthen the odds in your favor, you will have to eliminate the nailing board behind the check curtain if you can't eliminate the curtain itself. You might even turn the board flat against the roof and bolt it there, if you have to.

Remember, in a coal mine, any one of a host of distractions could claim a shuttle-car operator's attention at the precise moment when he should be thinking of ducking his head to get safely under a nailing board. Subtract from his mental burden by providing him with adequate clearance.

Proceed in the same manner with other types of accidents. Analyze accident reports, try to pinpoint the level at which human failure contributed most to the accident, then search for safeguards that will prevent injuries even though these human failures occur.

That's cold, scientific safety engineering. It will pay off in fewer accidents and higher section morale. If you need a driving motive to spur you on, just remember: Death is so permanent!

COAL — FUEL OF THE FUTURE

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The fuel industries are the base for the way of life to which we have become accustomed.

The greatest of these industries are coal and petroleum. They are alike in the fundamental respect that they provide fuel for comfort and for generating power for our industrial economy. But they differ in important respects and they are intricately intertwined.

We all are familiar with the fact that our coal reserves are immensely greater than our petroleum reserves. Although estimation of recoverable reserves is little more than educated guesswork, it is significant to observe that the maximum estimate of reserves of oil plus natural gas is only 10% of the *minimum* estimate for world reserves of coal. For the United States, the figure is 18%.

If we reverse the process and compare minimum estimates for oil plus gas with *maximum* estimates for coal, we arrive at less than 1% for either the world or the United States. The true picture, as it will develop in the future, probably will lie somewhere between the two extremes. In the United States, recoverable oil plus gas is likely to run about 3% of recoverable coal.

We have other fuels, of course. There is oil shale, for instance, which eventually may provide about 3% as much energy as coal. And we have some tar, which will provide scarcely a trace of energy, and peat, which someday may give about 1% of coal. But the conclusion is inescapable —and always has been inescapable—that our future economy over the next two centuries is at the mercy of a sound coal industry.

How Coal and Oil Differ

We are inclined to talk about the petroleum industry and the coal industry as though the word "industry" meant the same thing to each. It does not. And here's why:

A fuel industry may be made up of one or all of four different departments, as follows:

1. The mining of coal or petroleum—the recovery from the earth of crude or run-of-mine material.

TABLE I—HOW PETROLEUM IS MOVED IN THE UNITED STATES

	Per Cent
In industry-owned equipment:	
Pipelines	36
Tank trucks	28
Marine tankers	16
Marine barges	10
In railroad-owned tank cars	10
Total	100

From *Energy Sources: The Wealth of the World,* by Ayres and Scarlott.

Here the differences are sharp and clear. The removal from the earth of liquid or gas is a much simpler physical operation than the removal of solids. But for oil, we have the added task of discovery, which for coal is largely a matter of ancient records. The discovery of oil has been a profitable gamble, but a gamble none the less, and one which someday will become unprofitable.

2. The conversion of the crude to marketable products.

Here again the difference is marked. At present, considerable run-of-mine coal is sold for use without beneficiation. Almost no crude petroleum is used as such. The conversion of crude oil is essential to obtain the kind of liquid fuels required by the motorcar and other major petroleum markets. The refining of petroleum has its counterpart in the conversion of coal to electric power. People can do things with electric power that they cannot do with coal. Likewise, they can do things with motor fuel that they cannot do with crude petroleum.

But when a coal company manufactures power for sale, it is no longer regarded as a part of the coal industry. Instead, it suddenly becomes a part of the public-utility industry. Yet the operation is not fundamentally different from the conversion of oil to motor fuel for public retail sale. Later on, of course, another major conversion for coal will be to motor fuel.

3. The transportation of fuel to its points of use.

Here we note an important difference. Nearly 90% of petroleum is transported in equipment owned and operated by the petroleum industry, as shown in Table I. This equipment includes pipe lines, marine

TABLE II—HOW HOME-HEATING SYSTEMS RATE EFFICIENCY-WISE

Energy System	Efficiency Including Necessary Conversions
Electric with heat pump:	
Performance coefficient, 4	65
Performance cofficient, 3	49
Oil	61
Natural gas	61
Coal, domestic stoker	60
Enriched water gas	46
Coal, hand-fired	42
Electric (national average)	16.3

tankers, marine barges and tank trucks. Only about 10% of petroleum is carried on railways. The control of transportation is essential to the petroleum industry and eventually will become essential to an integrated coal industry.

In contrast with oil, the great bulk of coal ton-miles involves equipment owned and operated by others, principally railways and ships. When a coal company moves its own coal for long distances, it is likely to be exiled into the railway industry.

Pipe-line transportation of coal appears to be in the offing. It will come, but it has been a long time on the way, the first experiments in pipe-line transportation of solids having been made in 1860.

4. The distribution of energy to ultimate consumers.

A lot of coal is distributed by the coal industry but about 22% is distributed in the form of electric power and gas by public utilities. Nearly all petroleum is distributed by the petroleum industry. A very little—less than 4%—is sold by public utilities in the form of electric power and manufactured gas.

In addition to their differences in these four departments, the oil and coal industries differ in the scope and integration of their operations. To be sure, all kinds of oil companies form the oil industry. A few are concerned only with recovery of fuel from the earth. A few purchase crude oil, which they refine and market. Some have no facilities for transportation and distribution. But the major oil companies are fully integrated and function in all four ways—recovery, conversion, transportation and distribution.

On the contrary, coal companies rarely are integrated except by losing their primary status as coal companies. Some of them are so-called "captive" companies absorbed by public utilities, the steel industry or railroads. The coal industry still is largely a mining industry. Mining has not yet become incidental to manufacture, transportation of energy and distribution of final energy forms to ultimate consumers.

New Energy Forms Wanted

Trends of fuel consumption over the past few decades have been confusing. We have been going through—and still are going through—a transition period from which certain unmistakable trends are beginning to emerge. Our economy is strongly characterized by two developments:

1. Increasing preference for electric power, which means coal, and . . .
2. Increasing preference for liquid and gaseous fuels for end uses, which means petroleum now and coal later on.

The accelerated demand for electric power is almost sensational. Some recent studies show that the rate of demand for electric power is going up at least 1.6 times as fast as the rise in gross national product. The reasons for this phenomenon are so many and so varied that we cannot go into them here. But in spite of optimistic programs for building generating stations a power shortage now is with us and is likely to continue for some years. To double an industry every 10 years is no mean task. Electric power demand now is going up even faster than that.

Our hydroelectric installations sometimes are described as vast, but terms like this are relative. The total energy now derived from water power is only about equivalent to the fuel-wood we burn or to the quantity of anthracite produced—about 4% of our total energy requirements. New water-power installations will be made, but the maximum practical increase will take care of only a minor part of expansion within the next few decades. So we find that the most rapidly increasing demand for energy is in the domain of coal.

Where Oil Shale Fits In

During recent months careful studies have been made of costs of recovery of liquid fuel from oil shale and coal. On the basis of present technology it is much cheaper to make motor fuel from oil shale than from coal. For this reason, oil shale will be exploited first, but this development cannot be expected to postpone more than a few years the large-scale conversion of coal. These are the reasons why coal will move into the picture:

1. Low-cost oil shale is limited to thick deposits with horizontal cleavage from overburden, located on the sides of deep canyons for disposal of ash from retorts. Oil shale yields only about 10% oil—the rest is ash. On the average, it will be necessary to dispose of more than a ton of ash for every barrel of oil.

2. All low-cost oil shale is located in Colorado and Wyoming, where water is scarce.

3. The rate of increase in demand for liquid fuel can be taken care of by supplemental oil-shale operations for only a few years.

4. Since technologists know that our ultimate dependence must be on coal, extraordinary efforts will be made to lower the cost of coal conversion.

How Coal Will Be Used

So the picture for the long term is that the downward trend of coal's proportionate share of our energy demand will be sharply reversed. While the demand for liquid fuel probably will continue upward for a long time, more and more of the liquid will come from coal. In the meantime, coal will be required to an increasing extent for electric power. On the other hand, the use of coal as such will go downward for nearly all applications except conversion to electric power, to metallurgical coke or to liquid, and for generation of steam in large boilers. In this respect, coal may become like crude petroleum, less than 2% of which is used as such.

There are many good reasons for expecting this sort of industrial demand. Competition between industries is a curious thing. We often try to accomplish an illogical task when that happens to be our business. But it always is a losing battle. For example, in Washington, D.C., where strong competition exists between the oil and natural-gas industries, both industries want the home-heating business. But gas will win out in the end, if it is in sufficient supply and if prices of the two are comparable, because gas is nicer to use.

In some other cities, gas and electric power are competing for kitchen ranges. Given costs not too far apart, electric power will win out because it is nicer to use. In 1950 the ratio of gas ranges to electric ranges sold narrowed to about 3.2, against a ratio of 16.1 in 1935. The ratio of gas to electric ranges in service has declined from 20:1 in 1935 to 4:1 in 1950. Thus, in transmuted form, coal is moving back into the kitchen.

Electric power has not yet come into its own for home heating but the handwriting is on the wall. Thousands of new homes with electric heating now are under construction. With heat-pump installations, electric power already is beginning to displace gas, as gas is displacing oil and oil is displacing coal. The reason is clear. Electric power is nicer to use. Coal is in the way of completing a full cycle.

New Light on Diesels

The displacement of the steam locomotive by the diesel-electric now is a familiar story. But the story is not yet fully told. When oil finally is obtained from coal, the diesel-electric may be displaced by some efficient coal-burning device, since the over-all efficiency of coal conversion plus diesel-electric conversion would be much lower than that of a gas turbine, for instance.

Diesel-electric developments have made conflicting impacts on coal economy. In 1948 transportation of coal was about 200,000,000,000 ton-miles. The coal required for this transportation would have been about

36,000,000 tons if the whole job had been done by coal-burning steam locomotives. But the coal equivalent of the oil required, if the job had been done altogether by diesel-electric locomotives, would have been about 13,500,000 tons—little more than one-third as much.

Thus the market for coal is contracted by the substitution of oil. Yet, since it costs less to move coal by diesel-electric locomotive, the expansion of the coal market in other directions *should be* far greater than the contraction attibutable to diesel inroads. Nearly half the cost of coal on the Atlantic Coast is for transportation. It happens that freight rates are going up, but it may be presumed that the rise would have been more rapid if the diesel had not moved in. Here, then, is an instance where the sale of oil may accelerate the sale of coal.

Another somewhat similar story is the development of steam-turbine oils that last 20 times as long in service as former oils. These oils have contributed to the low cost of electric power, which means more sales of electric power and a bigger utility market for coal.

Gasoline or diesel fuel in an amount equivalent to 500,000 tons of coal per year is required to deliver about 100,000,000 tons of coal by motor truck to points of ultimate retail use. A cheaper or more convenient way to deliver coal would be difficult to find. It happens that approximately the same amount of coal—500,000 tons—is required to generate the electric power used for the production of oil and gas.

Energy Loss—Coal and Oil

Energy always is required to convert fuels from one form to another. The thermal efficiency of modern oil refineries averages about 87%. In other words, 13% of the crude, or an equivalent amount of energy from other sources, is required to operate the refinery. Some refineries therefore burn coal to conserve oil. This practice is likely to grow. On the coal side, losses somewhat greater than 13% occur in making a finished product from run-of-mine coal.

The thermal efficiency of conversion of coal to electric power now averages about 21%. Large modern plants, of course, do much better. Though this figure seems low, electric power is utilized with high efficiency for heating as well as for power.

Meanwhile, with efficiencies of power plants going up and destined to rise still further, the thermal efficiencies of oil refineries have been going down—and must continue to go down—because of the growing complexity of liquid-fuel preparation. When the time comes for conversion of coal to motor fuel, efficiencies are likely to run about 75% instead of the present 87%. This figure seems high compared with the best electric-power generation. But if we balance the conversion inefficiency and the utilization efficiency of the coal-electric power system against the conversion efficiency and utilization inefficiency of the liquid-fuel system, we see that the two energy systems are pretty much on a par.

Efficiency—Big Market Factor

The excellent work of electric-power engineers in improving efficiencies of power-generating plants means, of course, less coal per kilowatt-hour, but it also means more coal per annum or per capita because people use more electric power when it is cheap. A somewhat similar paradox is found in the development of more efficient sources of light. The Welsbach mantle, for example, tripled the light output of gas burners but instead of cutting consumption of fuel to one-third, the invention increased the demand for fuel manyfold by providing more adequate light. This has happened with every subsequent improvement in light generation.

Likewise, the reason that demand for motor fuel has gone up so steadily and so rapidly is that the oil industry has found ways of keeping the cost of motor fuel (*ex taxes*) from rising for the past 25 years. This achievement has been notable because the quality of motor fuel has been radically improved over the period.

One reason for the usefulness of oil and gas is that they can be transported easily in pipe lines for thousands of miles. Electric power is limited in this respect. Engineers see little prospect of increasing the distance for transmission of electric power beyond the present 300 to 500 miles. For large blocks of power, the limits are even lower. The problems are largely economic. And yet much of our coal is far from centers of consumption. For this reason, commercial experiments now under way for pipe line transportation of crushed coal are of fundamental importance. Such transportation would move coal cheaply to electric-power plants, which would convert it to power for nearby customers.

Remember?

CAPE GIRARDEAU, MO., JUNE 23, 1928

BOAT TRIP, 1928

CONSTITUTION AND BY-LAWS

Adopted June 24, 1913
Amended Nov. 12, 1926
Amended Nov. 8, 1929
Amended Nov. 8, 1935
Amended Oct. 21, 1938

ARTICLE I.

Name and Purpose.

The Illinois Mining Institute has for its object the advancement of the mining industry by encouraging and promoting the study and investigation of mining problems, by encouraging education in practical and scientific mining, and by diffusing information in regard to mining that would be of benefit to its members.

ARTICLE II.

Membership.

Section 1. Any person directly engaged or interested in any branch of mining, mining supplies, mining appliances, or mining machinery may become an active member of the Institute. Any person desiring to become a member of the Institute shall fill out a blank for that purpose, giving his name, residence, age, and occupation. This application shall be accompanied by one year's dues of $3.00. Each application for membership shall be submitted to the Executive Board, who shall make an investigation as to the qualifications of the applicant, and shall be authorized to elect to membership and issue a certificate of membership to such applicant subject to the ratification of the next regular meeting of the Institute.

Section 2. Any person of distinction in mining may be elected an honorary member of the Institute by two-thirds vote of the members present at any regular meeting. Any member who has been an active member of the Institute and shall have retired from active business in mining may become an honorary member.

Section 3. The annual dues for active members shall be $3.00 and any person in arrears on August 1, of the current year, after having been sent two notifications of dues, shall be dropped from membership. Members in arrears for dues will not receive the printed proceedings of the Institute.

Section 4. Any active member may become a life member by the payment of $50.00 and shall be exempt from further payment of dues during his lifetime.

ARTICLE III.

Officers.

Section 1. The officers shall consist of a President, Vice-President, Secretary-Treasurer and twelve Executive Board members. The services of all officers shall be without compensation.

Section 2. Nominations for officers and the executive board shall be made by nominating committee of three (3) appointed by the Presiident at least thirty days before the annual November meeting, provided that anyone can be nominated on the floor of the meeting for any office for which an election is being held.

Section 3. The President, Vice-President and Secretary-Treasurer shall be elected by ballot, annually, at the regular November meeting and shall hold office for the ensuing year.

Four Executive Board members shall be elected by ballot, annually, at the regular November meeting and shall hold office for the ensuing three years.

To make effective this change, at the regular November meeting in 1938, in addition to the four Executive Board members who shall be elected for the three year term, there shall also be elected by ballot eight other Executive Board members, four for a two year term and four for a one year term.

Section 4. In case of death, resignation, or expulsion of any officer, the executive board may fill the vacancy by appointment until the next regular meeting, when the vacancy shall be filled by regular election. In case of a vacancy in the office of president, the duties shall devolve upon the vice-president.

Section 5. The executive board shall consist of the officers and twelve other board members.

ARTICLE IV.

Duties of Officers.

Section 1. The president shall perform the duties commonly performed by the presiding officer and chairman. He shall, with the executive board, exercise a general supervision over the affairs of the Institute between sessions.

Section 2. The vice-president shall preside in the absence of the president and perform all the duties of the president in his absence.

Section 3. The secretary-treasurer shall keep a record of each meeting, shall read and file all resolutions and papers that come before the Institute, sign all orders for money, and shall purchase necessary supplies.

He shall keep a true record of all money received by him and payments made on account of the Institute. He shall pay out no money except on an order signed by himself, and shall retain these orders as vouchers. He shall give bond in such sum as the Institute may provide, the premium on said bond being paid by the Institute.

He shall act as editor-in-chief for the Institute and may furnish the newspapers and other periodicals such accounts of our transactions and discussions as are proper to be published. His own judgment is to prevail in such matters unless objection is lodged at a regular meeting or by the executive board.

The retiring president shall act ex-officio in any capacity for the ensuing year.

Section 4. The president shall appoint an auditing committee annually to audit the accounts of the secretary-treasurer, and said audit shall be submitted to the November meeting of the Institute.

Section 5. The Executive Board shall perform the duties specifically prescribed by this constitution; it shall supervise the expenditures and disbursements of all money of the Institute, and no expenditure other than current expenses shall be authorized without first having the approval of the Executive Committee; it shall act as program committee for each meeting to determine what is to be published in the proceedings and shall perform such other duties as may be referred to them by regular or special meeting of the Institute.

ARTICLE V.

Meetings.

Section 1. Regular meetings shall be held in June and November of each year and on such days and in such places as may be determined by the executive board of the Institute. Notice of all meetings shall be given at least thirty days in advance of such meetings.

Section 2. Meetings of the executive board shall be held on the call of the president, or at the request of three members of the executive board, the president shall call a meeting of the board.

ARTICLE VI.

Amendments.

Section 1. This Constitution may be altered or amended at any regularly called meeting by a majority vote of the members present, provided notice in writing has been given at a previous semi-annual meeting of said proposed change of amendment.

ARTICLE VII.

Order of Business.

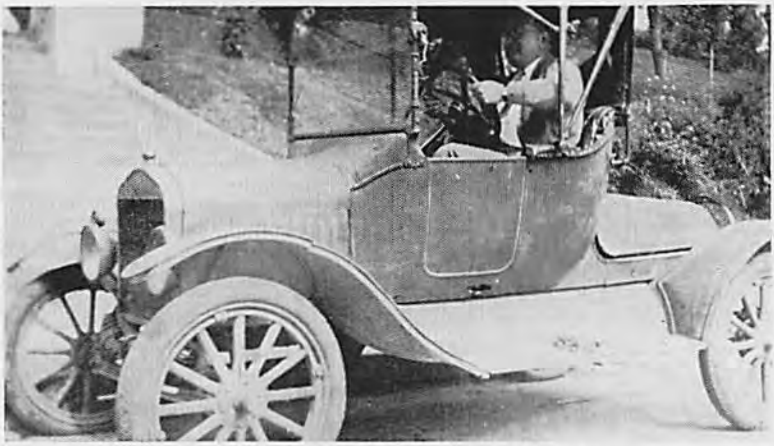
At all meetings, the following shall be the order of business:

(1) Reading of minutes.
(2) Report of executive board.
(3) Report of officers.
(4) Report of committees.
(5) Election of new members.
(6) Unfinished business.
(7) New business.
(8) Election of officers.
(9) Program.
(10) Adjournment.

* * *

Remember?

CAPE GIRARDEAU, MO., JUNE 23, 1928



CAPE GIRARDEAU, MO., JUNE 23, 1928

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DOZIER, JOS., Chief Elect..............................Peabody No. 58 Mine, Taylorville, Ill.
DRANE, JOHN................Simplex Wire & Cable Co., 559 S. Main St., Clinton, Ind.
DRESS, LANING............Roberts & Schaefer Co., 130 N. Wells St., Chicago 6, Ill.
DRYSDALE, GEORGE W..............................
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DUNCAN, GEORGE, SR......................Duncan Foundry & Machine Co., Alton, Ill.
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JOHNSON, V. E., Comb. Engr.............
Freeman Coal Mng. Corp., 129 Prospect, Elmhurst, Ill
JOHNSON, W. H., Vice-President.............
Johnson's Industrial Supply Co., 32 S. Central Ave., St. Louis 5, Mo.
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Sheridan-Wyoming Coal Co., Inc., Sheridan, Wyoming
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JONES, EVERETT, Lubrication Engr.............
Standard Oil Co., Decatur Div., 101 W. Cerro Gordo St., Decatur, Ill.
JONES, ISHAM, Mine Engr.............Old Ben Coal Corp. No. 11, R. R. 1, Marion, Ill.
†JONES, JOHN E.............Old Ben Coal Corp., West Frankfort, Ill.
JONES, JOHN E., JR.........E. M. School Bldg. 413, U. S. N. T. S., Great Lakes, Ill.
JONES, L. L.............Hoe Supply Co., 118 N. McCann St., Benton, Ill.
JONES, MAURICE L.............
Diamond Supply Co., 616 N. W. Second St., Evansville, Ind.
JONES, R. J.............
Equitable Powder Mfg. Co., 550 N. Farnham St., Galesburg, Ill.
JONES, ROBERT.............Superior Coal Co., Gillespie, Ill.

JONES, ROBERT M. Euclid Chicago Co., 6027 Northwest Highway, Chicago 31, Ill.
JONES, SHELDON. Socony-Vacuum Oil Co., Box 42, Benton, Ill.
JONES, THOMAS. Kennametal, Inc., 116 E. Ninth St., Bicknell, Ind.
*JONES, WALTER M. Joy Manufacturing Co., Centralia, Ill.
JOY, DEWEY E. Cutter Bit Service Co., Christopher, Ill.
JOY, JOS. F. Comanche & Iroquois Roads, Brookside Farms, Pittsburgh 16, Pa.
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JUSTICE, CLYDE H., Pres. Du Quoin Iron & Supply Co., Inc., Du Quoin, Ill.
KACHIK, D. J. Paul Weir Co., 20 N. Wacker Dr., Chicago 6, Ill.
KAGA, R. L. Bixby-Zimmer Engineering Co., Lock Box 147, Arcola, Ill.
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KELCE, MERL C., V. P. Sinclair Coal Co., 3615 Olive St., St. Louis, Mo.
KELLEY, WM. O. Olin Industries, East Alton, Ill.
KELLY, E. F., JR. Central Ill. Pub. Serv. Co., Springfield, Ill.
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KISS, LAWRENCE, Gen. Supt. Superior Coal Co., Gillespie, Ill
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MACKE, ARTHUR Midcontinent Coal Corp., Marissa, Ill.
MAC MURDO, GEORGE C. Peabody Coal Co., 504 W. Second, Taylorville, Ill.
MAC QUEEN, G. E., Service Engr. Macwhyte Co., 1001 Boeke Rd., Evansville 14, Ind.
MAC VEAN, GORDON National Mine Service Co., 907 Commonwealth Bldg., Pittsburgh 22, Pa.
MACWHYTE CO. Kenosha, Wis.
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MANCHA, RAYMOND..........Joy Mfg. Co., Oliver Bldg., Pittsburgh, Pa.
MARBRY, H. W..........Ohio Oil Co., Springfield, Ill.
MARCOLINA, JOHN, Top Foreman..........
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MARKS, DEWEY..........Sahara Coal Co., Eldorado, Ill.
MARSH, DONALD L., Ass't. Gen'l Mgr..........
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MARSH, JAMES B..........B. F. Goodrich Co., 8 N. Crescent Drive, Jacksonville, Ill.
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MAXWELL, E. L..........Fairview Collieries, Fairview, Ill.
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McCULLOCH, WM. C..........Roberts & Schaefer Co., 130 N. Wells St., Chicago 6, Ill.
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McDOWELL, W. J.........Nail City Bronze Co., 7005 Crandon Ave., Chicago 49, Ill.
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McLAREN, W. S..McLaren Coal Co., Marion, Ill.
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MEAGHER, GEORGE...........................C. W. & F. Coal Co., West Frankfort, Ill
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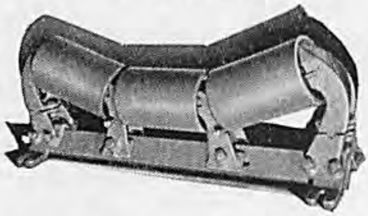

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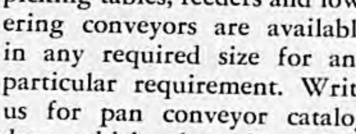

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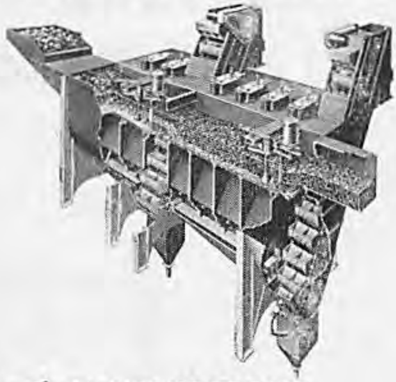

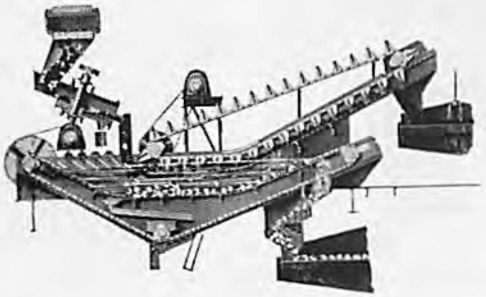

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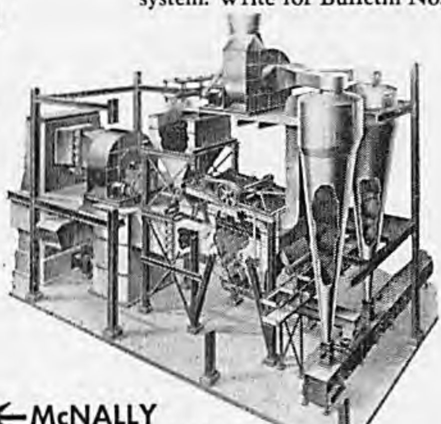

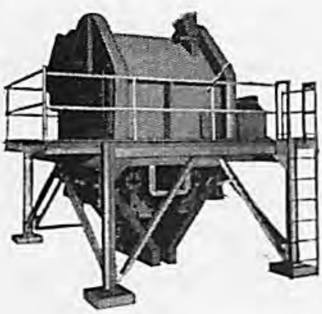

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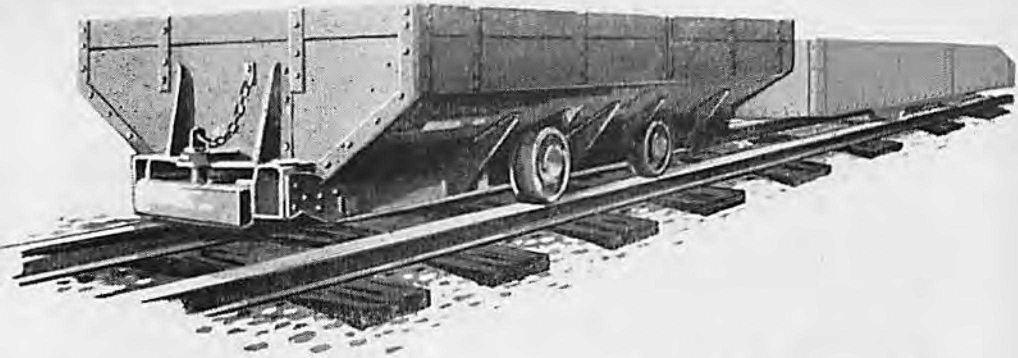

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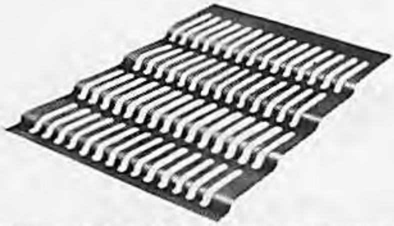

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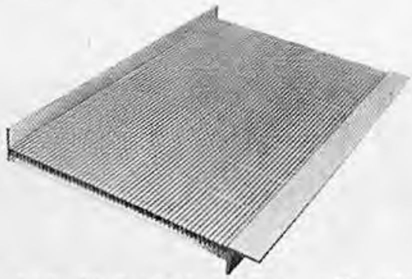

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Carboloy Coal Mining Tools—of Carboloy Cemented Carbide, hardest metal made by man—will cut coal faster, more freely, more efficiently at lower tool cost per ton.

Improved design accounts for the tools' efficiency. Uniform, high-quality Carboloy Cemented Carbide inserts assure longer bit life through heavy use and numerous regrinds, guarantee lower tool cost per ton.

Carboloy Coal Mining Tools may be obtained from these Carboloy distributors serving the coal mining industry:

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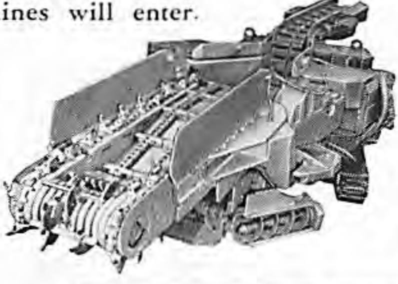
JOY

"The World's Most Complete Line of Modern Mining Equipment"

Products for ***THE COAL MINES***

CONTINUOUS MINERS

These machines will handle split seams—can be used in any mine the machines will enter.



JOY Continuous Miners are built in three models: the 3-JCM for medium coal, the 4-JCM for thick seams and the 2-WM for very low coal. All are field-proved units, highly flexible and mobile—the greatest single advance in coal mine mechanization today for safety and high-tonnage, low-cost production. Continuous Miners can handle seams from 30″ to more than 100″ high, eliminating completely the former separate jobs of cutting, drilling, shooting, and loading away from the face.

ROOF-BOLTING EQUIPMENT

COMPLETE LINE OF DRILLS

Joy makes a complete line of pneumatic and hydraulic drills for roof-bolting. The standard SAE-91, telescopic models of the SAE-91, SA-91 and SAL-37, and the SAW Wagon Stoper handle all seam heights where pneumatic drills are required. Where roof conditions permit the use of a rotary, the Joy hydraulic self-propelled drills will bottom holes faster than any machine on the market.

PERMISSIBLE COMPRESSORS

JOY WK-82 and 83 Mine-Air Compressors are B of M-approved . . . highly efficient, heavy duty air-cooled units, available in rubber-tire or track models, either self-propelled or draw-bar type. Capacities range from 130 to 240 CFM, height from 30″ to 34″. JOY Roof-Bolting Equipment is backed by 50 years of compressor and drill-building experience.

JOY MINING EQUIPMENT MOVES

CUTTING MACHINES

TRACKLESS CUTTERS

The JOY 11-RU, above, only 30″ high for work in thin seams, and the 10-RU for thick seams, are highly maneuverable, fast tramming, completely hydraulically controlled universal cutters for mechanized mining. Both can make horizontal cuts, as well as shear cuts, anywhere in the face. The JOY 12-RB, for very low coal, is only 26″ high.

SHORT WALL CUTTERS

The JOY 11-B, left, is a short-length, narrow machine for conveyor mining. Also available are the 7-B, a heavy-duty cutter for high capacity production; and the 5B-1, a unit for small mines. The 11-B and 7-B have a JOY Bugduster as standard equipment.

LOADING MACHINES

14-BU LOADER

JOY builds three loaders for thin seam mining—the 30″ high 14-BU, with a capacity up to 8 tons/min., the 12-BU, a 28½″ Loader of 1½ ton/min. capacity for conveyor mining, and the 20-BU-1, with a max. cap. of 8 tons/min. for very low coal. For thick seams, the 8-BU is designed for narrow places and exploratory work, and the 11-BU is a high-production Loader rated up to 10 tons/min. in 60″ seams.

SHUTTLE CARS

JOY Shuttle Cars are built in various heights and capacities to suit any requirements. They are available either battery-powered or with hydraulic cable reel, and may have fixed high, fixed low, or hydraulic adjustable elevating discharge. Models with 4-wheel steering and 4-wheel drive are the 6-SC, (right) only 29″ high for low coal, the 42″ Model 5-SC, and the high-capacity 10-SC.

MODELS FOR EVERY MINING NEED

SULMET COAL CUTTER AND AUGER BITS

with Tungsten Carbide inserts for lasting sharpness

Sulmet Bits have a field-proved cutting life many times greater than the hardest alloy steel bit. They consume less power, cut faster; cut more places with fewer bit changes.

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TONNAGE FAST...AT LOW COST

COAL DRILLS

The CD-26 is a self-propelled, hydraulically controlled trackless coal drill that keeps ahead of any loader. Rotation speed is variable independent of feed, and the feed can be varied independent of speed, to suit drilling conditions. JOY Mobile Coal Drills are available in single or twin-boom models, with hydraulic or electric controls.

JOY CD-26
TWIN-BOOM DRILL

AXIVANE VENTILATION FANS

THE PIONEER VANEAXIAL FAN

JOY AXIVANE* Fans are designed for lower speed operation, which reduces noise, increases life and simplifies lubrication. Other features include wide range of blade adjustment and simultaneously adjustable blades, eliminating guesswork settings. JOY Fans are always at peak efficiency, even when air demand increases or decreases considerably.

*Reg. U.S. Pat. Off.

CONVEYORS

Troughed Belt Conveyors

Three series of belt conveyor designs are available, each engineered for the particular type of job required. JOY Tandem Pulley Drive Belt Conveyors feature low belt tension and integral extended discharge suited to gathering and main haulage underground. JOY Single Pulley Drive Belt Conveyors are particularly adapted to slope-belt installations and the hauling of sticky or wet materials. JOY Type "C" Conveyors offer a complete line from 3 to 20 HP with interchangeable parts. These units are adaptable to multiple operations. All JOY Conveyors are furnished with sealed precision bearings as standard equipment.

Chain Conveyors

For mechanical mining in thin seams, JOY Chain Conveyors are available in a variety of sizes for face loading, room and gathering work. The new Model FA is the most modern chain conveyor on the market—simpler, lighter, much more compact and efficient in every way, giving far longer service and requiring less maintenance.

Shaker Conveyors

JOY Shaker Conveyors will move coal in inclines up to 15%, over rolling and dipping mine bottoms without spilling. Cushion stroke reduces shock loads on all parts, adds greatly to the life of each unit.

"Complete Line of Modern Mining Equipment"

3 Minutes installs a roof bolt

That's standard performance for electrically-operated CP MOBILE ROOF BOLTING UNIT — RBD-30. This includes the complete bolting cycle — the hole is drilled and expansion bolt set without repositioning the unit — one motor drives both auger and bolt setter. Easy to operate under any condition — in high coal or seams as low as thirty inches.

Drills shot holes in coal

to 4½″ in diameter

Self-propelled CP DOUBLE ARM PERMISSIBLE TRAM-DRILL, for trackless mines, has all-electric powered motors and controls for each arm wired independently; with all controls in easy reach of operator. Single Arm types available. Drill Arms can be furnished separately.

Chicago Pneumatic offers the world's largest line of permissible electric Post-mounted and Hand-held Coal Drills.

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We are again taking this opportunity to thank all of you for the friendly reception given to Atlas people and Atlas products during the past year. Thanks also to those who have complimented us so highly on our products and service.

We believe that the superior quality of our Coalite permissibles and the recent improvements in electric blasting caps speak for themselves. For strip mining, of course, the sensational results of our Rockmaster System are national news. Rockmaster superiority is evidenced in our machine-gun camera photographs which any of our people will be glad to show you.

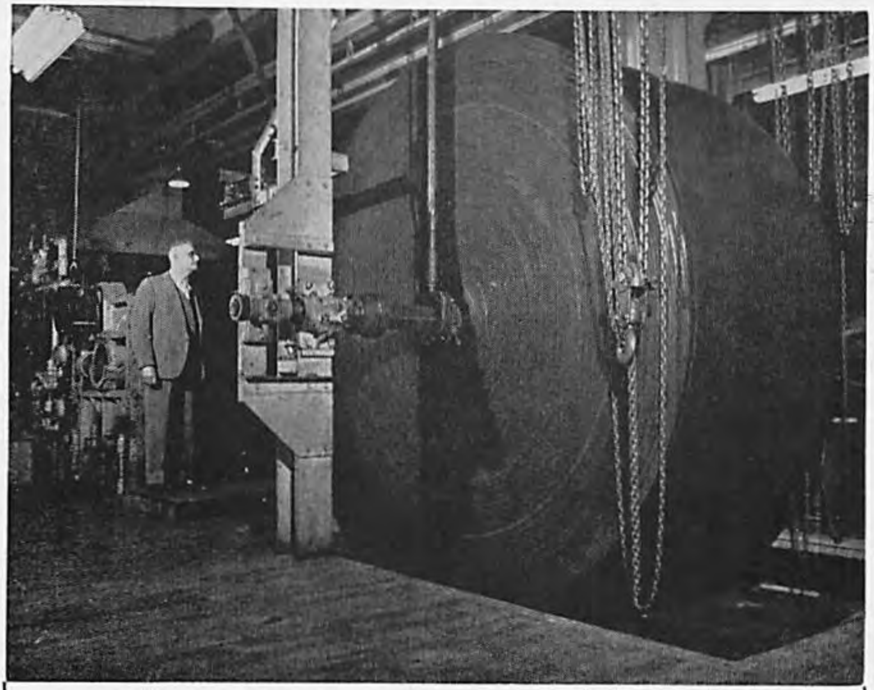
Speaking of our people, may I remind you again that there are Charlie Duesing, Earl Quick and myself working out of the Chicago office, Richard Ash in Carbondale and Guy E. Bertaux, Jr. in Quincy -- not to mention all the Atlas distributors in Illinois.

All of us are ready to serve YOU.

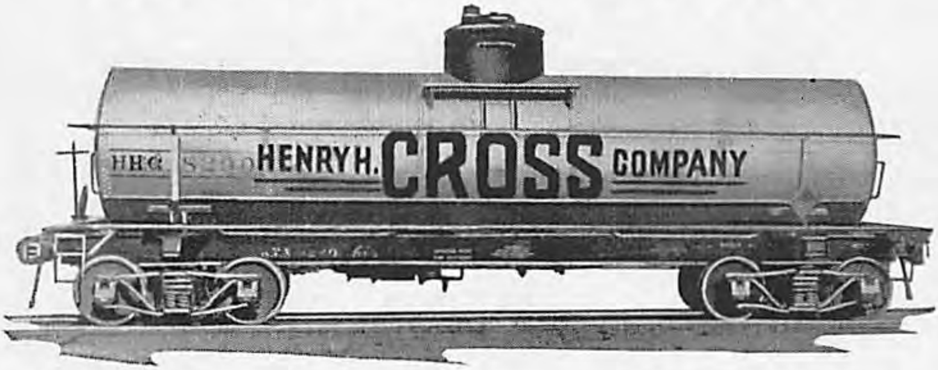
Sincerely,

John F. Flippo

John F. Flippo
Manager, Chicago District



LOADS OF SATISFACTION



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STOPS STRIPPING

You Can Still Get Up to 50 Profitable Tons of Coal per Man-Shift . . .

with a CARDOX-HARDSOCG

Surface AUGERMINER

CARDOX-HARDSOCG Surface AugerMiners are restoring many a "dead" strip mine to new and profitable life. They're drilling up to 50 tons of coal per man-shift from seams where overburden had forced abandonment of mining by conventional methods.

Maybe you have such a property. If you have, find out how an AugerMiner can turn the coal you left behind you into low cost tonnage.

IT'S *BONUS* RECOVERY

Through earlier stripping you have already paid to expose the coal seam. Now use it as a new source of income, produced at a cost usually much less than for the original working. You'll get clean, high grade coal because vertical directional control keeps the auger drilling into the best part of the seam, avoiding rock and shale. Sizing is controlled, to some extent, by the type cutterhead used.

Ask your nearest CARDOX Representative—or write for new AugerMiner Bulletin now.

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If you are experiencing difficulty cleaning coal efficiently, then investigate the NELDCO Dense Media Coal Cleaning System. Washeries in this country and in Europe are enjoying the benefits of higher yields of clean coal from run-of-mine product; simpler plant operating conditions and the inherent adaptability to changes in the quality of raw coal mined without impairment of standards for clean coal quality.

Let us show you how the NELDCO Dense Media System will clean coal within any size range between 10″ and ¼″; eliminate hand-picking; make your coal a better product and get a better market price.

Standardized Coal Cleaning Plants — Capacities 50 to 350 tons per hour. Send for Book No. 151.

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If you prefer a custom-built plant, we can design and build an operation to suit your requirements.

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DESIGNERS AND BUILDERS OF COAL CLEANING PLANTS USING THE DENSE MEDIA PROCESS

ASK THE "MASTER MINERS" WHO USE —

GEMCO Tru-Blu Tools!

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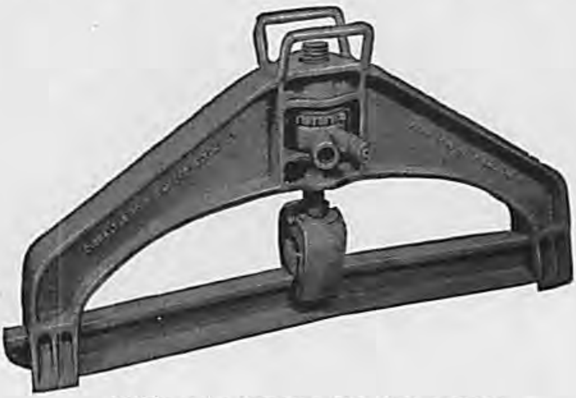

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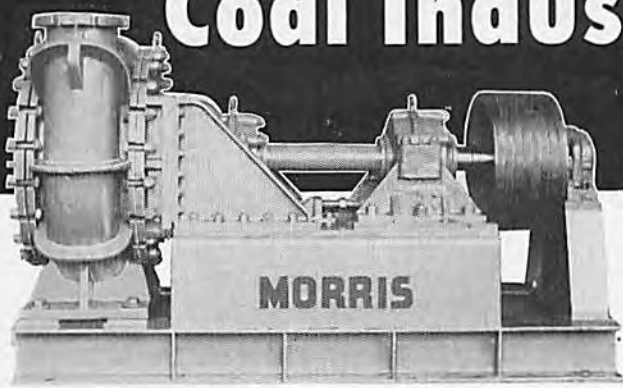
FOR THE

Coal Industry



Type G
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Moderate Speeds...

Suggestion . . .

Pumping coal directly from strip mines to the breakers—a definite possibility.

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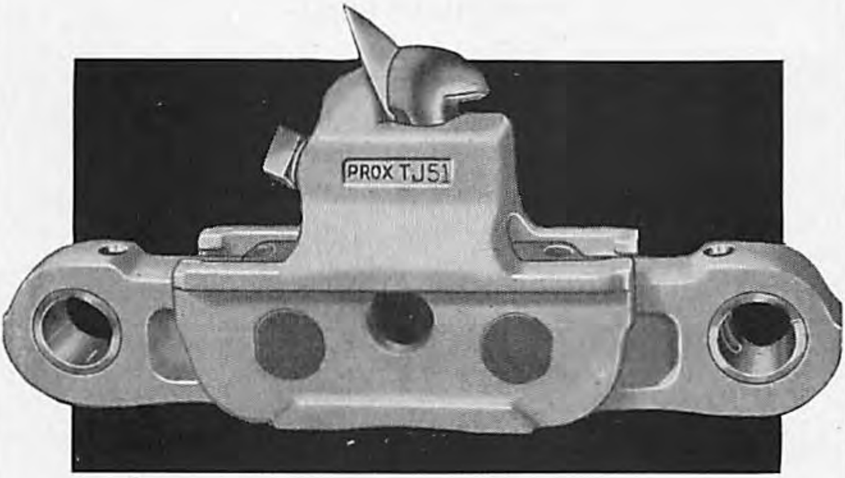

Chemically treated pins and bushings resist rust and corrosion . . . add to journal life! Expert engineering keeps the entire chain rolling smoothly, helps eliminate dust. New pin design shortens assembly time and provides for faster-on-the-job repair and replacement!

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A modern method of mine haulage . . the Jeffrey Shuttle car. It provides efficient and dependable service in the handling of coal, ore, rock, etc. Is flexible with quick loading and discharging.

Jeffery Shuttle Cars are the answer to low cost transportation . . to the need for continuous haulage. Of the cable reel type, they are built in heights ranging from 30" to 48" and have many outstanding features. These are covered in our Catalog No. 840 which will be sent upon request. Write today.

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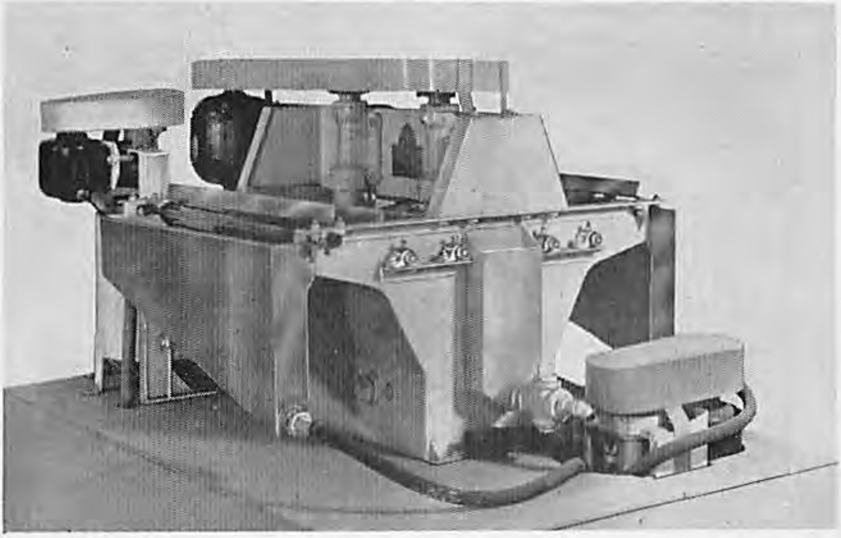

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KENNAMETAL INC., LATROBE, PA.

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Kennametal machine bits have the built-in stamina to give long service life and reduce mining cost. They have hard Kennametal cemented carbide cutting edges and bit shanks that have the highest possible strength for their size. Operators have saved up to 6 cents per ton on mining cost due to fewer bit changes, lower power cost, and less bit maintenance and machine repair.

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Kennametal rotary bits are designed to give the most ideal balance possible between bit life and drilling speed. They drill coal faster and more economically, and also drill clay, slate, and shale without undue damage, or without big losses in drilling speed. Their hard Kennametal cutting edge enables them to drill 3,000 to 7,000 feet at average speed increases of 10% to 20%.

ROTARY BITS FOR DRILLING BOLT HOLES

Kennametal roof bolting bits are designed to give continuous service in rock. They are used on regular coal drills, usually on a special mounting, and offer fast drilling speeds in slate, shale, and laminated sandstone. Their hard Kennametal tips stay sharp and assure long service life.

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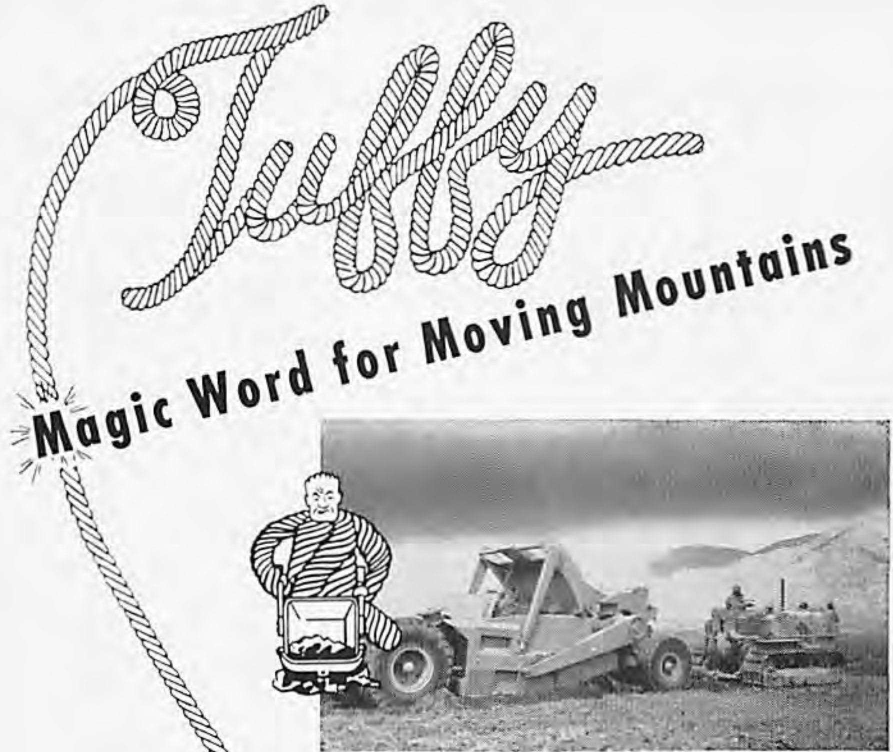
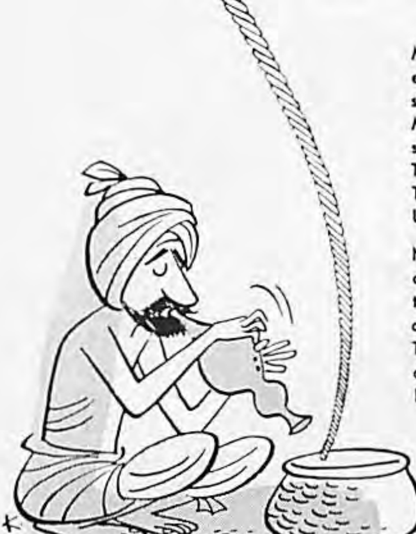
WORLD'S LARGEST MANUFACTURERS OF CEMENTED CARBIDE MINING TOOLS





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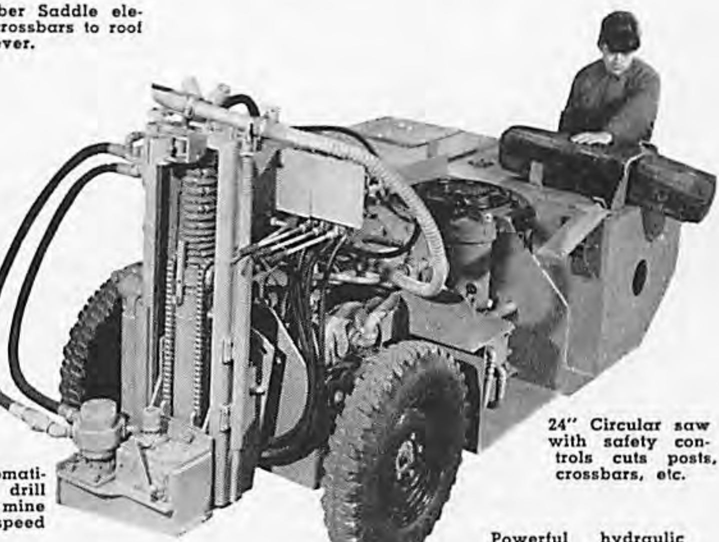
Fletcher Roof Control Drill

with Timbering Attachments



FLETCHER ROOF CONTROL DRILLS have been the first to incorporate the features most wanted by the Mining Industry. It's no wonder they are used where drilling is hardest and production is highest. Now, with the optional addition of timbering attachments you can buy a *complete* Roof Control unit to handle your toughest problems. You'll still have the wonderfully rugged, high capacity Fletcher Drill, but with added flexibility.—There are Fletcher Roof Control Drills in mines near you. Why not put them in yours?

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J.H. FLETCHER & CO.

COAL MINING EQUIPMENT

Rome 60 MINING CABLES

NEOPRENE SHEATHED...

MOLDED IN LEAD

P-105 BM molded in the Neoprene sheath assures full compliance with Federal and Penn. Safety Codes.

Mine operators like Rome 60 Mining Cables for their rugged Neoprene protection, inside and out. For instance, in Rome 60 Flat Twin (Parallel Duplex) Type G, for shuttle car service, power conductors and grounding conductor are separated by Neoprene. Outside is a tough tear and abrasion resistant Neoprene sheath. Insulated for 75° C. continuous operation, Rome 60 Mining Cables are preferred for their durability and safety.

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ROME • NEW YORK
From Bar to Finished Wire

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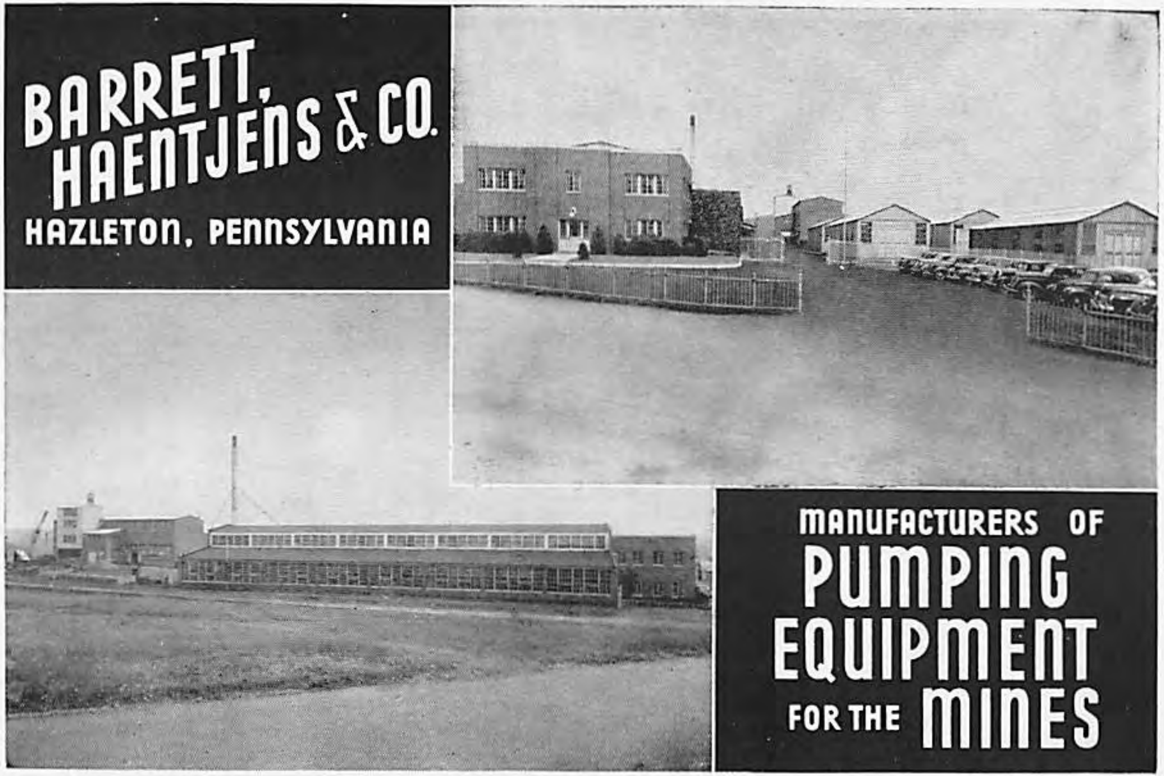
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MANUFACTURERS OF
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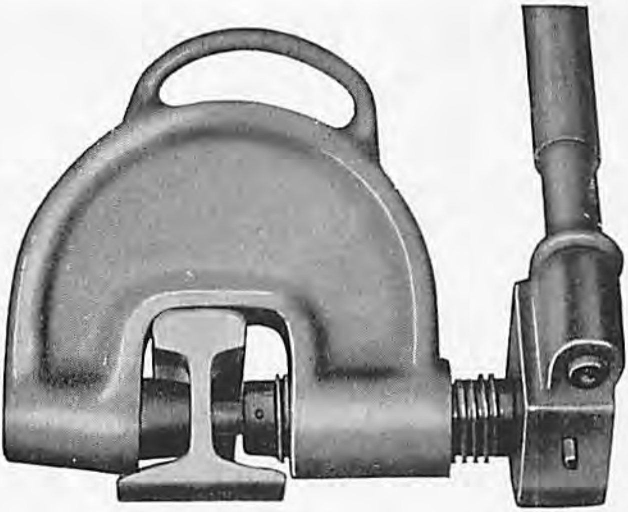

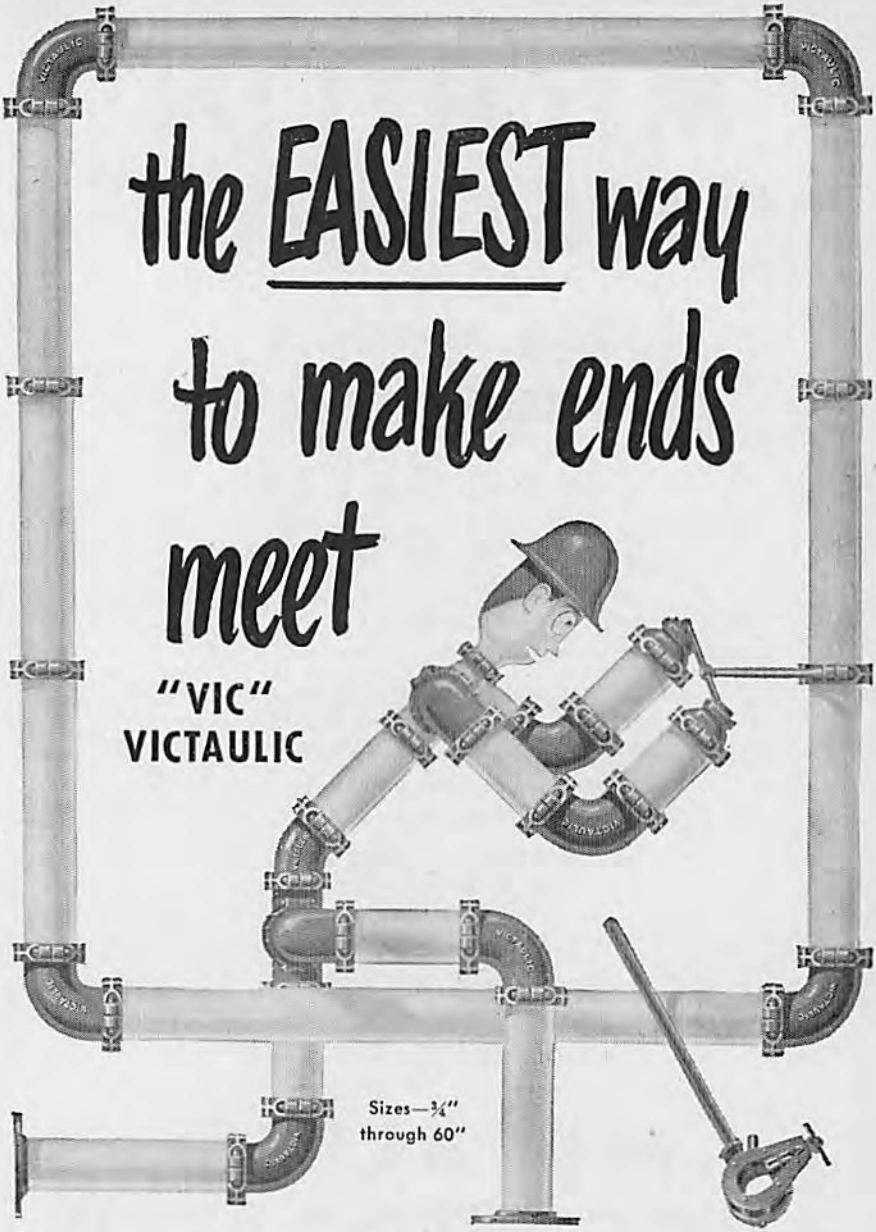
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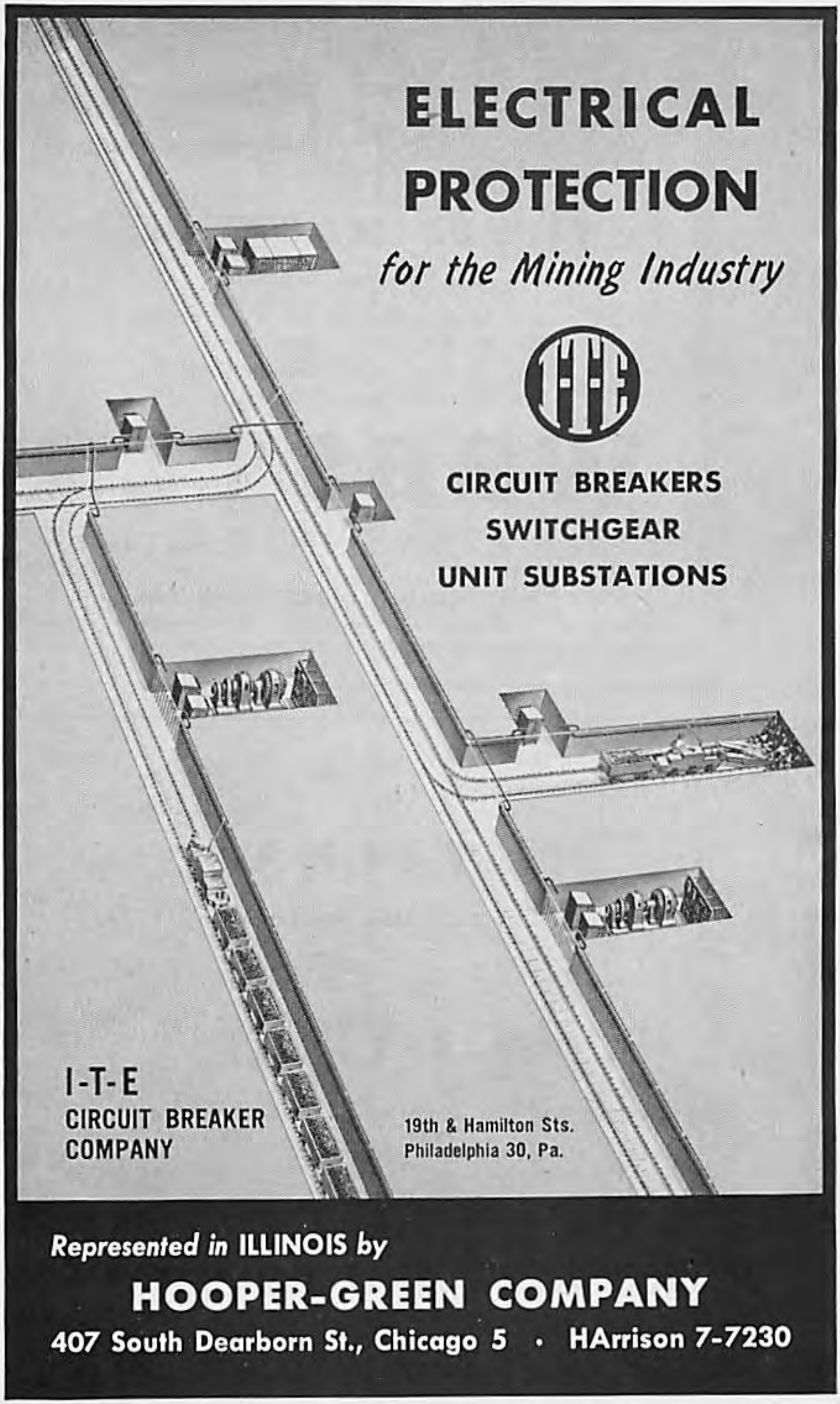
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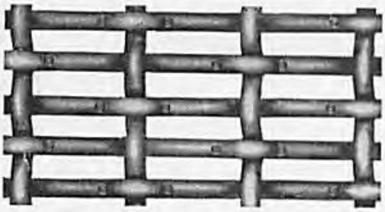

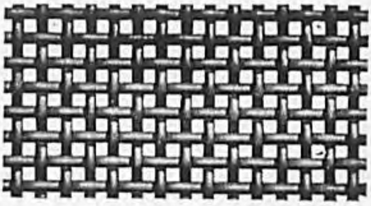

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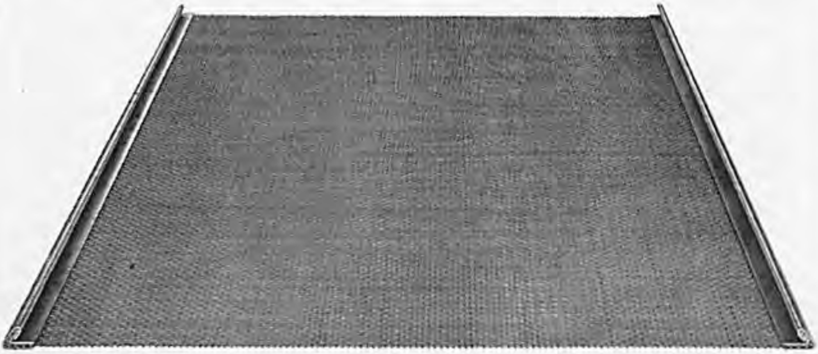

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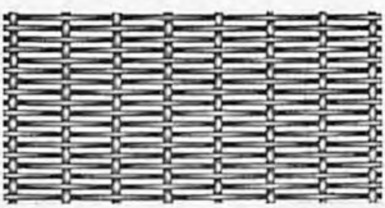

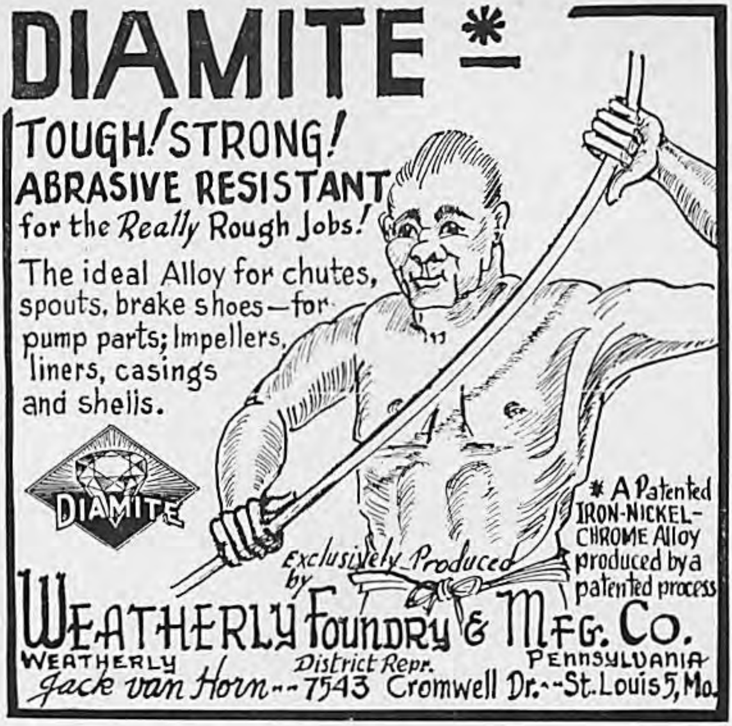
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