PROCEEDINGS OF THE ILLINOIS MINING INSTITUTE

FOUNDED FEBRUARY, 1892

1938

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of the

ILLINOIS MINING INSTITUTE

FOUNDED FEBRUARY, 1892

1938

Summer Meeting
on Board S. S. Golden Eagle
June 10-11-12

and

Annual Meeting
SPRINGFIELD, ILLINOIS
October 21

H. H. TAYLOR, JR.
President, 1938

OFFICERS 1938

PRESIDENT

H. H. Taylor, Jr.

Chicago, Illinois

VICE-PRESIDENT

Paul Weir

Chicago, Illinois

SECRETARY-TREASURER

B. E. Schonthal

28 East Jackson Boulevard

Chicago, Illinois

EXECUTIVE BOARD

R. L. Adams

D. H. Devonald

C. F. Hamilton*

C. T. Hayden

M. M. Leighton

James McSherry

F. S. Pfahler

C. J. Sandoe

L. D. Smith

T. J. Thomas

Louis Ware

W. P. Young

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* Deceased, September 22, 1938.

OFFICERS 1939

PRESIDENT

Paul Weir

Chicago, Ill.

VICE-PRESIDENT

Roy L. Adams

West Frankfort, Ill.

SECRETARY-TREASURER

B. E. Schonthal

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F. S. Pfahler	L. A. Wasson
C. J. Sandoe	W. P. Young

OUR RIVER TRIPS

°

When your winter's work is over and the mines are slowing down,
  And you feel a strong temptation to beat it out of town
To mingle with a few old friends, who also feel the need
  Of a little recreation and a slowing down in speed;
Just pull yourself together as the time is drawing near
  For the river trip we always make in June of every year;
When we shed our cares and troubles and join the I. M. I.,
  To sail away, for work and play, as in the years gone by.
If you've never made this journey, just pack your little grip
  And meet us in St. Louis on the day we start the trip.
The Steamer *Golden Eagle* will be lying at her dock,
  Where you'll find a warm reception from six till ten o'clock.
Perchance you'll be invited to join a friendly game
  Of deuces wild, one eyed Jacks, or anything you name.
But, when the night is over and breakfast tucked away,
  We gather on the forward deck and there we spend the day
Enjoying a program, prepared with utmost care,
  And presented by most able men, for all of us to share;
A program, full of interest, for those who care to hear
  Of new achievements being made in mining through the year.
Then, when the sun has gone to rest and lights are burning low
  And we start to harmonizing on the songs of long ago,
You'll seem to have a feeling of contentment in the air
  And a sense of satisfaction in knowing you are there;
A sense of satisfaction that you're making lifelong friends
  Who'll travel with you all the way until life's journey ends.
Then, when the morning comes again and sun is riding high,
  We gather 'round the main stairway to bid our friends goodbye,
As we're headin' toward the landing and we want to tell them all
  That we'll see them up in Springfield at our meeting in the Fall.
We've sailed these mighty rivers for three and twenty years,
  Without the least misgiving or even thought of fears,
For we love this staunch old Steamer, from keel to soft toned bell,
  And with Captain Buck upon the bridge, we know that all is well.

J. A. ("JEFF") JEFFERIS

PAST PRESIDENTS OF ILLINOIS MINING INSTITUTE

FOUNDED FEBRUARY, 1892

1892-3	JAMES C. SIMPSON, Gen. Mgr., Consolidated Coal Co., St. Louis, Mo.
1893-4	JAMES C. SIMPSON, Gen. Mgr., Consolidated Coal Co., St. Louis, Mo.
1894-5	WALTON RUTLEDGE, State Mine Inspector, Alton, Ill.
1895 1911	Institute inactive.
1912-3	JOHN P. REESE, Gen. Supt., Superior Coal Co., Gillespie, Ill.
1913-4	THOMAS MOSES, Supt., Bunsen Coal Co., Georgetown, Ill.
1914-5	J. W. STARKS, State Mine Inspector, Georgetown, Ill.
1915-6	WILLIAM BURTON, V. P., Illinois Miners, Springfield, Ill.
1916-7	FRED PFAHLER, Gen. Supt., Superior Coal Co., Gillespie, Ill.
1917-8	PATRICK HOGAN, State Mine Inspector, Carbon, Ill.
1918-9	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, Litchfield, 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.

A WORD TO THE MEMBERS FROM THE SECRETARY

I doubt whether our members realize the tremendous amount of work connected with getting together the Yearbook which is presented herewith.

Probably none of the members have ever stopped to consider what is necessary to make this book possible.

First of all, we are dependent upon the suppliers for advertisements in order to defray the expenses of the Yearbook.

This is our tenth issue. Many of our advertisers have contributed to each issue and have expressed satisfaction in the results obtained from the space carried in the publication.

We are anxious to have this feeling prevail with our supporters, the advertisers.

It will be of great assistance for future issues if you will give the advertisers that support to which they are entitled and patronize them by using their products.

The success of this publication depends materially on this cooperation. The advertising committee has done a fine job in their untiring efforts; their cooperation with the suppliers makes this publication possible.

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ILLINOIS MINING INSTITUTE BOAT TRIP

June 10-11-12, 1938

Twentieth Annual Summer Meeting and Boat Trip of the Illinois Mining Institute held on S. S. Golden Eagle, leaving St. Louis Friday, June 10, 1938, at 10:30 o'clock P. M., and returning to St. Louis, Sunday, June 12, 1938, at 7:30 o'clock A. M.

MORNING SESSION

Meeting called to order at 10:00 A. M., by Mr. H. H. Taylor, Jr., President.

President Taylor: The meeting will come to order.

I am going to take advantage of you today. You are supposed to have an address of welcome. Instead of just sitting down again after introducing the Chairman of the Day, I am going to give you one. I have had a few things on my mind, and since this is the only chance I will have to spout I think I will take the opportunity.

I feel any organization that expects to live out its purpose must be of some useful service. The turnout we have here today, in a period of so-called business recession, certainly indicates to me that our Illinois Mining Institute has a justification for its existence.

I am firmly convinced that half of the business recession we are going through now is due to recession in efforts. We cannot wish or hope our way out of it, but have to work our way out. I think if you did not believe as I do you would not be here today.

What we need are new ideas and new inspirations to take the place of our fears. I am told that industry in this country spends a half million dollars a day in research activities, employing some 35,000 people. The average executive looks upon research as something nice in theory as applied to the other fellow's business, but not his own. That is because he does not understand it properly.

I look upon the Illinois Mining Institute as a research activity. How many times have we had problems we were struggling with, mentioned them to some friend, and had him make a suggestion or ask a question that cleared the thing up? I think we are prone to get so close to our own problems we get in a rut and lose our perspective, and contact with each other changes our viewpoint and makes us lose the idea it cannot be done.

The operating men in our organization are bound to get ten fold the money spent here in good ideas. You fellows selling equipment to the trade are bound to increase your sales by your contacts here and enhance your profits. I think there are better times ahead for the fellow who will make his own opportunities.

I think our Institute is just as important to us today, and will be more so in the future than it has been in the past. I am personally tickled to death we have the turnout we have this morning.

I will ask the Secretary to call the roll, and ask you to answer present when your names are mentioned.

ATTENDANCE

ILLINOIS MINING INSTITUTE TWENTIETH ANNUAL BOAT TRIP

St. Louis, Up the Illinois River, and Return
June 10-11-12, 1938

AITKEN, W. I.....Dooley Brothers, Peoria, Ill.
ANDERSON, JAMES S.....Saxton Coal Mining Co., Terre Haute, Ind.
BARTLETT, R. A.....Sahara Coal Co., Eldorado, Ill.
BEAN, FRANK M.....B. E. Schonthal & Co., Murphysboro, Ill.
BELLAMY, C. C.....Shell Petroleum Corp., Centralia, Ill.
BENTLY, J. G.....The Johnson-March Corp., W. Frankfort, Ill.
BLAKE, ARTHUR.....Peabody Coal Co., Taylorville, Ill.
BROWN, BYRON.....Franklin County Coal Corp., Herrin, Ill.
BURKEY, W. H.....Gould Storage Battery Co., Chicago, Ill.
BURNETT, FRED.....Peabody Coal Co., Harco, Ill.
CLARKSON, JOHN L.....Clarkson Coal & Mng. Co., Nashville, Ill.
CLAYTON, R. R.....Hercules Powder Co., Chicago, Ill.
COOK, WALTER.....Central Mine Equipment Co., St. Louis, Mo.
DAWSON, HUGH.....Bethlehem Steel Co., Herrin, Ill.
DE WITT, C. S.....C. W. & F. Coal Co., Chicago, Ill.
DOOLEY, JAMES E.....Dooley Brothers, Peoria, Ill.
EDGAR, R. L.....Watt Car & Wheel Co., Barnesville, Ohio
ELLIS, HOWARD.....Cardox Corp., Chicago, Ill.
EUBANKS, FRANK.....Old Ben Coal Corp., W. Frankfort, Ill.
FIRTH, JOSEPH, JR.....State Mine Inspector, Benld, Ill.
FLEMING, J. B.....Mine Safety Appliances Co., Urbana, Ill.
FOSTER, JOHN R.....C. W. & F. Coal Co., W. Frankfort, Ill.
GIVEN, IVAN A.....''Coal Age,'' New York, N. Y.
GRIFFIN, JOHN.....Koppers-Rheolaveur Co., Pittsburgh, Pa.
HALL, LEE W.....Goodman Mfg. Co., Benton, Ill.
HARVEY, HADLEY.....Ohio Brass Co., Evansville, Ind.
HAZEN, LEE.....Bell & Zoller Coal & Mng. Co., Zeigler, Ill.
HITT, JOSEPH E.....Walter Bledsoe & Co., St. Louis, Mo.
JEFFERIS, J. A.....Illinois Terminal R. R. Co., St. Louis, Mo.
JENKINS, G. STEWART.....Consolidated Coal Co., St. Louis, Mo.
JOHNSON, J. H.....Superior Coal Co., Gillespie, Ill.
JONES, D. W.....Princeton Mining Co., Princeton, Ind.
JONES, JOHN E.....Old Ben Coal Corp., W. Frankfort, Ill.
KOSTBADE, C. J.....Berry Bearing Co., Chicago, Ill.
LINDSAY, GEORGE.....Rex Coal Co., Eldorado, Ill.
LINDSAY, W. L.....Socony-Vacuum Oil Co., St. Louis, Mo.
LIVINGSTONE, A. R.....Court Reporter, Springfield, Ill.

MARDIS, EARLE J. American Steel & Wire Co., Chicago, Ill.
MARTIN, ENOCH. Dept. Mines & Minerals, Springfield, Ill.
McCABE, LOUIS C. State Geological Survey, Urbana, Ill.
McCOLLUM, H. C. Allen & Garcia Co., Chicago, Ill.
McCULLOUGH, E. W. American Car & Foundry Co., Terre Haute, Ind.
McPHAIL, ROBERT. Peabody Coal Co., W. Frankfort, Ill.
MEAGHER, GEORGE. C. W. & F. Coal Co., W. Frankfort, Ill.
MILLER, FRED. Franklin County Coal Corp., Herrin, Ill.
MONICO, J. A. Illinois Powder Co., St. Louis, Mo.
NEIDRINGHAUS, RAYMOND C. A. Leschen & Sons Rope Co., St. Louis, Mo.
OLDHAM, R. J. Centralia Coal Co., Centralia, Ill.
PICKARD, A. E. Mt. Vernon Car Mfg. Co., Mt. Vernon, Ill.
POLAKOV, WALTER N. U. M. W. A., Washington, D. C.
POWELL, JAMES. Superior Coal Co., Gillespie, Ill.
POWERS, F. A. Hulburt Oil & Grease Co., Peoria, Ill.
RHINE, F. E. Joy Mfg. Co., Franklin, Pa.
RODENBUSH, JOHN. C. W. & F. Coal Co., W. Frankfort, Ill.
ROMAN, F. W. Hercules Powder Co., Chicago, Ill.
SANDOE, C. J. West Virginia Coal Co., St. Louis, Mo.
SCHONTHAL, B. E. B. E. Schonthal & Co., Chicago, Ill.
SCHULL, F. M. Binkley Coal Co., Clinton, Ind.
SHERMAN, HUGH S. General Electric Co., St. Louis, Mo.
SIMPSON, JOHN. Bituminous Casualty Corp., Pana, Ill.
SMITH, CLOYD M. "Mechanization," Washington, D. C.
STINTON, W. S. Socony-Vacuum Oil Co., St. Louis, Mo.
TAYLOR, H. H., JR. Franklin County Coal Corp., Chicago, Ill.
THOMPSON, J. I. Koppers-Rheolaveur Co., Pittsburgh, Pa.
THOMPSON, R. A. Hercules Powder Co., Collinsville, Ill.
TREADWELL, H. A. C. W. & F. Coal Co., Benton, Ill.
VLASAK, JOSEPH. St. Louis & O'Fallon Coal Co., E. St. Louis, Ill.
VON PERBANDT, LOUIS. Allen & Garcia Co., Chicago, Ill.
WEIR, PAUL. Mining Engineer, Chicago, Ill.
WEISSENBORN, F. E. Ill. Coal Operators Assn., St. Louis, Mo.
WIEDERANDERS, E. O. Jeffrey Mfg. Co., Springfield, Ill.
WILKEY, FRED S. Ill. Coal Operators Assn., Chicago, Ill.
WILSON, J. C. Ohio Brass Co., Mansfield, Ohio
WOOSLEY, C. W. Pyramid Coal Co., Pinckneyville, Ill.
YOUNG, WM. P. Crescent Mining Co., Pekin, Ill.

Mr. C. J. Sandoe: I think this is one of the best meetings we have ever had in point of attendance. There are only six people on the boat not in this meeting. I think we should thank the Sergeants at Arms for the good work they have done.

President Taylor: Is there any unfinished business?

Secretary Schonthal: I have an amendment to the by-laws, presented at the Springfield Meeting last Fall. According to our Constitution, the amendment to the by-laws must be read at two regular meetings. This is the second reading:

"Proposed amendment to Section 3, Article 3, of the Constitution and by-laws."

I will read Section 3, Article 3, of the Constitution as it now is so that you will understand:

> "Section 3. The officers and Executive Board Members shall be selected by ballot, annually, at the regular November Meeting and shall hold office for the ensuing year."

As the amendment is proposed, the Section would read as follows:

> "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."

That is the amendment as proposed, offered and read at the fall meeting, and this is the second reading of it.

President Taylor: I wonder if Mr. Weir hasn't a word to say about this matter, which he presented last fall.

Vice-President Paul Weir: At the time I presented the report at the fall meeting in Springfield, I explained what the purpose was and what we hoped to accomplish if this amendment were adopted.

I think for the good of the Institute there should be a change in the Executive Board from time to time. It is hoped that this amendment will accomplish that purpose and give recognition to the young fellows who are coming along and are active in the Institute. A good many of us have taken an interest in the Institute over a period of time, and have sort of shot our wad on it. Young fellows are coming along, and I think they should be recognized by perhaps a change which will permit them to become members of the Executive Board from time to time.

I move the adoption of the report.

(Which said motion was duly seconded.)

President Taylor: It has been regularly moved and seconded that the amendment as read be adopted. Is there any discussion?

(Whereupon the motion was unanimously carried, and the amendment to the Constitution and By-Laws declared adopted.)

President Taylor: Any other unfinished business?

Secretary Schonthal: That is all, Mr. President.

President Taylor: Is there any new business to come before the organization? If not, I will turn the meeting over to our Vice-President, Mr. Paul Weir, and ask him to conduct the morning session. Mr. Weir, will you come forward and take charge of the meeting?

I think it might be well to state if there are any more suggestions put out by any of the Committees such as was made by the Sergeant-at-Arms who was trying to get a vote of thanks for himself, it will be pounded down just as quickly as that one was.

Vice-President Weir: There have been some changes in the program, in the order in which the papers will be presented. Mr. Roman's paper on explosives will be presented first. Mr. Roman is the Explosives Engineer of the Hercules Powder Company, Chicago, Illinois, and he wants to get off the boat somewhere along the line. He has asked for the prime position on the program. Of course, we want to accommodate the gentleman. We want to get rid of him.

The first paper of the morning will be "Blasting With Permissible Powder," by Mr. Roman of the Hercules Powder Company.

Mr. F. W. Roman (Explosives Engineer, Hercules Powder Company, Chicago, Illinois): Thank you, gentlemen.

BLASTING WITH PERMISSIBLE POWDERS

By F. W. ROMAN

Explosives Engineer, Hercules Powder Company, Chicago, Illinois

Before entering into any discussion of the *use* of Permissible Powders, it might be well to trace the origin and to fix in mind the meaning of the term "Permissible" as applied to explosives. Although the United States was in the front rank in the development of graded dynamites, it was rather slow to take up the study and application of explosives adapted for use in gassy and dusty coal mines. European countries had been devoting time and attention to this problem since the eighties and had gained considerable experience. In 1907, James R. Garfield, then Secretary of the Interior, was instrumental in starting a governmental study of problems attendant upon the cause of mine disasters, and the testing of explosives under mining conditions. The value of the work done was so apparent that the United States Bureau of Mines was created as an independent bureau of the Interior Department by an Act of Congress of May 16, 1910. The purpose of the Bureau was "to make diligent investigation of the methods of mining, especially in relating to the safety of mines, the use of explosives and the prevention of accidents, and other matters relating to mining."

One of the first acts of the Bureau was to notify the manufacturers of explosives in the United States that any explosives they might desire to submit would be officially tested for admissibility to a list of "permissible explosives," that is, explosives which would be permissible for use in gassy or dusty mines when used under certain conditions. Samples submitted are tested for chemical analysis, unit deflective charge, or strength; density, rate of detonation, etc., and tolerances are laid down by the Bureau of Mines which must be complied with in subsequent manufacture.

If this problem of safety in coal mines was a prime one during the days of hand labor, how much greater it has become since mechanization! The whole process has been speeded up. Things have to keep moving on the basis of the loading unit and there can be no delays. More dust is created by the mechanical loading. All of these factors make it more important than ever before that proper explosives be used and that miners devote attention to loading and firing in accordance with good blasting practice and the Bureau of Mines' conditions for permissibility.

Coupled with these "safety" considerations, we have the matter of breaking up the coal in the most efficient manner for the loading machine. Hence, mechanical loading requires greater supervision in the use of explosives, together with a more careful distribution of the explosive itself.

Supervision must start with the preparation of the working place. A common fault observed in many preparations is the mining machine cut. The cutting machine should be "sumped" in such a manner as to cut a square rib. If the rib cut is at an angle we get a "keystone" effect with the result that as the energy from the permissible seeks its outlet, it backs up into the "pocket," buckles and pulverizes the coal. The bug dust should be completely cleaned out from the "kerf," as this cut is primarily made to allow an expansion in breaking down the coal.

The correct alignment of drill holes is another item of importance. The general practice and a good starting point is to drill the rib holes about 18 inches from the rib, and parallel with the center line of the working place. Here again we find the "keystone" effect with resulting pulverized coal if these holes are not parallel. Care should also be taken in spacing the auxiliary bore holes so that correct equalization of burden will be maintained.

The type of permissible to be used, together with its distribution depends entirely upon the type of coal, height of seam, whether the coal has distinct faces and butts, sulphur or other impurities and any distinct bands. In a soft coal without any impurities, 4 ft. or under, it is our experience that a bulky slow speed permissible is most effective. Where impurities are encountered a medium dense, medium speed can be used. If in either case we have distinct faces and butts, a slow speed permissible should be used. On the other hand, if it is an open coal, a permissible with a higher rate of detonation will perform its work before the gases from the explosive seep out through the openings. As we get into higher coals with either embedded impurities or distinct bands, it is generally found necessary to go to permissibles with greater densities.

You will note frequent mention of different densities and bulk, as well as speeds or rate of detonations. To assist the mine operators to partially control their blasting problems, the explosive manufacturers have on their lists a series of permissibles ranging from the bulky, slow rate of detonation powder to the dense slow ones; also the bulky, fast explosive to the dense fast permissible.

As you know, every mine is largely a problem in itself and as such must be dealt with individually. However, there is one practice which is beneficial in a great number of instances in Illinois mines, namely, the use of air spacing in the bore hole. There are a number of ways in which this can be secured.

One operator observed, used a dummy cartridge with a string the length of the distance between the explosive column and the collar of the bore hole. This dummy was pushed back and then pulled out allowing the desired air space, with the balance of the hole tamped solid. Another operator secured air spacing by inserting loosely packed, untamped rock dust dummies through part of the column in bore hole, tamping the balance of the bore hole solid to the collar. Other operators depend entirely on using a bore hole considerably larger than the diameter of the permissible cartridge, thus allowing an air space around the explosive column.

Air spacing of any type appears to have the benefit of reducing the first shock created by the detonation of the permissible explosive, thus reducing the pulverizing effect. Its action may be compared to placing a cushioning material upon a rock before hitting it with a sledge hammer.

Again it should be borne in mind that each operation is to a great extent an individual problem. The manufacturers have types of permissibles to meet varying conditions and are ready and glad at all times to assist in the choice of the powder, as well as to make a study of material, equipment and methods so that the explosive will give the operator the greatest efficiency.

In closing it should be pointed out that the Bureau of Mines have placed a joint responsibility on the manufacturer of explosives and the mine operator in the matter of permissible explosives. Manufacturers of explosives must submit samples which are subjected to the tests prescribed by the Bureau. Thereafter the manufacturers must keep within tolerances laid down by the Bureau of Mines in order that the explosives may be permissible. However, in order to comply with the Bureau's regulations for permissibles, "It is provided further:

"That, in accordance with Schedule 17C, under which the previously named explosives have been tested, explosives enumerated on the permissible lists of the United States Bureau of Mines are permissible in use only when they satisfy the following requirements:

"1. That the explosive is in all respects similar to the sample submitted by the manufacturer for test.

"2. That electric detonators (not fuse and detonators) are used of not less efficiency than no. 6, the detonating charge of which shall consist by weight of 80 parts of mercury fulminate and 20 parts of potassium chlorate (or their equivalents)—and that the required electric firing must be done by means of a permissible-type blasting unit.

"3. That the explosive, if frozen, shall be thawed thoroughly in a safe and suitable manner before use.

"4. That the quantity used for a shot does not exceed 680 grams ($1\frac{1}{2}$ pounds), and that it is properly confined with clay or other incombustible stemming.

"5. That the diameter of the cartridge used must be not less than that designated in the column 'Smallest permissible diameter.'

"6. That the shot is not fired in the presence of a dangerous percentage of firedamp.

"7. That the shot is not a dependent shot, is not bored into the solid, and does not have a burden so heavy that the shot obviously is liable to blow out.

"8. That the explosive be stored under proper conditions so that it does not undergo change in character."

Thus it will be seen that the manufacturer of explosives and the mine operator each has a responsibility to assure that the full value of the Bureau of Mines' work on permissible explosives may be realized.

* * *

Vice-President Weir: Mr. Roman, I wonder if you will remain in front while we see if any of the members have any questions they would like to ask you, or any comments to make on your paper?

One thing that has always impressed me is that all too frequently permissible powder is not shot in the manner provided for in the Bureau of Mines regulations. It ceases to become permissible powder if more than one and one-half pounds are fired in the hole at one time.

Are there any questions?

President Taylor: There is a question in my mind. You mentioned something about dense and bulky powder, and differentiate between the two. What is the reason for having two different definitions of powder?

Mr. Roman: By using lighter or heavier carbonaceous material, the density of the permissible can be varied, thereby obtaining powders of various cartridge counts. This gives different bulk strengths to the powders.

President Taylor: Depending upon the type of work you want to do, whether you want a reasonably strong column of explosives?

Mr. Roman: Yes.

Mr. John E. Jones: A recent example of the incorrect use of permissible powder is the explosion in the Red Jacket Mine in Virginia, in which some 42 men lost their lives recently from a blast of a permissible explosive placed in a non-permissible manner. As most of you know, permissible explosives were blasted which were not put into a hole and were not tamped.

President Taylor: In the particular disaster to which Mr. Jones refers, they were attempting to break a rock by placing a couple sticks of powder on the rock and mud tamping.

Mr. John E. Jones: Dust tamping.

President Taylor: Just a handful of dust on the powder.

Mr. John E. Jones: Quite a lot of dust, I understand.

Mr. Roman: That is referred to as mud capping in the open. This type of shooting should not be carried out in the mine where you have dusty conditions. It wasn't shot under the regulations of permissible.

President Taylor: And ceases to be permissible powder.

Mr. Roman: Yes, sir, just reverting back to dynamite when you do that.

Mr. H. A. Treadwell: I would like to have every superintendent and mine manager and every fellow who has anything to do with the shooting, stop and think back and see just how you are shooting your bottoms. How many of them are going in with a pick and digging a little hole and laying a stick of permissible in it and shooting? You do not have to get up and say so, but I would like to have you fellows think about it.

This disaster of the Red Jacket could have happened in Illinois. I think it is a good thing for you fellows to think about. I think it would be a good thing to think about and investigate the way you are taking up your bottoms.

There is another point in your paper, Mr. Roman, on blasting. A few years ago we were all very much excited over it. Since we have gone to mechanized mining, we have forgotten some of it. But isn't it a fact with cushion blasting we have a better chance of moving our coal away from the face?

Mr. Roman: That generally holds true. I think your people probably carried on as extensive a campaign of cushion blasting as any company in the country.

Mr. Treadwell: Your company brought out different methods of making cushion blasting, and one method you show is to bore a hole larger in diameter. A number of years ago the Explosive Engineer put out an article on cushion blasting that was very, very interesting. I lost my copy, and have never been able to find it. I think it would be a good thing if the Explosive Engineer can ever find that thing to reissue it. It is the best article I know of on cushion blasting, and I think there is a lot of benefit to be gained in mechanical loading, from good supervision on cushion blasting. We find it moves the coal out and gives freer loading.

Mr. James S. Anderson: Mr. Roman talked about air space, and I believe Mr. Treadwell mentioned drilling the hole larger than the cartridge. Of course, we all understand a lot of it depends upon the depth of the cut. In a place I know of, we have a ninety foot cut. We drill an eight and one-half foot hole, and the seam averages five feet. I have been wondering if by using the usual first cartridge and using three sticks in the hole if we got the full benefit of that powder in the back of the hole. You put three sticks of powder, say six and three-quarter inches long, in an eight and a half foot hole—what about the front of the cut?

Mr. Roman: Of course, you have a very badly overbalanced condition in a shot like that. We all know in shooting down coal in most of our mines through this section we use the regular undercut, undercut at the bottom and place our holes fairly close to the roof. You have the advantage of the weight of the coal, and if you have any natural parting in your seam it generally comes between the coal and the roof. Where you use a nine foot undercut in a five foot seam of coal and put your powder at the back end of an eight and one-half foot hole, you have an unbalanced condition.

There is considerable work being done on just such problems as that at the present time, but we haven't anything definite worked out so that we can give you anything at the present time. Borrowing from our experience in shooting open work such as quarries and other types of work of that kind, we are endeavoring through air space and other mediums to overcome some of the condition you relate. I do not know what will be the final solution to the problem.

Mr. James S. Anderson: I have been studying that very thing, and I have got a thin cartridge. It has the double effect. It has the air space you speak of, and for the same amount of force brings the powder out nearer the front of the hole.

Mr. Roman: You get better distribution that way.

Mr. James S. Anderson: Yes.

Mr. Roman: That is one way of endeavoring to battle that problem.

Mr. James S. Anderson: If you are using one and three quarters by six cartridges of permissible and use three sticks to the hole, we have found that we will get much better results in undercuts from seven to eight and one half feet deep by using cartridges of say, one and one quarter by eight inches long, which will allow us to put in about 48 inches of powder or six sticks per hole instead of 18 inches or three sticks per hole. This gives us a very good cut on the ribs and produces a size coal that is much easier for the loading machine to handle.

Mr. Roman: As I say, that is a difficult problem at the present time, especially in low seam coal. Everybody is working on it and the likelihood is somebody will arrive at something very beneficial, possibly through the medium of the smaller size cartridge with additional air space, as Mr. Treadwell suggests. I think you are approaching the problem in the right manner by the smaller cartridge and air space in the long undercut. We have some other things in the fire at the present time that might eventually work out to be beneficial in problems like that, but haven't carried it far enough along to have anything definite on it.

Vice-President Weir: Are there any other questions?

Mr. F. M. Schull: I have a problem somewhat different from that of Mr. Anderson's. I have a certain mine, with a seam where we have fifteen inch thick top coal, about eighteen inches to twenty inches of bottom, and you cut the middle band out with a six inch undercut. It is a nice one to fool with permissible powder.

Mr. Roman: Your difficulty, I imagine, is in the bottom entirely. You can drop the top down easily enough.

Mr. F. M. Schull: We cut it down in the back. We made quite a study of that. We have tried different things to work the problem out, and some of them worked out very successfully with permissible powder. All those things are very interesting to me.

Mr. Roman: Using a nine foot undercut?

Mr. F. M. Schull: No, six and a half, or about six foot cuts. We have five and one-half feet in places, and in places not quite that much. You are not in the middle, but a little nearer to the top. The thirty will run a little closer to the top than the bottom, and you have the six foot hole with fifteen inches of coal on the top and eighteen inches on the bottom.

Mr. Roman: Are you shooting permissible?

Mr. F. M. Schull: We shoot permissible, one hundred pounds to start with.

Mr. Roman: We had a problem something similar to that over in a mine in Indiana. Here is a little suggestion you might try out that might be beneficial. You are not getting correct distribution. The way we approached the problem in this other incident, with similar conditions, was to use a long and a short hole. Drill your rib holes back to the back of the cut, or within six inches, and then come in between the long holes and drill short holes that will go part way, to loosen the front of the coal. You can go to a bulkier type of powder, and you will not have any more energy involved over the whole surface than you would if using denser powder. If distributed over more points with short and long holes, it might give you something that would be beneficial.

Mr. F. M. Schull: Our drilling costs were clear out of line, in drilling the top and bottom of that thickness of coal. Your drilling is the problem. We drill the holes in the coal, and shoot with an electric detonator. It is like one big lump or piece of coal down there, and you cannot find a seam in it. We tamped and shot with an electric battery.

Mr. Roman: And that was beneficial?

Mr. F. M. Schull: Yes.

Mr. Roman: You got better distribution?

Mr. F. M. Schull: Yes.

A Voice: Do you do the bottom the same way?

Mr. F. M. Schull: Yes. We got it down to where we could break the coal almost the size we wanted it by reducing the powder or increasing it a bit.

The Voice: How many holes did you put in the bottom?

Mr. F. M. Schull: In a fifteen foot entry, you had to drill four holes to get it so you would get it small enough to get it over the top.

Mr. D. W. Jones: I would like to bring a question up, Mr. Roman. We do not seem to be consistent in our theory about permissible powder, in some way. We give a driller instructions to clean the dust out of the hole, clean it properly, and put the powder in direct contact. If we have a mis-shot, they say dust is between the powder and that is why it did not go off. Then we come along and tell them to leave an air space. When we have mis-shots there, what will we blame that on, the sensitiveness of the powder?

Mr. Roman: I would say you have two different problems there, with some foreign matter between your cartridge or any type of dynamite, whether permissible or otherwise. When you place foreign matter between your explosives, it will not carry through the foreign matter. But if you have an air space in there, with the customary No. 6 Blasting Caps, using any permissible, it ought to have sensitiveness enough to shoot with a No. 6 Cap, and I cannot see how you would have misses from having the air space.

Mr. F. M. Schull: I want to verify my impression. He used the detonator in each cartridge

Mr. Roman: Yes, sir.

Mr. A. E. Pickard: I would like to know something. He just got through saying if you put something between the shells they would not shoot. Now, then, are you going to put one shell here and another here and nothing between and have them shoot?

Mr. Roman: I do not think you understood what he said. He said he put the detonator in each of the charges.

Vice-President Weir: Are there any further questions? If not, Mr. Roman, we thank you very kindly for your excellent paper.

Now, I mentioned previously there have been some changes in the program. This oil industry, with the exception of gasoline for automobiles and lubricants for our machinery, is pretty much a pain in the neck to the coal industry, in more than one way. First, they give us a substantial amount of competition in the fuel markets, and second, here in Illinois they are commencing to drill a lot of holes through our coal mines. One of our members here this morning has had quite a little experience in the last few months in handling the problem of what to do with these drill holes when they go through open work. Drilling is becoming so widespread in the State that undoubtedly a good many men will have that same problem within a reasonably short time.

I am going to ask Mr. R. J. Oldham to tell us something of his experience. He has not prepared a formal paper, and will speak extemporaneously. I imagine there will be quite a few questions which you will probably want to ask him.

We will recess until we go through the locks.

(Recess.)

Vice-President Weir: Gentlemen, let us proceed. Mr. Oldham, you are on the spot.

DRILLING FOR OIL AND GAS THROUGH ACTIVE AND INACTIVE COAL MINES IN ILLINOIS

By R. J. OLDHAM
General Manager, Centralia Coal Company, Centralia, Illinois

Mr. Weir and members of the Institute, I am more or less on the spot. The Committee asked this morning that I discuss with you briefly some of the things which confront the operators in the oil basin of Southern Illinois.

As you all know, the development, which is now taking place in Southern Illinois, runs somewhere in the leasing from Mattoon, Illinois, to almost the southern part of the State. To give you some history of the development, I will refer principally to the territory around Centralia because that is the place where I am most familiar.

The development has been going on for quite some time, and is now very active in the Centralia Basin. The active development started about the middle of September of last year. At that time there was not much concern from the standpoint of our Coal Company, due to the fact that the development started about two miles northwest of Centralia and was not in mined area. However, when the discovery well was brought in, we were faced with the necessity of determining what we would do if, and when, the development reached our active mining property.

I might say here that the pool has now developed from a northwesterly direction to a southeasterly direction, some four miles in length, and approximately a mile and a quarter in width. On the northern edge of the field it entered the old, inactive properties of this company, which were operated many years ago by a predecessor of the Centralia Coal Company.

They started drilling into the inactive mine, which had no connection whatsoever with our present active mine. Naturally, our concern was not so great, due to the fact there was no life or property involved there. These mines had been abandoned a number of years, but we could determine then just what was confronting us when, and if, the pool extended down to our inactive properties, which are connected with our present active mine, which did happen as the pool developed.

And to give you some idea how fast the drilling will move, from the time one of the rotary units moves onto a location until the time it moves off of the location, there is more time consumed in setting up and getting ready to drill and removing the equipment than there is in the actual drilling of the hole. Some holes have been drilled from 1375 to 1385 feet in forty-two hours. So you can imagine the speed of the drilling and how hard it has been to keep up with it.

I do not want to leave the impression that all of the drilling rigs drill that fast. That was a good operator with good equipment and very competent men.

Fortunately, we have some very reliable, responsible drilling companies in Centralia. On the other hand, we have some very irresponsible promoters. The responsible companies will do the job right, for they drill their wells in the manner in which they operate their companies, but the irresponsible promoters—of which, as I say, there are unfortunately too many—their idea is to drill the well as quickly as possible with the least expense and get production started regardless.

The great concern that confronted us was that we not only had the Benoist Sand, which was from 1350 to 1385 feet below the surface, but we had the sand known as the Petro Sand at a shallow depth of about 785 feet. At approximately 1200 to 1225 feet was what is known as the Stein Sand. Then below the Benoist Sand is the McClosky Limestone.

All this was developed to the point where drilling entered our inactive No. 1 Mine, which started operation near the year 1875. At that time, from talking with men still around Centralia who worked in this mine, of which there are very few, they tried to tell us, in their way, just about how this mine was developed and about the extent of the development. However, we found that to be very inaccurate. There were no maps available of this property. That was before the days of filing, before the days of good surveying and maps were made by mine managers or someone designated by them and the mining system was not uniform. The result was we did not know just where to locate pillars. We attempted to do this and were successful where our maps were reliable, where the maps were not reliable there was no data upon which to base any of the information which they wanted.

We found, just as soon as they entered this No. 1 Mine, we not only had one level which had been mined, but for a short distance coal had been mined from two levels. The first No. 6 coal at about 575 feet and the No. 5 coal was found at about 780 to 790 feet below the surface.

The operators, that anticipated the mined out area, started in with a large enough hole so that they could protect themselves by running casing and cementing by a process which would assure us that the water and the gases were shut off from above and below the coal seam.

This is of great concern to many of you because there is no doubt in my mind but what there will be drilling in the active part of the mines of many coal companies during the next few years.

At the time the drilling started through our No. 1 inactive mine, we appealed to the Department of Mines and Minerals, who were very willing to cooperate with us. Mr. Martin and State Mine Inspectors of Clinton, Marion and Washington Counties met in our office to discuss the matter from every angle to arrive at some method to assure ourselves of all protection possible to protect life and property.

After several meetings, recommendations were made. As you know, our mining law in Illinois does not cover a lot of drilling regulations, which, no doubt, it will in the future and the Department has been very kind to us in assisting in every way possible.

When a man has gone down with a hole sufficiently large to protect us against salt water, fresh water or gas, he has a very simple problem in shutting it off, but if he hasn't gone down with a hole sufficiently large to do that, he has a very difficult problem and it is a bad problem for us.

Where they drill into the open mine—I am speaking now of the No. 6 seam—it is necessary to drill at least 100 feet below the No. 6 coal to get a very good bench of lime on which to set their casing. We have asked them, and in fact have insisted, that they drill this hole at least two inches larger than the pipe or casing they are going to run. Then they use the Halliburton Cementing Process. I imagine some of you are familiar with the Halliburton System. It is a very dependable process in cementing, and in our opinion makes a very satisfactory job.

During the time they are drilling below the open mine, they have this liability. They are making a hundred feet of hole there with rotary drills. They must have a return of their drilling fluid. They use water and cuttings to make the drilling medium. The fluid is pumped down the hole inside the rotary pipe or drill pipe. It comes out the bottom around the drill bit and returns to the surface. You can readily see when they hit the open mine they lose the return. When they lose the return, there is only one thing they can do to make the hole and that is go on down and let the return, which carries the cuttings, run into the open mine. That is all they can do. The rotary drill cannot drill without the drilling fluid. They are helpless without it. That means all their drilling fluid and cuttings must go in the mine.

The minute they get to 100 feet, they set the casing, which should be two inches smaller in diameter, which is called the combination float and guide shoe on the bottom of the casing. Then they take the Halliburton Process and start pumping the cement down through the inside of the pipe. That cement goes to the bottom of the pipe, comes out through this combination float and guide shoe and returns on the outside of the casing, thus cementing casing in hole. We have found, by experience, no less than 100 bags of cement should be used in that 100 feet. That assures you that you have enough return that it will pyramid in your open works and assure you enough of it gets out to get that return. They use a cement which sets within 48 hours.

Then, above the mine, we ask them to use, or rather insist they use, what is known as a cave catcher or pedal basket, which fits over the outside of the casing. That is merely a precaution used in connection with what is known as the Halliburton Shot Hole Device. This shot hole device is a tool of the same diameter of the casing used in the hole and it is placed in the line of cap rock over your coal to where you can assure yourself it would make a good fit. This shot hole device, being the same diameter of your pipe, usually four to five feet in length, is perforated. Around the perforations they wrap about 50 feet of canvas. The canvas is split from top to bottom and then stitched together so that it will stay around the casing. That is lowered with your casing and the minute that is placed in your cap rock or line immediately above the No. 6 coal, they put 800 pounds of water pressure on it with the pump they use with their process and that immediately rips open the canvas that had been stitched together and they call that their shot tail device, which immediately bridges. When they form this bridge, you have this cave catcher or pedal basket below that and that assures you, should this shot hole device turn wrong side out and go on down the side of your pipe, that you have something there to hold. By having the pedal basket on the outside the falling material goes into that and forms your bridge.

Then they pump a plug down in there, and just below the perforations they have some dowels, which are usually anywhere from 3/16ths to 1/4 inch long. They are made of fused steel or copper. The minute the plug lands on those, it stops at that point. Then they start pumping cement down through the inside of the pipe. The minute that cement gets down to the plug, it runs out through the perforations in this pipe and follows the outside of your casing. The minute we get a return of that to the surface, the cement job is completed and that stands up for 48 hours, when the cement sets. Then they go into that and drill this plug out.

In some holes 800 pounds of pressure will put it down. On one hole I know of, it required 1270 pounds to put it down. They had some failure with the plugs and we found, when we went in this hole, instead of 70 feet of cement left in the hole, we had 340 feet of cement left in the hole. But it is a precaution and it does shut off the water from above.

Now, as you know, our State law reads that where a hole penetrates a coal field of more than four feet in thickness and more than 100 feet below the surface, fresh water shall be cased off. That is all right so far as the law goes, but it does not say anything in there about the cementing process.

The cementing process has a twofold job. After this hole is run to the oil sand, then what is called an oil string or pipe is run inside of that hole. We are requesting they run that at least three inches smaller in diameter than the inside of the pipe set through the mine. That insures us when they run their cement from the bottom of that hole to the top and get the return, we have that pipe, which runs not only through the mine, but we have at least one and a quarter to one and a half inches of cement outside that pipe, which assures us water or gas will have no effect upon that pipe and allow seepage of gas and water into the mine.

Now, as I said, on the locating of pillars, of course we have attempted to do that. Take the town lot drilling, which will confront a lot of you, you are limited as to space. Wells are drilled on lots 40 feet in width and 120 feet in length. You know when coal was extracted from a mine abandoned many years ago, there were not many pillars left and it is difficult to try and locate them. The only thing they can do when they get into trouble and lose a return, is to take the necessary steps to get that return by the above described method.

Cable tool drilling is different. They go down and case off for water as they go. They have attempted not to cement their holes in, but so far we have found the cable boys who go down have had to come back and cement because of the water that goes down and follows the sand. They are very friendly now to us, irrespective of what we think of the thing.

The Department of Mines and Minerals have, as I said before, done everything within their power up to this time to assist us. I know they stand ready and that if they had a law back of them they would do everything possible, but, unfortunately, we do not have the law.

I think it behooves every man here, who is confronted with this situation, to get behind the Department. It isn't the big producer, or the responsible producer who will cause the trouble, but in every oil field the history has been that it is the irresponsible promoter that gives the real grief. He uses second-hand pipe and has the cheapest job he can get. A lot of them have attempted to run a one inch pipe down and put their cement down the hole through the pipe and lift it after the cement comes up the hole. That is very unsatisfactory. There is only one way to do it and that is put it down inside the pipe and get the return. Even if you have to waste a few bags of cement, you are sure the water is shut off and the hole properly taken care of. It will take, generally, from 360 to 450 bags of cement to cement one of the holes.

There is another factor in this, that is the oil interests are practically all from out of the State and they are direct competitors of the coal industry. There is no question about that at all. Here is the point. If they are not responsible men, if they are not financially responsible and if they give you gas in sufficient quantities in your mines and water in sufficient quantities to come over to where it causes a loss of life or a loss of property, it is a serious thing. It is due a lot of consideration and it is a thing that every man here should begin to think about because it is confronting you.

It has come on us fast and we have tried to keep up with it. I try to visit the holes and see what is going on. I try to confer with the men in every way possible to get them to do the job right. Some are cooperating and some are not. It is a deep concern to us. I think anything any of us can do to get behind our Department—I am quite sure they are well aware of what is going on, and all they lack is a law to support them, and if we can get the law behind us, such laws as they have in the east, we will be in much better shape. They have some very good laws, particularly in West Virginia. Pennsylvania has some very good laws.

I might take the time to tell you what they are doing in West Virginia. When you get ready to drill an oil well in West Virginia, what you have to do is file a map with the Department of Mines and Minerals showing your location. The minute you show that location to them, they send a notice out to all the coal interest within that vicinity and notify them of this proposed location. They have ten days in which to file their exceptions. If an exception is filed with the Department, both the coal and the oil interests are to be represented. If the location is shown to be detrimental, the Department requires the relocation of that well. If there is no objection to it a permit is granted based upon the original location.

We have in Illinois a filing law as to the exact location with respect to section lines or known landmarks and that should be filed with the county recorder in the county in which the well is drilled and also the Department of Mines and Minerals. Some of them are doing that and some are paying no attention to it. It should be done and I am sure there is one man here, Mr. Clarkson, who has had the same experience of just that thing, almost, some forty years ago, of drilling an oil well unknown to the company, and they cut into it with a cutting machine. Mr. Clarkson will tell you he has a flow of 160 gallons per minute, running five hours a day under 220 pounds pressure. It is costing him plenty of dollars to handle that proposition.

He discussed with me last night about the Halliburton process for shutting it off. I think that can be done. It will require them to find the old hole and shut it off. That will save him handling that expense. But had that been filed with Mr. Clarkson in his county, he would have had that location spotted on his map and would not have cut into the hole.

Boys, just as sure as we are here, this is coming on to us. You might as well get on the bandwagon and start with us, for we will have plenty of it.

I will be very glad to answer any questions any of you might have, insofar as I can.

* * *

Mr. Treadwell: This cement they use, do they put anything with it?

Mr. Oldham: They are using two brands in there, which set quickly and you get a reasonably good strength in four hours, but they allow it to stand forty-eight hours.

Vice-President Weir: Do I understand in a mine long since abandoned you follow the same practice, where they go through the old workings?

Mr. Oldham: Well, the mines which are abandoned and which are connected with the present active operations.

Vice-President Weir: I mean those in no way connected.

Mr. Oldham: No, but they have to do that in order to get the return with a rotary drill. It isn't a question of whether they want to or not. They cannot get the returns, and if they cannot they can not drill. They must take it and shield it off in order to get return. They get the return at the top, which goes in what is called the slush pit, where the deposit enters another pit, settles out and they can pick it up and put it down to the bottom again.

Mr. Treadwell: Otherwise they would be constantly furnishing new water and that is prohibitive.

Mr. Oldham: Yes, sir.

Professor L. C. McCabe: We have been particularly concerned with this for the last two or three years. We have had the experience in the old Southeaster Field, where No. 6 coal is met at 1000 feet, of not being able to get drill records showing thickness of coal, for the very reason our law, which had entirely good intentions, is ignored. For a long, long time, where No. 6 coal was approximately 1000 feet in depth, where there are no operating mines now, we never got a drill record showing No. 6 coal running four feet in thickness. There might have been two causes for that. It may have been because drillers were not getting an accurate thickness of coal, which is quite often the case, especially with a rotary rig, or because the law was ignored in order to prevent the selling of the coal. We are beginning to get good records now.

But I think this is a very serious proposition. The oil prospect in Illinois is not going to be limited to Centralia or its basin, but will spread all over the State. Unless there is more adequate control, we are going to have serious difficulties. Not only from water, for much of our lower water is artesian. If a mine development would run into a hole of that type, we know what it would mean.

Another serious trouble is some of the abandoned holes make a considerable amount of gas, and in drifting through the area there is danger from that source.

I would like to say, if we can get a law that we get a geological record of the drilling, that they give us the statement of our geological conditions—

Mr. Oldham: I think that is correct, but I do not think you will get it from at least 90% of the rotary drillers. As an example of that, one place I know definitely there is No. 6 coal at 615 feet, and yet within probably 900 feet or not to exceed 1000 feet from there, the man drilling the hole told me he picked up No. 6 coal at 493 feet. That shows how much they run over. When you consider it takes ninety minutes to get returns from the hole out the top, many things can happen. We do not accept the logs showing us the exact location of the coal as being accurate by any means, for one may be fifty or thirty-five feet away and have maybe twenty-five feet difference in the place they pick up the coal.

President Taylor: Mr. Martin, are there any comments you would like to make?

Mr. Enoch Martin: Mr. Chairman, I think if this Institute has in mind the amendment of the mining laws, they should, in order to safeguard themselves in this proposition, as suggested by this young man over there, have a log of the borings filed either in the University Department of Mining or the Department of Mines and Minerals.

I think, too, the law ought to provide that whoever drills in Illinois, whether it is prospecting for coal, gas, oil or whatever it is, that for satisfactory performance in regard to capping or sealing the hole, they should be required to file in the courts a complete record, and to be sure that record is completed that they be required to furnish a surety bond until the Court of Record, whether the Judge of the County Court or the Circuit Court, would complete the record by notifying the parties interested that safety laws had been complied with.

In our conference in Centralia, we tried to prevail, if you recall, upon the gentlemen who were going to go to the holes, that they furnish us with that log. I never got a copy of it, did you?

Mr. Oldham: No, sir, I haven't.

Mr. Enoch Martin: That should be required, and that 100 foot law should be amended.

(The remarks of Mr. Martin in regard to amendment to the present law were not reported because of confusion in the room and the inability of the reporter to hear.)

Mr. Enoch Martin: I suggest if the Institute takes a notion to do anything in that connection, we would be delighted to cooperate in any way we possibly can to help you so that you may help yourselves.

Professor Louis C. McCabe: I think that goes for the Geological Survey, too. We would be glad to help in any way we can to make a study of the thing and try to arrive at a solution.

Vice-President Weir: Gentlemen, there are two problems that have been pointed out by the speaker. First, is the immediate problem of the preservation of life and property. The second problem concerns the future, so that the value of virgin coal land will not be destroyed by careless drilling. Your President, Mr. Taylor, in opening the meeting this morning, very well said that all these organizations have to have a purpose behind them, have to accomplish something from time to time to justify their existence. I am wondering if this Institute would care to take any action in any way which would tend to seek an amendment to existing laws, or perhaps new laws which would handle not only the immediate problem, but look toward the conservation of virgin coal in this State.

Mr. Enoch Martin: As the law now reads, this inspection service of the holes drilled in the coal area is not a mining matter. The only person authorized under the law at this time is someone selected by other organizations. He makes the inspections and passes upon the question of adequacy. The mining law has no jurisdiction.

Mr. John E. Jones: The problem has been very well summarized as to what is needed and what some of the difficulties are, and by Mr. Martin as to the form of the mining law. I am a member of the Illinois Mining Investigating Commission, which in cooperation with the Department of Mines has brought out a starting point for the development of laws to cope with this problem. This you have heard from these men.

I want to add this thought. The General Assembly has not yet met for the necessary changing of the laws. We have from now until January 1, 1939, before we can hope to get a law in the Statute Books regarding this problem. We have some six or eight months in which to formulate amendments or laws and have them passed by July 1, 1939, and there is no question that there is something needed and needed badly.

In the meantime, of course, the Department of Mines is doing its level best with the present laws. As suggested by your Chairman, from the standpoint of the Illinois Mining Institute, the formulations of a proper set of laws for this hazard that is being placed before us is a good thing.

Mr. Enoch Martin: The only possible chance of getting any law passed before next July would be an emergency clause. At this Special Session, there would have to be an emergency clause attached to the law. The Governor in this Special Session has called attention to the oil problem. I do not know that you would get a law of that kind passed in this Special Session or any other Special Session, but as pointed out by Mr. Jones, a member of the Mining Investigation Commission, and an able member, we are not asking this Institute to take any action at all except the men that are concerned in the operating end of the coal business to keep in mind the suggestion of Mr. Jones and the Department of Mines and remarks of the gentleman from Centralia, and that you may seriously consider these things, and after consideration help Mr. Jones and Mr. McSherry in any way you see fit, in a group meeting, through a committee, or through representation of any sort. That is the kind of cooperation we need and not a resolution through this Mining Institute.

Vice-President Weir: Mr. Jones, may I ask a question, please? Is the scope of the Mining Investigations

Commission such that it would take in everything that is required to consider this situation?

Mr. John E. Jones: It is supposed to be such that it can do so.

Vice-President Weir: It seems there is a chance you may need something in addition to changes in the mining laws, or perhaps new mining laws. It may be there will be something required outside the scope of the Commission.

Mr. John E. Jones: There is a possibility of that. It must be mining laws to keep within the scope of the Commission. We have this period of time in which to give it study, and as pointed out it is of such importance that there should be no time lost in having something done, and still it does give time to give the study and get the best thoughts from the experience of other States.

Vice-President Weir: Is there any further discussion? Mr. Oldham, I appreciate your pointing out to us the nature of the problems which confront you in Centralia and as encountered throughout the State. However, I am somewhat optimistic about every operator in the State being disturbed by oil.

If there is no further discussion, this meeting will recess until 2:00 o'clock this afternoon.

(Whereupon, at 12:15 o'clock P. M., a recess was taken until 2:00 o'clock P. M. of the same day.)

AFTERNOON SESSION

At 2:00 o'clock P. M., the afternoon session was opened by Mr. H. H. Taylor, Jr., President.

President Taylor: You will please come to order for the afternoon session.

Mr. Weir, will you continue in your official position handling the session this afternoon?

Vice-President Weir: The last Appalachian Agreement negotiated between the miners and operators in New York in 1937 provided for a joint commission to make a study of the problems which were being introduced by mechanization in the coal mines in the Appalachian district. Arising out of that came the employment by the United Mine Workers of America of an engineer. I mean a mining engineer, an industrial engineer, and not a hoisting engineer.

Quite a number of years ago, in handling the labor dispute with some of these Franklin County miners, we introduced some sketches which had been prepared by engineers. The Sub-District Board Member said, "Well, by God, there is only one thing we lack. We lack engineers. If we had them, we would be all right."

The United Mine Workers have a distinguished engineer, who very fortunately is here this afternoon: Doctor Walter N. Polakov, who is now studying for the United Mine Workers some of the problems which are introduced into the industry by the mechanization of mines. We have asked Doctor Polakov to tell us something of the work which he is doing. I know all of us will be very glad to hear from Doctor Polakov at this time.

Dr. Polakov, would you like to come up in front?

A MESSAGE TO THE INSTITUTE

By DR. WALTER N. POLAKOV
United Mine Workers of America

It was a great pleasure to me to meet you all here and convey to you the good feelings of the organization which I represent.

As the Chairman told you, just about a year ago the Appalachian Agreement, the new Appalachian Agreement, incorporated a paragraph calling for the study of mechanization and its effect upon employment, cost of production, wages, and other ramifications of it. The United Mine Workers asked me to carry that work on their behalf.

There was a committee appointed by the operators to do their work. It is supposed to be a joint study, but after a year the joint feature of it hasn't developed yet. The operators still knew what they wished to do, and we have finished what we set out to do several months ago.

Since then, the Executive Board of the United Mine Workers asked me to organize an Engineering Department for the United Mine Workers of America, something quite unprecedented, and that properly deserves a few words of remark, and perhaps I should say a few words about myself in the way of salesmanship to you, who I am and why.

I happened to get my engineering and doctor's degree in Germany. I have been in this country since 1905, doing largely what may be called industrial engineering work, or management engineering work, starting with the American Locomotive Company and then coming to phosphate mines in Florida, and then going up to the iron mines in the Lake Superior District, and then back into the industrial work, the power industry and so on. Most of the work I have done, however, is in the power utility field, and in the organization and management of industry.

Now, you know that when a labor organization is committed to contractual agreements and to collective representation and bargaining, it is too narrow a point of view to say that either is a salesman's market or a buyer's—a seller's market or a buyer's market. If it is a seller's market, Labor can sell its labor for hire, and vice versa, Labor has to take a back seat. It is too narrow from that point of view, for whatever advantage may be taken by one or the other side of the bargain will come as an economic repercussion sooner or later. You cannot keep on forever getting something for nothing, as the saying goes.

And for that reason, out of the study of mechanization, particularly mechanization of loading and operation in mines, that involves the study or relative study of safety, wage accounting, cost of labor as involved in the financial structure of the corporations, a study of possible rate structures of the railroads, and all the ramifications that go into the question.

Now, the question comes up in a larger scope of not only what is necessary to do so far as the agreement with the operators goes but also what is to be done so far as national economy is concerned under present conditions.

In other words, Labor today is facing one thing that concerns everybody in this country, the reduction or shrinkage of the market. There are several reasons why the market is shrinking. One of them, as you know, is the progress and development of machinery. There are a few antiques like this boat that still burn as much fuel as the others and do less work. Most of them use less coal and produce more power, whether it is a public utility or the industrial plant or the domestic heating plant. The same way in metallurgy. Coke is used to produce steel. The same way in the preparation of coke, and on down the line.

The second thing is that there is less demand for coal because—shall we say Capital is on strike? We are not producing the potential Plenty which we today can produce. We do not produce even Plenty, hardly enough to maintain the 14,000,000 who are now out of jobs. That represents practically one-third of the population that is being frozen out of existence. If they do not have money to buy coal for domestic purposes, and are not employed in the mills and factories, they do not use the coal to keep these people working, and here again is less demand for coal solely because of the economic depression.

And finally, last but not least, is the competition in other fuels such as natural gas, oil, and all forms of it, and to some extent—very small, to be sure—water power.

The authorities in this country thought the coal problem was a difficult one, and that the industry is a sick one and needs a nurse, and so they have organized the Bituminous Coal Commission. The Bituminous Coal Commission finds itself in a situation where they are circumscribed in every direction. How can one deal with one industry without taking into consideration other industries? In other words, if they had organized a Fuel and Power Commission, then there would be something done. That would embrace not only bituminous coal but also anthracite and all forms of power and fuel and hydro-electric development. Then a coordinate plan could have been developed, but under the circumstances there could be only little patches and a little balm here and there applied to industry, as it will be applied.

Under all these circumstances, organized Labor realized they have to do something, and they have split that something into two very definite plans. One is immediate, the matter of life and death today. Another is the future, which does not concern the United Mine Workers alone but concerns everybody in this democracy of ours. In other words, the immediate problem is to survive the crisis without starving to death.

As you probably read in the papers, the Department of Labor has appointed last May, to represent the Labor point of view, A. D. Lewis. There were two others, one representing the Operators and the other representing the Government. The key note of the Lewis announcement was in agreement with the agenda of the meeting in Geneva, the question of the reduction of work and wages. In Europe, as you know, there isn't a country that works as long in the mines as in America. In France they have a seven-hour working day. In England they have a seven-hour work day. We have seven hours and fifty-seven minutes on a competitive basis, because our seven hours is from face to face, whereas Europe is from lamp house to lamp house.

Many countries in Europe have already instituted a six-hour work day for five days a week, and if they haven't instituted it actually they have already either passed resolutions or prepared to do so.

So that national convention that was representing some twenty countries producing coal, has been deliberating on this subject. A resolution was presented so far as American Labor is concerned that they will favor five days, six hours, a thirty-hour week as a means of distributing employment. Of course, that would not affect the operators especially under the present conditions, when they are working only a few days a week, whether there will be one set of men or another set of men working. This would entail considerable sacrifice on the part of organized Labor.

Another resolution that has been presented there by the United Mine Workers, and supported by the rest of the delegates, is that mechanization is desirable from many points of view. Mechanization is really the civilizing force, and mechanization brings out the engineering from the old relationship in step with the modern power age, mass production in industry. But heretofore, in many instances, with only a few exceptions, the mechanization accrues benefits only to the stockholders of the operating companies, and even that is sometimes very questionable. So far as the question of safety, so far as the question of larger income, so far as the question of employment, and so on, mechanization has proved a failure. But in principle you cannot and you shall not object to mechanization, because this is a technology program, and it is folly to stand in front of it any more than to stand in front of an onrushing locomotive or express train. The desired result is to develop a workable scheme whereby mechanization will produce benefits to all concerned, and all concerned means Labor, Operators, and the Consuming Public.

This has been and still is a major job for our Engineering Research Department to study these things and the ramifications of them. Along with the question of competing fuels, problems of safety, educational campaigns, whether we develop any of these in cooperation with the operators and managers—and the problem of participation and the benefits if any from further extension of mechanism.

In connection with this, it might be of interest to you that in another week or so we will complete a study which was entirely unique in itself, a comprehensive study of wage rates in Indiana and Illinois, for every section, an occupational job analysis for every job, existing rates, existing activities, annual wages of various groups, the various forms of operation, and a comparison of one with another. It is an ambitious and comprehensive piece of economic research.

That is, roughly speaking, what we are up against. In order to carry that kind of a program successfully, after the first year's research, I as Director of the Department have very definitely come to the conclusion that after we find,—whatever we find will be largely rendered useless unless the management of the mines will cooperate with our department in a sense of both checking this information and carrying such studies as will supplement our case. So that we can actually say we place our cards on the table, play fair, and can know what it is all about.

That, roughly speaking, is my message and my understanding of my job. I thank you.

* * *

Vice-President Weir: Thank you very much, Dr. Polakov. Perhaps you have been told that the Wage Conference in District No. 12 and with the Illinois Operators in 1928 provided for a Commission similar to that now in existence by virtue of the Appalachian Agreement. We sort of look back toward the east and say that is one thing we went through.

The Presiding Officer this afternoon will be Mr. Hitt, Vice-President of the Walter Bledsoe & Company, St. Louis, Missouri.

Mr. Joseph E. Hitt (Walter Bledsoe & Company, St. Louis): I have been out of coal mining, the operating end of it, for about ten years. When I come back today and meet the fellows, I see they are still carrying the burden of inconsistency. Our friend Paul Weir succeeded in having your Constitution amended to permit eight young directors, and then our young active President selects an old timer to preside this morning, and he in turn this afternoon takes another has-been and asks me to preside. That is certainly inconsistency.

As you know, the program was changed somewhat today, and we still have the paper on this morning's program to be read. "Safety Practices and Accident Prevention from the Point of View of a State Mine Inspector," by Joseph Firth, Jr., State Mine Inspector, whom you all know.

Mr. Joseph Firth, Jr., (State Mine Inspector, Benld, Illinois):

SAFETY PRACTICES AND ACCIDENT PREVENTION FROM THE POINT OF VIEW OF A STATE MINE INSPECTOR

By JOSEPH FIRTH, JR.
State Mine Inspector, Benld, Illinois

Safety and reduction of mine accidents appears to depend upon the same fundamentals, whether from the point of view of the State Mine Inspector, the operator, or the safety engineer. Conditions of mine operation with respect to safety are governed in our State by the mining law. The State Mining Laws of Illinois set forth plainly the duties of the State Mine Inspector, in fact, almost all of the laws pertain in some way to the inspection of mines as the inspector is the representative of the Department of Mines and Minerals. Most of you are of course familiar with these laws and of the inspector's part in them, and realize that the reason for the laws is primarily to protect life and property in and around the mines. Most of you too realize that to get safety in mines requires more than a mere policing on the part of the inspector. It will be recognized that the authority of the inspector is confined to the enforcement of the State Mining Laws, but the present Department of Mines and Minerals believes that the inspectors should give full cooperation in the prevention of accidents where no semblance of a violation has occurred.

Inspectors have not always been welcome at all mines—in fact, they were looked upon as a more or less necessary nuisance—but that idea has given way to the knowledge that proper inspections prevent accidents. Some companies have become so convinced of this that they employ inspectors of their own.

To me, safety in coal mining means the making of all working conditions as free from accidents as possible. There are two kinds of accidents, the inevitable and the preventable. The inevitable accidents are those which just happen and can be blamed on no one; the records of our Department show this type of accident to be very rare. In studying the various causes of the preventable accidents we are finally led to the conclusion that the human element is the greatest factor with which we must contend. Our records show that about 75% of all accidents are caused by the lack of ordinary care on the part of someone.

Accidents don't just happen. In nearly every case there is a reason, and through careful supervision and cooperation of the workers, the causes of accidents can be eliminated. Remove the cause and the number of accidents will correspondingly decrease.

While I think everyone is interested in promoting safety, there has been in some mines a lack of cooperation between employees and employer in preventing accidents. The inspector is possibly the person who can correct this by persuasion of both parties that accidents are harmful and expensive to everyone; the same things that harm property are usually the same things that harm the men.

First-Aid training is an essential part of safety programs in the mining industry. However, first-aid will not eliminate accidents, but it will make the employee more safety conscious and make him feel that he has a personal part in the safety program. The most outstanding safety records established by mines in our State belong to organizations who have trained their men in first-aid. First-Aid has been and will continue to be one of the most helpful factors in accident prevention. The records of the Department of Mines and Minerals indicate the number of persons trained in first-aid in Illinois last year was 7,730—more than twice the number trained during 1936. A word of praise and appreciation should be said here for the operators, the miners, and the United States Bureau of Mines, who have cooperated in making these training campaigns successful.

In starting a safety campaign it is important to create as much interest and feeling among the workmen as possible. After interest has been created, it is necessary to adopt some definite course to follow. In this plan may be:

1. Planned safety rules.
2. A supervisory force adequate and competent to enforce safety rules.
3. Safeguards against mechanical, electrical and other hazards.
4. Mining operations planned with respect to safety of the workers.
5. Education of officials and employees in safety practices.

6. A permanent active safety organization.

The safety organization should discuss and determine safety policies, and one very important feature should be the investigation of conditions surrounding all accidents, and the discussion by the safety organization of proper procedure to eliminate similar accidents in the future.

An effective safety campaign does not end with the installation of safety devices and safety programs, it really just begins. If a mine were equipped with every safety device or appliance provided for by the State Mining Law or known to the mining industry, there would still be accidents unless the workers and officials were made to think in terms of safe practice.

Mining men and officials in their effort to make mining safer are confronted from time to time with various complicated questions, and with the installation of mechanical appliances these questions have increased. The answers to these questions are not always obvious. Experienced men differ in their opinions of the best way to overcome a particular hazard. To reduce differences of opinion and obtain a generally acceptable answer to any question the members of the safety organization of the mine at which the question arises, should meet and discuss the various questions and attempt to reach a common opinion.

In most cases there is no set rule on how to do the various jobs to be done in coal mines. A workman is told to do a certain job, but he is seldom told how to do it. There is only one way to do each job most efficiently, and the supervisor should not only know that way but should have it done that way. When the job is done the efficient way it will be the safest way.

Many workmen are injured because of the lack of proper training or instructions as to the correct way to do their work. Statistics show that of all mine accidents, roof and face falls take the heaviest toll. Hence, the safety of the workmen depends to a large extent on roof and face conditions. Due to the size of the various inspection districts, the Inspector does well to make three inspections a year at each mine in his district, and isn't much help in reducing this type of accident. So it becomes necessary to see that ample supervision is provided, that the face boss is capable and not afraid to do his duty. I have found that where proper timbering systems are enforced, and adequate roof and face inspections are maintained by competent workmen and officials, fewer roof and face accidents occur. Closer supervision, competent workers, and frequent examination of roof and face conditions in the working places will go a long way towards reducing this type of accident.

We know the work of coal mining presents a definite measure of physical hazard, still there are men who have worked in the mines thirty and forty years without being injured. This indicates a capacity for self-protection and safe workmanship. I have two mines in my district operated by the same company and the mine with the best natural conditions has the poorest accident record. My own explanation for that is that everyone believes that the mine is safe and does not take the precautions that they do at the less favored property.

We have found that accidents are not always caused by bad mining conditions, sometimes it seems almost the reverse. We have also found that there isn't just one major cause for injuries. Our investigations do indicate, however, that there is one essential element in the prevention of injuries, and that is the cooperation between employee and employer. It is in advancing the attainment of this cooperation that the inspector can assist.

* * *

Chairman Hitt: I think this paper should bring out some nice discussions. Is there any discussion?

Dr. Walter N. Polakov: I would like to ask a question rather than enter into discussion, namely, whether Mr. Firth has any concrete suggestions as to how the organized Mine Workers can participate in furthering the safety program?

Mr. Firth: To reduce accidents, they tell us you must educate the worker. I would suggest the United Mine Workers can do a great deal in reducing the number of accidents by introducing vocational training among the workers, train the workers in safe and sane practices.

Chairman Hitt: Is there any other discussion?

Mr. D. W. Jones: Mr. Firth stated most of the injuries occurred at the face. According to the State Statistics, I would like to know whether most of the accidents take place due to lack of timbering. Indiana has recently passed a State law requiring timbering, to put it up within twelve feet of the face. That is a law, and is compulsory. I do not think personally that that has reduced any accidents at the face, but there might be records showing whether a law of that kind can be substantiated.

Mr. Firth: We had a total of 75 men killed underground during 1937. In falls of roofs and sides, that caused the death of 45 of these men, 45 out of 75.

Mr. D. W. Jones: Do you have any report showing them due to timbering?

Mr. Firth: Not necessarily every case. I haven't studied the report, but not necessarily every case would have been reported according to that.

Dr. Walter N. Polakov: To what extent does vibration of the face stimulate falls?

Mr. Firth: I cannot undertake to answer that.

Dr. Walter N. Polakov: Can anybody answer that?

Mr. H. A. Treadwell: Injuries from fall of face and roof and overloading have been materially reduced. That has been our experience.

Mr. Firth: This report substantiates that. We have found there have been 31 miner and loader fatalities occurring in 1937, while there have only been five cleanup men and five machine men that have been killed.

Dr. Walter N. Polakov: You made one statement about timbering, having a standard method of timbering. Have you any record where the standard method of timbering has been enforced in a mine, as to what effect that has had upon accidents where they have had a haphazard method previous to that, and then put in a standard method?

Mr. Firth: Yes, in one particular mine in my district they ran into a very bad condition. Up to that time the conditions had not been particularly bad, and after it became bad they enforced safety rules on timbering, and from that day on the accident record was 50% better than it had been before.

Chairman Hitt: It has been my observation there is a tremendously closer cooperation between the operators and the State Mining Department than there was fifteen years ago. Is that your experience?

Mr. Firth: Much more.

Chairman Hitt: You do get full cooperation?

Mr. Firth: In most cases. In some cases not so good, but in the majority of them, yes.

Mr. F. M. Schull: What method did they use to enforce safety rules of timbering?

Mr. Firth: They had a minimum distance to timber from the face. They used about a fourteen-foot cross bar, using three legs under it. They were never to advance or move those props until they reset the support props on the face of it.

Mr. F. M. Schull: That was made what, then? In other words, you would be handling it as a violation of contract if they did not carry it out?

Mr. Firth: Yes. The face boss had his orders. They were at no time to advance beyond a certain point without timbering. That is in the best of places. Where it was worse, the timbering was carried closer, and they used a fourteen-foot bar in all places, with three legs.

Mr. F. M. Schull: We have found that in our plans, in some places, we have met with opposition to some of the safety rules put in. I think the organization of our own safety chapters at all our mines—and several others on the board who have them can speak for themselves—I think that went as far toward our safety movement as anything we ever did, when we accepted and adopted the old safety chapter in our mines and tried successfully to bring the labor and the workers closer together.

We have had some wonderful results which I credit to the old safety chapter in the way of having our safety rules carried out in a more friendly manner, not trying to use force but through the meetings we have had through the men and the company officers. We have as nearly as possible one officer of the home chapter as a boss, and one is working, every other one. We do not permit any man to be censured or condemned or anything for having an accident, no difference how much to blame he is. It is not done in the sense of criticism, but in a sense of constructive criticism. Not to find fault with the man because he made a mistake, but to try to prevent the same thing from happening again. That is the way we tried to iron the wrinkles out. I was just trying to bring out the best way, for if there is a better way we want to adopt it.

Mr. Firth: In the particular mine I mentioned, I might say it is a very good mine and had very good methods. The rate at this particular face was lower than at many other mines. They never had a fatality in three years of operation, while they had them in other territories. I do not know it was due particularly to the safety methods they put in as much as to the fact that the men knew it was a bad place and watched it more carefully. Between the two, I think that is what made the record.

Mr. F. M. Schull: No doubt. I do not know what your version is, but if you can use anything, I don't care what you call it, that will bring about a feeling of cooperation with the men and the bosses, that is what stops accidents. That is my feeling.

Mr. Firth: That is what prevails in this particular territory. The men knew it was very bad, and cooperated with the boss in working safe. In other territories the condition was good and they did not pay as much attention. They would think they need not, and consequently there would be another accident.

Mr. F. M. Schull: You said a while ago accidents did not "happen" at all. We found that out during our whole career, and I think everybody else has. I think there are others that have some safety chapters in their mines. I would like to hear whether they think they have had good or bad results. We think ours was helpful. I don't know how they think about theirs.

Chairman Hitt: Is there any more discussion? We would like to hear from you.

A Voice: I would like to substantiate what Mr. Schull said. We have some safety chapters at our place and it makes the men take a personal interest in enforcing safety instead of depending upon the supervision to follow out safety suggestions. If they come through the home safety meetings, the men themselves will make an effort to enforce them.

Chairman Hitt: I suggest anyone else that talks give their name. The reporter does not know the names, and wants them.

We will proceed with the afternoon program. Mr. Roman's paper has been read. The second paper "Dust Treating of Coals," by Mr. Lee Hazen, Chief Chemist of the Bell & Zoller Coal & Mining Company, Zeigler, Illinois.

DUST TREATING OF COALS

By LEE HAZEN
Chief Chemist, Bell & Zoller Coal & Mining Company,
Zeigler, Illinois

The coal industry first began to make an effort to reduce the dust resulting from handling and firing bituminous coals when home owners started using oil and gas for domestic heating.

Treating with calcium chloride was the first commercial method used. The coal that was treated with calcium chloride was improved, for a time at least, but petroleum products have largely displaced calcium chloride as a dust-proofing agent.

Oil was first used as a dust-proofing agent at about the same time as calcium chloride. Low viscosity oils and oil emulsions were mainly used in the beginning because they were cheaper and equipment for spraying the heavier oils had not been developed.

The first methods used for dust-proofing coal were not satisfactory although the treated coal was, no doubt, much less dusty than the untreated coal. The chief trouble, particularly with reference to Illinois coals, was that the treatment was effective for only a short time. The increased use of domestic stokers has given impetus to the study of the problem of dust-proofing coal. The user of stoker coal has been made dust conscious and he demands a stoker coal that is dustless when delivered and one that will remain dustless until the pile is entirely consumed.

The Bell & Zoller Coal & Mining Company began to make some studies of the problem in the fall of 1936. At that time, very little work had been done on the problem, at least, the results had not been published, although some excellent publications have become available since then. Oils recommended for use then were not over 200 sec. vis., and the quantity recommended seldom exceeded five quarts per ton. It is probable that the quantities recommended were based upon satisfactory treatment of eastern low moisture coals.

At that time, oils of 100 to 150 sec. viscosity were being used. It was discovered that the coal treated with these oils would become dusty after a period of 4 to 6 weeks. It was thought then that the oil evaporated and allowed the coal to become dusty. Several different oils which had decidedly different evaporation rates at elevated temperatures were obtained and it was found that there was no appreciable difference in their evaporation rates at ordinary temperatures such as would be encountered in a basement.

Some 200 sec. viscosity oil was sprayed on partially air-dried buckwheat in quantities of 1.5, 3.0, 4.5, and 6.0 gallons of oil per ton; after the coal was sprayed, it was sealed in glass jars. The coal treated with 1.5 gallons per ton became dusty and lost its oiled appearance in one week; that treated with 3.0 gallons per ton showed a very small amount of dust in 8 weeks and became quite dusty in 20 weeks; that treated with 4.5 and 6.0 gallons per ton did not become dusty nor lose its oiled

Dust testing cabinet

appearance. Apparently, the coal became dusty due to absorption and not because the oil evaporated.

Later, a dust testing cabinet was built so numerical values could be assigned to the comparative effectiveness of different oils. The cabinet built is similar to the Koppers Cabinet although somewhat smaller. The principle of operation of the testing cabinet is the same; the amount of dust that will settle on a polished plate inserted in the cabinet a few seconds after the treated coal sample is carefully brushed off and weighed. Results are then calculated as grams dust per ton of coal or dustiness index.

An arbitrary mixture of partially air-dried coal of 42% of 3/4″ x 5/16″, 50% of 5/16″ x 10 mesh, and 8% of minus 10 mesh dust was accurately made for each sample and the samples were then treated with 100 sec., 200 sec., and 350 sec. viscosity oils. The 350 sec. oil was found to be several times more effective than either the 100 sec. or 200 sec. oils when 8 quarts per ton was applied. The variation in effectiveness was not so pronounced when 5 quarts per ton was applied. All samples were stored in sealed jars for at least a month before testing.

Other tests have been made which show that wet coal is more difficult to dust-proof than dry coal. An average of 12 tests showed that the treatment was 92% effective on dry coal and 81% effective on wet coal when 7 quarts per ton was applied.

Wax has been used for treating domestic stoker coal for the past year with very satisfactory results. Experimental work on a small scale has been very limited due to the difficulty of duplicating the necessary equipment. Tests to determine the amount of dust has shown a high per cent effectiveness even after long storage periods.

* * *

Chairman Hitt: This paper should bring out some very interesting discussions, because dusting is relatively new to all of us, especially with paraffine. I would like to hear something from someone.

I might say our experience with paraffine has been while it has been satisfactory we attributed largely the dust we did have to the fact it was water washed coal, and paraffined after it was washed.

Mr. Hazen: There is no doubt washed coal is more difficult to treat than dry coal.

Chairman Hitt: We find you have to put it on at a higher temperature, under a higher pressure, to make it effective. Anyone else? This must be a subject you are all interested in. You have dusted coal, Herb, or de-dusted. Haven't you something to say?

President Taylor: There are a couple of fellows from our operation that know more about it than I do.

Chairman Hitt: Point them out.

President Taylor: I think they know who they are, if they will get up and talk.

Chairman Hitt: We would like to hear from a couple of Herb. Taylor's fellows, both of them.

Mr. Fred Miller: Dust proofing of coal dates back to 1936, but we had the same experience that Mr. Hazen has outlined in his paper. The viscosity oils did not do a satisfactory job. We didn't know why. We found out now, and our process has changed from time to time until we are using a 350 viscosity oil. That has given us so far the best results. To date we haven't gone into the use of paraffine, because our main difficulty was we did not believe we knew how to apply it right. That is just as far as we have gone. We are looking for new ideas.

Chairman Hitt: And let somebody else do the experimenting for you. That is a good idea.

Mr. Fred Miller: Not at all. We did a lot of experimenting on the oil business when we got started. It is true that sort of work is expensive. That doesn't mean our mines are opposed to it by any means. We are ready to look for something better, but I do not believe we have found it yet.

Chairman Hitt: Where is the other fellow? Isn't there someone else who has had some experience with oil treating?

A Voice: In regard to the house of the consumer, the use of de-dusted coal, is there any reaction from the housewife, besides my own family?

Chairman Hitt: In regard to oil treated coal?

The Voice: My wife says something happens in the house, that there is an oil deposit in the room and it is hard to dust.

Chairman Hitt: We haven't had any experience. I do not think there is enough oil put in the coal to be a factor in that respect.

Mr. Hazen: Do you mean during combustion, and oil burning?

The Voice: After the coal is put in and as it is burning, and so forth.

Mr. A. E. Pickard: You talk to my wife about coal that has not been oil treated, and after two years of using it, and somebody is going to be hurt.

Chairman Hitt: Whose coal do you say you buy?

Mr. H. A. Treadwell: We have had a good deal the same experience. We have gotten up to the 350 oil. From our information, that is being put out in the east at 600.

Have you any information you could put out on that, and if so why are we getting better results from the heavier viscosity?

Mr. Hazen: I think I know why we get the better results. This Illinois coal is, after all, rather porous, and a light oil would be absorbed much more readily than a heavier or higher viscosity oil. Does that answer your question? It is merely a matter of the absorption of the coal.

Mr. H. A. Treadwell: There are two grades of oil that are being put on the market, one from a fuel oil residue and the other from a lubricant oil residue. Is there any difference in the suitability of it for dusting?

Mr. Hazen: I am afraid I can't answer that question.

Chairman Hitt: Has anyone else had experience with it?

President Taylor: There are several oil companies represented here. They should be able to give that for us.

Mr. James S. Anderson: I have had no experience with oil at all, but I wonder if the oil company hasn't got something to do with it. Where the coal is dry, they want to de-dust it, and when it is wet they want it dry. Unfortunately, where I am it is very wet. Our greatest trouble is how to get it dry. The trouble is we get into an oil frame of mind of oiling the coal, and maybe that will settle the question. Would you give me any line on that, why it is necessary where coal is dry to de-dust it, and where it is wet it should be dry?

Chairman Hitt: That question is out of order.

Mr. James S. Anderson: The question isn't out of order. The question is a serious problem, and probably you know something about it. The Walter Bledsoe Company happens to be the sales agency for our coal. They have difficulty in selling the coal because it is too wet. We are sure there is no dust in it at all. There are some particles, no doubt.

Chairman Hitt: How do you de-water it?

Mr. James S. Anderson: It is wet.

Chairman Hitt: And they are going to cut your moisture allowance on the 20th of this month.

Mr. James S. Anderson: I don't know how we will do it, except by using a drier, and that is an expensive proposition, too.

Chairman Hitt: We dry the No. 5. We do not dry any larger—

Mr. Hazen: So far as I know, there is no treatment to coal to reduce the moisture, if that is the question. I never heard of a treatment applied to it.

Mr. James S. Anderson: This man over here knows something about the thing I am trying to talk about.

Mr. Louis Von Perbandt: I do not believe the questions of oiling and drying are related at all. The oiling of coal seems to me to be a lot of propaganda on the part of the oil companies. So far as the treatment for the removal of dust, it seems to me to be more effective than to try to oil.

President Taylor: I can't just agree with that. I think the first part of your statement is entirely true, that the drying of coal and oil treating of coal are different, but so are the questions of de-dusting and oil treating of coal. You can go to the greatest length to which we are able to remove the dust and still find it necessary to oil treat the coal. Some of the coal produced in the Southern Illinois Field today could not be sold without oil treatment. They are just not accepted by the trade. There is a marked difference in the dust raised in delivering and handling in the dealer's yard, even with opposition to drying. Some of the coal put out just isn't sold without oiling at all. There just isn't any market for it.

Mr. A. E. Pickard: Take the coal he is talking about and start handling it in your basement without treating it, and somebody will get in trouble. It is going to be the guy that does it, and his wife will work him over because she is going to get dust all through the house and in the curtains and in the upholstery, unless you have a better house than I have.

Chairman Hitt: We have discussed largely this particular stoker coal. Has anyone had any experience with the treatment of larger sizes than egg?

Mr. A. E. Pickard: It applies to any of them.

Chairman Hitt: The 4 x 2? I asked that question, because we had one experience where a fellow said he did not want egg coal treated, because he said when it was treated in transit the friction that ordinarily grinds or powders the coal to a certain extent, that would go to the bottom of the coal and is left, and sticks to the coal and is put in the basement. I have heard that different times. Do you have that experience?

Mr. Hazen: Not that I know of.

Chairman Hitt: You did not discuss the larger size.

Mr. Hazen: Treating the larger sizes would not be as satisfactory as the smaller sizes, because you have more breakage.

Chairman Hitt: Do you think any advantage is gained by treating the larger size?

Mr. Hazen: There is an advantage, but not as much as in treating the smaller coal that does not break up so much.

Chairman Hitt: We have had some who said they did not want the larger size treated.

A Voice: We have the same experience. We have a neighbor with a nice house who did not want his coal oiled at all. I got him to try it once, and the next load came down untreated, and did I catch hell! I know it has a beneficial effect on that size coal.

I use 3 x 2 in my house, and I know there is a definite difference in the way it is treated. However, Mr. Hazen said the treatment is not nearly as effective for the larger size, and I agree with him.

There is one question I would like to ask, and that is I would like to have your experience what is sometimes called the creeping out of the oil on the coal that is being treated. Some people claim you have to depend on creeping and some say different.

Mr. Hazen: I don't know about creeping. I don't know whether it will creep or not. I really doubt if most oils will creep enough to make an appreciable difference. I think it must be done when it is put on. There may be oil men who will disagree with that.

Chairman Hitt: Isn't there an oil fellow here?

Mr. W. S. Stinton: One question was asked a moment ago which I haven't heard discussed, and that is the effect of cutting back oil with fuel and lubricant oil, whether or not there is any difference in the result. I do not know any scientific tests that have been carried out along that line. We have done some work on it in a limited way. Our results so far as we can analyze them show the period of protection to be of lesser duration when fuel oil is used than when lubricant oil is used.

There seems to be a rather logical reason for it. I think it has been pointed out in this discussion. You will absorb fuel oil, and naturally, the fuel oil being more volatile and less dense and lighter the brunt of it is absorbed more readily than the lubricant oil, which is used as a cutback for your heavier material.

My opinion of what is desired in treating coal is a substance of some kind which would form practically an airtight, moisture proof envelope around each piece of coal. We do not know yet exactly how to get such material. We are trying to. If and when we do, and if it is low in cost, then we will have the problem solved.

In the meantime, all experiments with which I am familiar indicate the heavier bodied oils do give protection over a longer period of time than a lighter oil, and I think the Institute paper which came out not long ago pretty well bears that out. Our experience has gone to oil as high as cylinder oil. We have used them in the experimental work. We find when we passed a certain viscosity of oil, a certain volume of the oil, improvements in the results are not apparent. They are not there. Just why we do not know, except this.

Take the heavier stock and then cut it back to a certain extent with a lighter stock. The experience seems to be that the lighter stock acts as a carrier or fluid which spreads these heavier ones around the surface, and the lighter oil is absorbed into the coal. The heavier portions remain on the surface, filling up the pores, and therefore giving greater protection over a period of time against dusting of the coal.

Another thing which has not been investigated very carefully, not very fully, but which I think is worth while looking into, in the winter time you have the other problem of freezing. If it is possible to oil treat the coal to prevent dusting and also prevent freezing in the car without further expense, with some kind of a preparation, that is desirable. The heavier oil seems to give some protection against that line also. Otherwise, it may freeze into a lump in the car, but is easily broken. Just a little shove or something like that will break it up. It isn't ice which needs a charge of dynamite to break it up.

About the creeping out of oil, of course that is a condition identified as surface tension, and the lower the surface tension the greater the creeping ability of the oil. There is undoubtedly some of that effect present whenever oil is applied. I think that was illustrated in an Institute paper in this way, that with the oil they seem to get more complete coverage of the entire surface of the coal. Using wax and similar substances, they tend to become solid when they get cold, and they found surfaces which were not covered with the wax at all.

Chairman Hitt: Does that answer your question, Mr. Treadwell?

Mr. H. A. Treadwell: Very well.

Chairman Hitt: So far as our practical experience is concerned, we haven't discovered that oil treatment can in any way be depended upon to prevent freezing. Has anyone anything to say about that? We have not found anything that is effective except the heat drying.

Mr. Fred Miller: I would like to ask one more question. How well does the stoker coal have to be dewatered before it takes effect?

Mr. Hazen: That is one of the questions I can't answer. We did treating in the laboratory of wet and dry coal, applying the same quantity of oil. Applying the same quantity on dry coal, we had protection for 91%; and when the coal was wet, the protection was slightly over 80%.

Mr. John Griffin: What was the moisture contents of what you call wet coal?

Mr. Hazen: That would not refer to moisture contents. That is where the surface of the coal was wet.

Mr. John Griffin: Another question I would like to ask. Has anyone done any treating of coal before washing and gotten any results of what effect it has upon the moisture contents of washed coal? Theoretically you would imagine it would reduce it. If the surface were wet with oil, it should shed water. I have heard reference to work of that kind, but have never seen any definite figures.

Mr. Hazen: I don't know of any case where they pre-treated the coal before washing. There is one mine in Butler, Pennsylvania, where they treat the coal before it goes to the tipple. They claim they notice a very definite improvement throughout the plant.

Chairman Hitt: That is a very pertinent question. I have never heard of anyone who had that experience of treating it before you wash it.

Mr. John Griffin: I know of an experiment recently made on coal in West Virginia, but all figures are unquestionably not in, and I don't know whether that coal—there was visual evidence that the coal seemed a little drier, but before I left Pittsburgh there were no definite figures in as to changes in moisture.

Chairman Hitt: They will be available, will they?

Mr. John Griffin: I hope so. I am not positive they actually got the figures.

Chairman Hitt: We may be treating the coal at the wrong time.

Professor Louis C. McCabe: I would like to ask if in your figures you considered the characteristics of the coal pre-treated.

Mr. Hazen: I think if you had to consider fine coal, you might find a difference. When you get down to stuff like minus 20 mesh, you might have some possible conglomeration and get a mechanical entanglement of impurities and particles in the conglomerate, but with stoker coal and stuff that size I do not think it would have any effect.

Mr. F. M. Schull: Are you treating the coal?

Mr. Hazen: No, sir.

Mr. F. M. Schull: You are not oil treating?

Mr. Hazen: No, sir.

Mr. F. M. Schull: I wondered if you were. We thought we had gotten some help by de-dusting No. 4 coal. Our coal is just as dry as yours is wet, just as dry as it could be. We put our screenings over a vibrating screen, $\frac{3}{8}$ths to zero, to take that out, which we thought would do away with complaints of what we call fry ash from so much fine stuff. Nevertheless, on top of that we had to put in an oiling system to satisfy some of the people. We had some customers who said "For Christ's sake, keep it as dry as it is, for that is the way we want it, as dry and dusty as it is." With others, if there was dust on it they wanted it the other way.

I wondered if Mr. Anderson had oil treated any wet coal and what results he had. As the fellow said, we go to school to learn, and keep learning all we can, and the more we learn the more we forget, and the more we forget the less we know what the hell it is all about.

Mr. J. A. Jefferis: We have heard from the coal man and the oil man and the specialist. I would like to say, if there are any dealers here—I mean operators here who still mine coal in the old way without de-dusting and oiling it and wrapping it in cellophane, I would like to give them a word of advice.

A few years ago, up at Fort Dodge, Iowa, I called upon a couple of Bell & Zoller customers, and one was in the back yard with some fine coal. I asked "What are you doing?" He said "Making banking coal." I said "What is that?" He said "I take this coal and sack it, put it in sacks, and when the truck comes along I throw some of that on there, and say 'I am taking the liberty of sending some banking coal.' " He said "We get rid of all our screened coal, and we have to go out and buy some from the other dealers." He said "We get the full price for it." You other fellows might take a tip from that.

Chairman Hitt: Now that we have washed and de-dusted the coal, and oil treated it, and Jeff has cellophaned it, I think the subject is fairly well exhausted. I understand—this is not on the program, but I understand the Old Ben Corporation has brought out some nice developments recently in rock dust. Now that we have de-dusted the coal, we can talk about rock dust. I wonder if you will say something about your recent development, Mr. Jones?

Mr. John E. Jones: It is quite logical we keep on with dust, I suppose. Following Joe's talk on safety, he gave us an analysis of safety from the State Inspector's point of view, and I am sure it covered the point of view of all of us in the safety and production end of coal. He summarized on the individual accidents. I want to talk just a little while on the disaster hazard we have. As you know, we have gone through quite a little experimenting on the question of rock dusting for that disaster hazard.

I was approached to give a paper on that here, and I explained that I could not very well give a paper just at this time. The reason is this. This new method of rock dusting is one that has been experimented with by the United States Bureau of Mines at their experimental mine. This has been going on for about eighteen months or two years. I do not want to make a report on that new method until the Government has completed their report on it. That report was given to me last week, so I am speaking about it now and giving the findings.

Their findings were this, and I will be very brief with it. The new system is acceptable. They have drawn eight conclusions with respect to it. Seven of those conclusions are fully acceptable. The eighth is acceptable with reservations, that it must be under certain conditions.

That is what I am going to do, tell you about that report, because the Director of the United States Bureau of Mines asked my permission to have that report published in an information circular for the entire mining industry. Of course, I was very proud to say yes. So that each of you who are on the mailing list of the United States Bureau of Mines will receive that report.

It will be a report from which all names have been extracted. It will be quite similar, I suppose, to the report I received, except there will be no names of companies or persons in that report. You will recognize it as the new method of rock dusting. It will have as a subject something containing paper bags and barrels. It is not necessary for me to go into that in explanation of the report.

I will spend just a few minutes on what you might expect the report to be. Some three or four years ago I became concerned over safety of our trackless passages in our coal mines with respect to rock dusting. Track passages are eventually rock dusted because we have rock dusting machines to do that. It is quite possible and frequently occurs that these passages are not rock dusted and kept as well as some of the track entries. Another idea was this, that rock dusting is one of the few things installed in coal mines which we hope will never be used. It is an installation which we wish was of a more permanent nature.

The way we put rock dust into coal mines is pretty much like snow. In it goes and out it goes, and continual repetition is necessary in order to keep a mine well rock dusted. Looking at those nice paper bags the manufacturers get the dust to us in, I thought what a pity it was, as we bursted hundreds and thousands of them, what a pity to burst those paper sacks inasmuch as the explosion was going to use the dust only if necessary. If the dust was not to be used, it might just as well remain in the paper sacks and be kept in better condition for a longer period of time.

So I began experimenting with it, and arrived at a principle I thought would be efficient with respect to an explosion bursting a bag, liberating the dust in time to quench the flame. And that is what the United States Bureau of Mines had been testing for many of the eighteen months to two years just passed. There are other factors, of course. One thing I wanted to add to the industrial safety of the mine is this. What else can that dust do besides stop an explosion? We have, as you know, the fire hazard. My idea was if we could have this rock dust in bags distributed throughout the mine, how easily available it would be, being in the bags, to obtain in the event of fire hazard. So I have tried to cover two hazards with one installation.

Another safety I tried to provide for was to get rock dusting in use in all coal mines. The coal mines now using rock dust are those we accept as hazardless from an explosion point of view. There are many coal mines on the borderline between being hazardless that are not being rock dusted. I thought how nice it would be if anyone developed a system of rock dusting that would be of less cost and more permanent.

It was necessary for me to get the rock dusting companies to give a different bag for this new method of rock dusting. The principal change in that bag is to make it lighter, so that it can be more easily installed. So that the bag we now get for our West Virginia and Illinois mines are bags fifty pounds in capacity.

I will not go any further with this, Mr. Chairman, except to say I have some photographs which have been taken which I will be glad to show those who are interested in the matter.

Secretary Schonthal: Will these papers be put out by the Bureau of Mines as available to the Institute, to be sent out to its members? Do you think we could write the Bureau when they are published and have a supply of them to send out to the membership?

Mr. John E. Jones: I am quite positive, yes.*

Secretary Schonthal: How should that be done? Will you mail me one, and I will write the Bureau of Mines?

Mr. John E. Jones: Yes, sir.

Secretary Schonthal: Thank you.

Chairman Hitt: Is there any other business before we adjourn until next October? If not, this meeting will stand adjourned.

(Whereupon, at 4:15 o'clock P. M., the meeting adjourned.)

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* See paper by Mr. Jones on above subject on page 115.

(Reprinted from American Mining Congress 1938 Yearbook)

REPORT ON TRACK ACCESSORIES

By SUBCOMMITTEE ON TRACK ACCESSORIES

The weight of the rail used varied from 50 to 100 lb. with a small amount of 40-lb. section. The 60-lb. rail section seems to be the preference of the majority of mines except in a few cases where the management felt that heavier rail was justified or where a heavier rail was bought at a lower rate per ton than the lighter rail and at a sufficient difference to make the heavier rail cheaper per foot of track. Where the grades are abnormally severe and heavy traction is necessary to pull the trips, a rail of 80 to 90-lb. section would be advantageous and would add greater life to the track on account of additional metal in the ball of the rail. It was also generally agreed that the additional width of the head of the larger rails helps improve the tractive effort of the locomotive. The same thing applies to heavy down grades where it is necessary to retard the trips by using sliders underneath the wheels of the mine cars.

Regardless of the weight of the rail, unless a reasonable maintenance program is used to drain the road bed, tamp the ties and tighten angle bar bolts we did not find any great advantage of the heavy rail over the lighter rail except possibly to increase slightly the length of time until bad track conditions developed. We found worse conditions on track of heavy rail and ties which was not properly maintained than with lighter rail sections where a reasonable maintenance program existed.

Splice or Angle Bars

The majority of the track inspected had rail joints of bolted angle bars, and in a few cases bolted splice bars or a combination of a splice bar on one side and an angle bar on the other side. In many of the mines inspected we found that little care had been given to maintenance of the track joints and except for several mines there was no effort made regularly to inspect or maintain tight joints. In one case new track of relaying rails was being laid with splice bars that fitted very loosely in the web of the rail, and it would be only a matter of several trips until the joints became loose. Unless the angle or splice bars fit tight they do little other than to keep the rails in line and prevent them from pulling apart.

It was also found that the general practice was to space the rails to suit the bolt holes instead of making the bolt holes fit so that the rails could be placed tight together. The advantage obtained from expense of redrilling holes would be far offset by future maintenance costs from wide gapping rail joints. The angle bar provides additional strength over the splice bar and should be used wherever possible. We found in several installations that a combination of the angle and splice bar was being used in order to expose the bottom flange of the rail to use the short U bond on the base of rail.

In purchasing relaying rail the buyer should make sure that the proper angle bars are furnished with the rail. A short length of angle bar does not give proper supporting strength to the rail joint and is not recommended. Considerable six-hole angle barred track was found in very good condition, but examination of four-hole angle bars properly tightened, proved to be heavy enough for mine track service.

A special rail joint fixture with a wooden insert was in good condition after 12 years of service, even though it was second hand when installed. The committee also noticed several installations of this same type joint fastening on surface railroads. Compromise joints were observed, that were made by taking 2 ft. each of the two sizes of rail and plate-welding them into a solid unit. This permits the use of standard angle bars for joining this special compromise section to the adjoining rail sections. The principle is very good and could be improved upon by making the compromise section a total length of 10 or 12 ft., so that the two bolted joints would not be so close together.

Loose Bolts in Rail Joints

Surface railroads estimate that of the total amount of maintenance expense on their tracks, 70 per cent of it goes for maintenance at the track joints. In many of the mines very little attention has been paid to the maintenance of the joints, and apparently there is little realization of the damaging effects that loose joints have on the track.

The bolts used in joints should be of the proper length and size to fit the holes in the plates, and should be turned up tightly to wedge the angle bars snugly between the bottom flange and head of the rails. Bolts that project an inch or an inch and one-half from the end of the nuts are not only a waste of money but are quickly broken off by derailed cars. Where the larger sized bolts are used, a wrench of 18 to 20 in. in length will not give the men sufficient leverage to tighten the nuts properly. The wrench should either be lengthened or a piece of pipe slipped over the end of it. An occasional oiling of the bolts will reduce the amount of rust that occurs on the threads, and will also indicate that the track men have inspected the joints. Much of the current carrying capacity of a tight joint is eliminated when it is permitted to become loose.

Lock Washers

There was no general practice of using lock washers, although it was generally agreed that they should be used on track bolts. At several mines the standard practice is the use of lock washers on all main line track bolts, and no loose bolts were found where they were in use. Even if lock washers are used the nuts must be tightened occasionally to take up any looseness in the joints. As the rust and dirt works out from between the contact surfaces of the angle bars and the rail, it is necessary to again tighten the bolts. Lock washers or "self-locking" nuts help prevent the nuts loosening from vibration and hold them in position until they can be retightened. Track bolts that had been tightened without lock washers were found loosened in two days. Where the angle bars fit tight and the track bolts had been tightened occasionally, we found many joints where there was no indication of loose bolts even without lock washers. Regardless of whether or not lock washers are used, the bolts should be tightened soon after their installation and then carefully watched and retightened when necessary.

Worn Joints

Badly worn joints of old 60-lb. rail have been reclaimed by building up the hammered ends of the joint with manganese steel, cleaning off the edges of the angle bars or splice bars, and welding them securely. This recovers at a nominal expense badly damaged joints resulting from lack of maintenance. At one mine visited one man is able to rebuild two such joints and place two cross rails at each joint in one shift. A portable grinder is used to clean the rail and level off the finished weld.

Butting Rail Ends

There was much diversified opinion as to proper method of spacing the rail ends, and the majority of information obtained was from opinions and not facts. We found wherever the rails have been butted tight together that the upper surface of the rail was smooth, and wherever an opening existed between the ends of the rails that there was a hammering action and the metal tended to flow and fill up the opening which resulted in a low place in the rail. The ill effect of the hammering at rough joints does not stop at the rail surface but loosens the track bolts and causes unnecessary hammering on the ties, causing low places in the road bed and a bridging action between the ties at each side of the joint where no hammering occurs. The result of the inspections indicate that the rails should be butted tight together, for it is not necessary to take care of rail expansion underground.

Welded Joints

In several of the mines visited we found tests being made of Thermit welded joints. One mine has had a section of 1,000 ft. of 80-lb. rail welded for a period of a year; from their standpoint it is economical, for they feel that tie plates are no longer needed. In addition, considering the elimination of bonds, angle bars, and bolts the actual expense of welding is slightly less than standard bolted angle bar joints. In another mine about 400 ft. of welded joints have been in service for several months and have proven very satisfactory. In a third group, several mines of Thermit welding have shown no signs of failure; while riding in on the entry trip over this stretch of track, members of the committee were able to read a newspaper with ease. The advantages of the continuous welded rail are that it eliminates joint maintenance, and results in a perfectly smooth surface for the cars and motors to pass over. Rail without joints eliminates local points where concentrated maintenance problems are found.

Steel Ties for Gaging Track

In a number of mines the use of steel ties for gaging purposes and stiffening of the track was observed. Under some conditions the steel ties are of value, but they should not be substituted for wooden ties or take the place of a wooden tie in main line track. The general belief seems to be, when using untreated wooden ties, that by adding a steel tie at about 6 to 10-ft. intervals the service of the untreated ties will be prolonged by relieving the strain on them during the early period of decay. We did find it is necessary that the clip bolts be tightened constantly in order to keep them in place, and that unless they are kept tight they will soon loosen and the clips fall off. Examination showed that if steel ties are to be used on main line roads they should be used in addition to the wooden ties and not supplant them. Care must be taken to see that the bolts are kept tight, or else the clips will become loose and their value materially reduced. The attached drawing shows the recommended method of applying a manufactured type of gage rod on light and heavy curves.

Welded Cross Rails

We examined several miles of cross welded main haulage track of 36-in. gage, that had been laid for four years, consisting of 75-lb. rail on 4-in. x 6-in. by 5-ft. creosoted ties with ½-in. by 3½-in. spikes. In order to strengthen the track and prevent the rails from spreading, two short lengths of 60-lb. rail were welded across and under the rails at each joint. These cross rails were placed 16 in. on each side of the joint making four to each rail length. In this practice the cross rail is made long enough to project 1 or 2 inches beyond the outside edge of the bottom flange of the rail; before electric welding, a portable grinder is used to clean all the rust from the surfaces where the weld will be placed. The cross rails also serve as cross bonds and joint bonds. This type of track before being welded must be accurately aligned to final position, for it is impossible to realign it, once it has been welded. After four years of service without ballast and on soft clay bottom this track showed no tendency to be out of alignment, and as there was no side pressure or moving of the rails there was no noticeable cutting of the ties.

The main line switches are also cross-welded to add stiffness and keep the rails in alignment. A cross rail is placed directly ahead of the switch points, another half way along the length of the switch point, another at the heel of the switch, three between the heel of the switch and frog, tying all four rails together, and two under the frog tying the frog to the outside rails. These switches are stiff, and are strongly braced for long service.

Switches

Of the wide variety of switches inspected those placed in accordance with American Mining Congress standards appeared to be of the better type. It is strongly recommended that double bridles be used on all main line switches, regardless of the length of the switch point, as a precaution against open switches should a bridle become loose from a broken clip or bolt. In one mine, to assure warning against cocked switch points, electric contacts are used to show a red light if the switch is opened a fraction of an inch, and a green light to indicate a tight switch joint. Unnecessary looseness of the angle bar bolts at the heel of the switch was noticed in a large majority of the switch points inspected. Figure shows the recommended type of installation for switch splice bars.

Guard Rail on Curves

In one mine visited guard rails are used on sharp turns without superelevation. It is a much better practice to superelevate the outer rail and eliminate guard rails.

Staggered Joints

We found considerable track where the joints were laid opposite and not staggered. In one mine the track that had been laid a number of years ago with opposite joints is now being replaced with staggered joint track. In another, we found track with opposite joints, and were informed that track with joints laid opposite would not cause the motor and cars to sway back and forth at the low joints, and that the track would settle evenly, thus eliminating side rolling of the cars. A much better practice is to keep the joints tamped tight and to stagger them.

MAINTENANCE PROGRAM

The amount of maintenance per mile of main line track varied widely, and was governed by the amount of traffic and by the drainage problem. Where the mines were naturally dry there is less maintenance necessary than with wet road bed conditions. In some cases the management is proud of the fact that they have spent very little on maintenance of their main line track because it was well laid in the beginning; but upon close examination it was found that damage had resulted from water soaked road beds, pumping ties, loose joints, surface bending, etc., and some of this damage could not be permanently repaired by regular maintenance expense. Contrary to the general belief of most mine managements, main line track must be constantly maintained if the expected life and service is to be obtained from the installations.

Submitted November 16, 1937.

NOTE—We regret that the illustrations referred to in this article were not available for reprint at the time this Yearbook went to press.

(Reprinted from American Mining Congress 1938 Yearbook)

SPECIFICATIONS FOR MAIN HAULAGE MINE TIES

By SUBCOMMITTEE ON MAIN HAULAGE TIES

General Quality—Except as hereinafter provided, all mine ties shall be free from any defects that may impair their strength or durability such as decay, large splits, large shakes, large or numerous holes or knots, grain with slant greater than one in 15. They shall be straight, well hewed or sawed, cut square at the ends, have bottom and top parallel, and have bark entirely removed.

Dimensions—All mine ties must not measure more than ¼ in. less than the specified dimensions throughout both sections between 6 in. and 18 in. from each end of the tie, but may have not more than 1 in. wane outside of those sections. Ties over 1 in. longer, shorter, or wider, or ½ in. thicker than the size ordered will be rejected.

Knots—A large knot is one whose average diameter exceeds one-third the width of the surface on which it appears; but such a knot may be allowed if it occurs outside the sections of the tie between 6 in. and 18 in. from each end. Numerous knots are any number equaling a large knot in damaging effect.

Shake—One which does not extend nearer than ½ in. to any surface will be allowed.

Split—One which is not more than 5 in. long will be allowed provided satisfactory anti-splitting devices have been properly applied.

Note—Mines will designate or determine first the sizes and lengths required and which of the following kinds of wood suitable for mine ties will be used:

Ashes	Hickories
Beech	Larches
Birches	Locusts
Catalpas	Maples
Cedars	Mulberries
Cherries	Oaks
Chestnut	Pines
Cypresses	Poplars
Douglas fir	Redwoods
Elms	Sassafras
Firs (true)	Spruces
Gums	Sycamores
Hackberries	Walnuts
Hemlocks	

Resistance to Decay

Untreated Ties — The average woods run timber available for main haulage mine ties is not naturally resistant to decay. Decay conditions vary in different mines and in the same mine. The average life of untreated mine ties varies generally from two to five years. The average life of mine ties in any mine can only be determined by actual study.

Pressure Treated Ties—The average woods run timber available for main haulage mine ties becomes decay resistant when properly seasoned and treated with adequate amounts of creosote oil or approved toxic salts using A. W. P. A. standard methods of treatment.

Economics of Main Haulage Mine Tie Use

Life Pressure Treated Ties—Inside Tracks—The average life of pressure treated main haulage ties is yet to be determined. Careful check inspections of treated ties which had been in mine tracks inside the mines for periods of from 7 to 17 years showed the treated ties in good condition without evidence of decay.

Life Pressure Treated Ties—Outside Tracks—Tie service conditions in outside main haulage mine tracks are identical with those of the railroads in respect to the decay resistance of untreated and treated ties. The tie service records of the American railroads show an average life under heavy traffic conditions of from 20 to 30 years for pressure creosoted cross ties. The average life of ties treated under pressure with ½ lb. zinc chloride per cu. ft. is approximately 12 to 15 years.

Labor Costs Main Haulage Mine Tie Renewals

Mine tie renewals in main haulage tracks are usually made on a "spot" basis—that is, individual ties are renewed separately. Under the existing wage contracts and with time and a half for overtime, the actual cost of "spot" tie renewals is an item worth real study. Under varying conditions in many mines the average "spot" tie renewals in main haulage tracks studied varied from 12 ties to 25 ties for two men in one seven-hour shift.

When Treated Ties Should Be Used

When the expected life of a main haulage track is longer than the average life of the available untreated ties, it is economical to use pressure treated ties. When the actual life of a main haulage track is completed the pressure treated ties should be removed from the old tracks, the spike holes plugged and the ties assembled for reuse in a new location. The additional cost of a treated tie usually will be more than offset by the saving of the cost of the first renewal of an untreated tie. Elimination of subsequent untreated tie renewals will continue to produce savings throughout the life of the track.

The Pressure Treatment Specifications

Processes—The standard specifications for the preservative treatment of ties by pressure processes as adopted by the A. W. P. A. shall govern the treatment of main haulage mine ties.

Preservatives—Net retentions of preservatives after treatment shall be:

a. Creosote:

A. W. P. A. Grade 1. Not less than 6 lb. per cu. ft. of ties. Empty Cell Process.

A. W. P. A. 80-20 Creosote Coal-Tar Solution. Not less than 6 lb. per cu. ft. of ties. Empty Cell Process.

b. Zinc Chloride:

A. W. P. A. specifications. Not less than ½ lb. dry salt per cu. ft. of ties. Full Cell Process.

c. Chromated Zinc Chloride:

Not less than ¾ lb. dry salt per cu. ft. of ties. Full Cell Process.

d. Wolman Salts:

Not less than 3/10 lb. dry salt per cu. ft. of ties. Full Cell Process.

Method of Spiking

All ties on tangent track should be spiked with the inside spikes opposite each other and the outside spikes ahead in the direction of traffic or on a single track line, the outside spikes ahead in the direction of the loaded trips.

Tie Spacing

The tie spacing shown for the various cross sections effects practically a uniform load at any distance below the surface, therefore, increased stabilization in cases of poor sub-grade can only be accomplished when the tie lengths are increased as this distributes the load over a wider area.

Under no conditions should mine ties have spacing of less than 10 in. between the ties because a smaller space than this will not permit sufficient room for adequate tamping.

Length of Tie

Track Gauge	Length of Tie
36″—39″	5′–6″
40″—44″	6′–0″
45″—48″	6′–6″

Note: Track gauge and alignment are best maintained when tracks are kept in good surface.

SIZE OF MAIN HAULAGE TIES

Cross Section	Usual Weight Rail *Pounds*	Size Spike *Inches*	Tie Spacing—30 ft. Rail Intermediate *Inches*	Joint *Inches*
4 x 6	60— 75	½ x 3½	21½	16
5 x 7	60— 80	½ x 4½	22½	22¼
6 x 8	85—100	9/16 x 5½	24	24

Note 1. Main haulage tracks laid on 4 x 6 ties are generally reinforced with welded cross rails or steel ties in addition to the usual number of wood ties, where the traffic density justifies such construction.

Note 2. Main haulage tracks laid on 5 x 7 ties are giving adequate results without any special reinforcements, under practically all conditions of service.

Note 3. Main haulage tracks laid on 6 x 8 ties are specified with heavy rail where due to heavy grades, curves, weight of equipment and traffic density, such construction is warranted.

For track gauges from 30 in. to 48 in. tie length approximately 2 ft. 6 in. over track gauge permits adequate tamping under each rail. This applies particularly to underground tracks. Surface tracks being subject to rain, freezing and thawing may require ties 3 ft. over track gauge in order to maintain surface economically.

For 56½-in. gauge track the minimum length tie to use is 8 ft. For outside tracks consideration should be given to ties 8½ ft. long where the nature of the roadbed warrants.

Tie Plates

Tie plates are not necessary on pressure treated oak mine ties—when the standards of track construction and maintenance are adequate for the operating conditions.

This conclusion may be reversed by an adverse combination of some of the following factors:

Drainage	Spacing of ties
Roadbed	Weight of rail
Ballast	Weight of loads
Grades	Speed of trips
Curves	Density of traffic
Size of Ties	

Pressure treated shortleaf pine mine ties need tie plates to prevent mechanical destruction. Other species of wood vary according to their strength properties.

Tie Plugs

Creosoted tie plus should be used to plug the spike holes in pressure treated mine ties when they are taken up from track that is no longer needed before reuse in a new location.

Maintenance

An adequate program of main haulage track inspection and maintenance is just as important as the selection of proper materials and construction methods. There is no substitute for maintenance.

—*Submitted November 16, 1937, by the Subcommittee on Main Haulage Ties.*

A. R. Joyce, *Chairman,*
W. W. Dartnell,
C. C. Hagenbuch,
E. H. Jenks,
J. M. Johnston.

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REPORT OF THE COAL DIVISION COMMITTEE ON MECHANICAL LOADING

By NEWELL G. ALFORD
Eavenson, Alford & Auchmutz, Pittsburgh, Pa.

The Committee on Mechanical Loading was formed at the organization meeting of the Coal Division of the American Mining Congress which was held in Washington, December 3, 1937, and on December 20 the committee met at Pittsburgh in order to determine what particular phase of mechanical loading should be the basis for the first report. In recognition of the fact that the purpose of the Coal Division is to develop information that will be helpful to the mining industry, the committee expressed as their opinion that there was a definite need for uniform methods of keeping performance records, time studies and cost figures for loading machine operations. Such standardization would have the advantage of eliminating the wide differences that now exist in the items included by different companies in cost and performance figures and would further provide a basis for making accurate comparisons between the efficiencies of various types of operations.

In order to carry out this study, a number of companies operating mobile loading machines in the different fields of the United States were asked to send samples of their forms to be used as a basis for their reports, and the copies received in answer to this request were submitted to the committee at a meeting held in Pittsburgh on February 28. The wide variance in these report forms was taken as an indication that there was a need for developing a greater uniformity in the manner of keeping mechanical loading records and this need was further emphasized by expressions from a number of companies endorsing the plan of the committee to develop such uniformity.

Considerable thought was given by the committee to deciding what items of labor should be taken to make up a mechanical loading unit, or in other words, what point should be considered as the completion of the operation of the mobile unit crew and the beginning of the general mine operation. This decision is complicated by the different methods now in use, as for example, (a) the number of loading machines working together as one unit in a panel, (b) the number of locomotives serving one loading machine, (c) the method of hauling between the machine and the main line. It was the general recommendation of the committee that the loading machine reports should include all operations that are customarily performed by the unit crews such as: cutting, drilling, shooting, timbering, track, loading, placing cars at the machine and shifting them to the side track beyond the room switch where trips are delivered by another locomotive.

It was further recommended by the committee that standard nomenclature should be adopted. The locomotive placing cars under the loading machine boom should be termed the service locomotive. The term relay locomotive should be used where mines have what is commonly designated as: Swing motor, shuttle, etc., to deliver trips from the main haulage to the service locomotive. It was also suggested that the locomotive crew should be designated as motorman and brakeman —the term brakeman being adopted instead of snapper, trip rider, etc.

A review of the sample forms for the daily reports of the section foremen showed that some companies included the number of men employed on a unit crew while others confined these reports to performance records, supplies used, etc. It was the suggestion of the committee that their recommended form should include both the performance records and the number of men employed, but that the form should be so designated that the listing of the men employed could be optional.

In order to expedite their study, the committee divided the subject of operating records into three general classifications and the following subcommittees were appointed:

(a) Subcommittee on Section Reports, under the chairmanship of E. W. Potter, is to design daily report forms for section foremen, and also a form for summarizing the section foreman reports.

(b) Subcommittee on Mechanical Reports, under the chairmanship of S. M. Cassidy, is to design daily report forms for machine maintenance and weekly machine inspection reports.

(c) Subcommittee on Time Study Forms, under the chairmanship of W. R. Cuthbert, is to design a standard time study form and a form for the time study analysis.

The subcommittees have made good progress on their studies and their preliminary reports are now about completed. These reports will be submitted to a meeting of the full committee at which time they will be subject to review and perhaps some modification. There are many difficulties in the way of designing standard record forms that can be utilized by the various types of mechanical loading, but it is the belief of the committee that such differences can be reconciled and that uniform methods can be designed which will be of decided benefit to those who are operating mobile loading machines.

NEWELL G. ALFORD,
Chairman, Committee on Mechanical Loading.

(Reprinted from American Mining Congress 1938 Yearbook)

PROBLEMS TO BE CONSIDERED BEFORE INSTALLING MECHANICAL LOADERS

By D. D. WILCOX
General Superintendent, Superior Coal Co., Gillespie, Illinois

Most of us who are interested in modern coal mining have visited one or more plants where mechanical loading was being successfully used. All we could see were the results obtained and very few marks were left of the progressive changes that were necessary in order to arrive at the successful stage. In fact, as far as outward appearances were concerned the machines were merely purchased and put to work. The manager of the property realized that the visitor was primarily interested in the performance of the machine, but what a story he can tell if he discovers the visitor is interested in the trials and troubles of bringing the machine up to its present stage. The usual belief is that there is a machine built for each condition of mining that can be installed without changing anything, but the facts are that with the installation of any type of loading device practically every department of the operation must be altered to make the plan a success.

As a matter of good management it should be made possible from the first to know the cost of production in detail so that corrections can readily be made where costs are excessive. The amount of coal loaded by the machine is only an indication of the efficiency and is by no means a proof. In fact the production may be too large to be efficient. Other departments may suffer. There may be too much haulage or other labor, or the repair cost too high. An accounting system should be adopted that will not only show the labor costs correctly itemized, but the repair costs on each unit. It is probable, too, since repair parts, readily accessible, are more important to insure constant operation of the machine, that the stock room accounts will be revamped.

The very advantages of mechanical mining may be turned into difficult problems. For instance, more coal is loaded from each working place in a given time, and this concentration of work may be congestion instead. Most operators could profitably make a detailed study of their operation before deciding on mechanical loading—a study not only for the purpose of deciding the kind of equipment best suited for his property, but also of the changes necessary to give the equipment an opportunity to make good. It might be well to classify the different problems with the understanding, of course, that the difficulties at one mine would not be the same as those at another. The trials will vary according to the type of equipment purchased, and with the knowledge that the mine was not sunk or maintained with any idea that loading machines might ever be a part of the operation.

The mining industry has been especially fortunate in having the high type of machinery manufacturers with which to deal. Their policy is long term customers. It is not at all unusual for manufacturers to refuse to sell equipment when, in their opinion, it will fail to do the work required by the operator. On the other hand they have a right to expect that the management of the mine will do their part. It is of that part that this article deals, for unless this is done it is like buying a modern automobile and expecting good results in a community where there are no passable roads.

It is probable that no occupation has required such hard labor as mining. The miners on a tonnage rate have always recognized that it was necessarily a part of their job to do this arduous work. The post drill and the cutting machine eased this somewhat, but the loading of the coal was still there, which was, in fact, the major part of the day's work. Installing loading machines eliminated these jobs and the men so employed had to be trained for other employment, and not so many employes were required. Training of men is necessary, not only to operate the machines, but to service and repair them. Even the electrician and the mechanics who have been employes have no knowledge of the new equipment, and miners who have put in a lifetime at the face have to be depended on to keep the machine in operation. Customs and habits are changed, and it is difficult to obtain immediate efficiency from employes when the change is made from piece work to day work. The problem of selection is difficult. There are no definite ways in which to determine the qualification of employes except the judgment of the foreman, which in many cases proves to be wrong. Some men have the natural knack of handling machinery, others have to have long faithful teaching—a few never master the technique. It is not safe to believe that the good miners will be good machine operators.

It is probable that the first problem that will be encountered will be the lack of adequate electrical power. A continuous flow of power now becomes a necessity, and several electrical terms that had been the sole property of the electrical force become familiar to everyone. Heavier feeder lines, sub-stations, adequate return, probable drill holes for transmission lines and sectional circuit breakers, are among the might be necessities. The concentration of working places means the concentration of power required and the shifting load due principally to main line motors adds another different problem. Power facilities must be closer to the peak load requirements, as all of the machines are in actual operation for a greater portion of the time. The output of the mine will be wholly dependent upon electrical power, consequently every minute lost because of lack of power becomes several times as important as before. It is extremely important before installing loading machines that a careful and complete check up be made of the power situation. This may even lead back to the boiler plant, and require additional boiler power. If power is purchased the necessity for knowing the requirements is just as important in order that proper arrangements may be made to do away with unnecessary peaks.

The importance of good track has long been an essential of good management, but the term has a different meaning with mechanical loading as the track must not only serve for haulage, but as an anchor for the loading machine. A mine car off the track is only an incident in hand loading, but a loading machine off the track is an important

Loading machine operating at Superior Coal Company. Added height is given by using steel ties.

event. The size of the rail probably would have to be increased as any rail under 30 pounds to the yard is unsatisfactory. Steel ties should have a place in the study in order to not only get better track at the face but because of the added head room. The importance of the study of track is more than the material used however, as the track and switches must be such to give as near continuous service to the loader as possible. The closer the switch is to the face the sooner the car can be changed. Several papers have been read at meetings of the American Mining Congress which show a method of placing the switches so that by using a two-motor gathering system the stops are reduced to a minimum. Other companies have experimented with a two-track layout at the face—with a circular track, or even with no track at all. Regardless of the method finally adopted it is safe to assume that the track in a hand loading mine will not be satisfactory for efficient machine loading. It is not only the track at the working face but also the main line haulage that needs adjusting—and the two principal reasons for this are the greater speed of recovery, and a definite knowledge that partings must be closer to the face. As the face moves faster the partings must be moved oftener.

The concentration of production means of course, concentration of men and also concentration of ventilation. It would be a safe assumption that one-fourth of the territory required for hand loading would be more than sufficient to produce the same tonnage with mechanical loading. Inasmuch as the explosives used would be more in direct proportion to the tonnage produced, it also follows that the ventilation must be increased in the machine territories in almost the same percentage that the tonnage in that territory is increased. In mines where ventilation has always received its proper place in the scheme of things, and where the main air courses have been kept clean, the problem is greatly simplified—but it needs checking up before machines are started.

It will, of course, be evident that the coal must be shot so that the machine can load it, while at the same time it should be realized that the shooting could be such that the product would suffer more than the saving made by the loader. A mobile loading machine does none of the work except loading, and all of the other labor at the face must be done by some other means. The machine will load larger chunks than is possible by hand loading, but the coal must be loose from the face. The machine will "dig" the coal only at the expense of excessive repair costs. The net result of a study of the shooting usually results in a complete change in the drilling, and possibly even the explosive used. The drilling and shooting can no longer be left to the so-called judgment of the miner; nor can the amount of explosives used be a mere matter of guess work, for the coal must be shot, and shot properly. The loading machine can't take a pick, or a wedge and sledge to make up the difference. To secure a satisfactory product it may be essential that the cutting be altered, or the coal be sheared as well as undercut. Care must be taken that the machine itself does not add to the degradation of the coal.

The undercutting, drilling and shooting are not the only added responsibilities of the management at the face, for the responsibility of proper timbering is also included. The timbering at the face has been done by the miner, who worked there constantly; whose own personal safety depended upon the job being done properly, and the pay for this work was a part of the tonnage price. The change to mechanical loading requires that competent men be assigned to do this timbering. Experience has taught that each place must be timbered in a certain way regardless of the system of mining. As a rule, the operation of the loading machine has to be adapted to the timbering, instead of the timbering being adapted to the loading machine. Certain clearances must be allowed for the loading machine, not only at the face, but along the entries and roadways, and especially on turns.

Mechanical loading produces a different kind of coal than hand loading. The coal is shot differently and loaded differently, but by all means it is essential that the impurities be not increased. In most cases the man at the face has been depended upon to see that the coal is loaded practically free from impurities, and the cleaning plants have been used as an auxiliary for the face cleaning. With mechanical loading it is neither practicable nor possible to expect any cleaning at the face of the working place while the machine is in operation. This investment for additional cleaning equipment, made necessary by the installation of loading machines, may even exceed the cost of the machines.

Concentration of work due to more coal being loaded in each place over a given period is not only a possibility under mechanical loading but a necessity. The machine should move only when necessary, and the moves should be as short as possible, for when the machine is moving it isn't loading. This brings up some new problems, one of which is development, and development

Track-mounted machine cutting up in seam. Machines carry two trolley poles as wire is always on side of entry opposite room necks.

that will not spread out fanwise and thus widen the spread between places. If at all possible the loading machines should do their own development work, otherwise additional machines will be required which will reduce the average yield per machine, or require an investment out of proportion to the results obtained. The general plan of work is usually one that has been found best suited to the mine or the field in which the mine is located; and any operator would be reluctant to modify this plan to any great extent without considerable thought. It may be possible, however, to change the plan of work without interfering with the general layout. The sketch shows a plan of panel work by which a change of the direction in which the room entries advance, permits driving them parallel with the haulage entries, which operation keeps the haulage and faces close together.

It will be readily recognized that the loading machine should have sufficient places as nearly adjacent to each other as possible, yet one of the items of cost made evident by the installation of machines is the cost per working place. The number of places should be the number required. Fewer places will mean a shortage of coal to load or an excessive move, while excessive places cause an expensive upkeep for timbers, track, ventilation, etc. Better care will be taken if every place is needed to furnish the machines with working places. The number required will be subject to the amount of coal in each fall, the cycle of face operation and the top conditions.

The gathering of coal from mobile loading machines is a problem distinct from that of gathering from hand loaders. In the first place a motor or mule is required at the machine while the car is being loaded, and while this is of short duration, the car usually has to be moved more than once during the loading operation. The motor then will not gather the same number of cars per day, and a greater number of haulage crews will be required to gather the same number of cars. Neither will a loading machine chunk the cars and the operation is too fast to permit hand "chunking," so in many cases the cars do not hold the amount of coal that was the case previously. In fact the amount of coal loaded in each car is an important item in the successful operation of loading machines. In places the cars have been too small, and new type cars have been installed—while in other mines the size of the shaft, the entries, the track gauge or the cage has prevented this correction. One Illinois operator has a five-ton car for loading at the face, which car is switched out to the parting where it is dumped into a pit and thence to the regular smaller sized pit cars. The type of gathering equipment is worthy of study, and since the loading machine can keep two locomotives constantly engaged, the question of reel and cable or storage batteries is worth investigating.

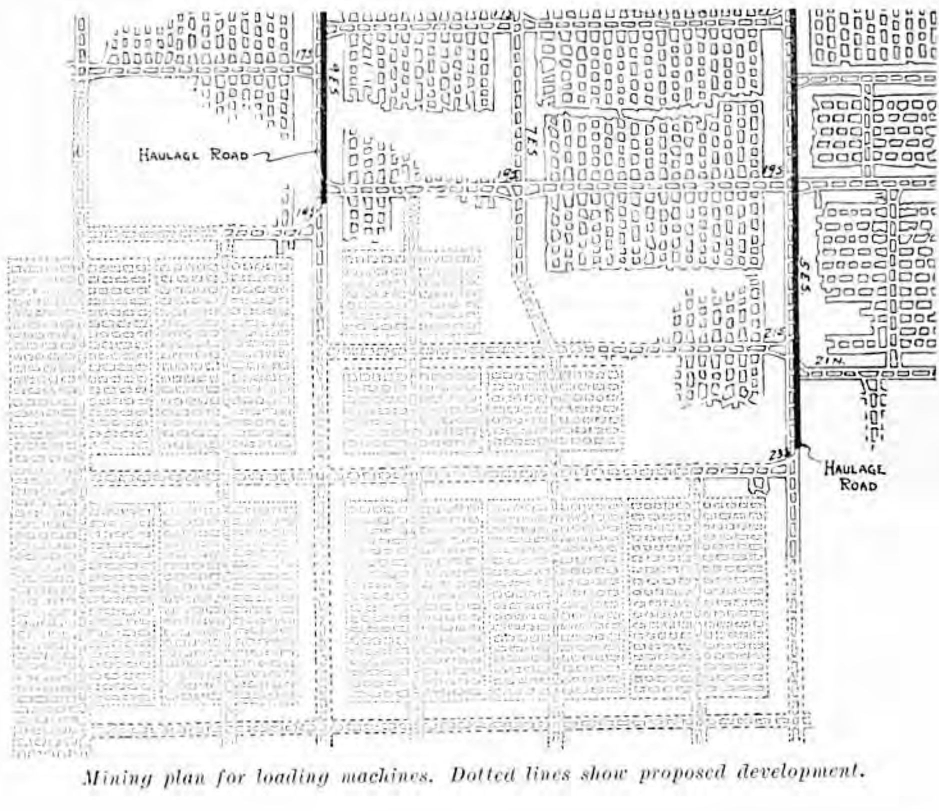
There is no secret about safety in the mines. Mines won't of their own accord stay safe. Safe mines are the result of constant attention to safety practices, and a knowledge on the part of the management as to the cause of accidents. Regardless of the methods used to secure safety, the mines with the best safety records are the best managed mines. It has been found that you can't conduct a spasmodic safety campaign and get results, any more than you can manage a mine by giving orders only on the first day of the month. The safest mine in the world will lose its standing if there is even a sign of a let up. New methods and new machinery create new safety problems. By the rules of reason loading by mechanical loaders should reduce the accidents, but during the period of installation and even afterwards there is a tendency to neglect the rules of safe operation, as everyone is interested wholly in the successful operation of the machine.

Besides there is a lack of knowledge of how injuries might occur. It is inevitable that the cause of injuries will change as the system changes. For instance it would be correct to assume that there would be more injuries caused by electricity as the number of men employed on and around electrical devices grows proportionately, especially since many of the employes are unaccustomed to its vagaries. Again the measure of accidents must be different. As we were accustomed to compare our accidents to the tons of coal produced, it now becomes plain that we should not be permitted to make a showing because of the increased production per man which may in effect increase the hazard to the individual workman. With the installation of loading machines the time of the foreman which was used to prevent accidents can not be profitably taken away in order that he might devote more time to increasing efficiency of the machine.

The coal mining game is steeped in tradition which permeates every individual connected with it, be he foreman or miner. A cardinal principle was that good track and good ventilation made a good mine, and that the foreman who demanded and got these things was a good manager. The importance of the management was below that of the man at the face. A large part of the duties of the management, and they were many, was giving service to the miner. The foreman rarely gave instructions to these men, but rather conferred with them as to the best or safest methods for them to do their work. The decision in most cases rested with the miner. The pay of the tonnage man depended not only on the efforts of himself, but on the work done by the tracklayer, the timberman or the haulage. The full cooperation of almost every employe was given without much effort on the part of the management.

The average miner prided himself on the safe condition of his working place. He fully realized that the responsibility for keeping it so was solely his, as it was definitely his place. Even then the management of the mine was a rather complex business. Injuries, pit committees, gas and fires, besides the constantly changing conditions at least added zest to the job.

To be a successful manager with loading machines most of the old ideas must be discarded. Some of the best foremen are unable to adjust themselves to the new idea, and even among those who do there are some who, despite their hard work and loyalty, have difficulty piecing together the old with the new. Then, too, there are mine foremen who are willing and thoroughly competent to make a real go of the machines, but they can't reasonably be



Mining plan for loading machines. Dotted lines show proposed development.

expected to do so by merely giving them the machines. They must have other equipment as well as time to make the necessary adjustments.

The purpose of this discussion is not to discourage the installation of mobile loading machines, but rather for the purpose of suggesting some possible problems that may arise when they are installed. Even the most improved of the loaders are still in the experimental stage, there being much to iron out in every operation. It is best, however, not to be misled by the idea that the purchase of the machines will end all mining problems; by a tale of a single day's production, a single day's cost, or a record made in an especially favored part of the mine.

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DISCUSSION ON PROBLEMS TO BE CONSIDERED BEFORE INSTALLING MECHANICAL LOADERS

RANDOM OBSERVATIONS OF THE TREND OF LOADING IN THE WEST

By GEO. A. SCHULTZ
Vice President, Liberty Fuel Co.

As for the methods used in adapting mechanization to the various coal fields in the west, there has been too much of the attitude that "John Smith is making a substantial saving using mobile loaders, therefore, we must have mobile loaders," or "Bill Jones is doing well with conveyor mining, and what he does, we also can do."

It is well recognized now, that every mine presents it own individual problems and careful consideration must be given any number of things other than the single phase of loading, if the best results are to be obtained.

The mine which has added thousands of dollars to its capital investment in order to lower its loading costs may find, as others have, that its increased power costs and track laying cost and reduction in realization, among other things, is sufficient to wipe out the saving made in loading and the net result has been only some more depreciation and taxes to put on the books. Every year the race is keener and every year more careful planning is required of the man who wants to finish one, two or three.

"A" mine is producing only railroad fuel or industrial coal and is loading record tonnages per mechanical unit, the figures are broadcast. Then the local management of "B" mine is put on the spot, and told to equal these records, though their mine is producing only commercial coal. As a result shooting and everything else is sacrificed in the effort to equal "A's" tonnage.

In some of the thick seams, under heavy cover in the west, 60 per cent of the coal is left standing in pillars and forever lost, because mobile mechanical loaders operate more efficiently and safer in rooms and entries than in pillar work. This loss of coal can be avoided if the life of the mine is considered rather than too much consideration being given to this particular year's operations.

State regulations permit the fullest benefit from conveyor mining in low seams in Wyoming and Colorado, while the regulations in Utah do not permit shooting on shift with powder, and also require brushing to a height of 5 ft., within 300 ft. of the working face. Thus regulation defeats two of the largest savings that can be made with this type of mining.

Every year social security, unemployment and compensation charges are mounting until in many instances they now represent as much as 12 per cent of the labor costs of mining coal. The only answer of course is a higher production per man employed or a higher realization on the coal sold.

In the west many mines using mobile loaders and track mounted cutting machines average one trackman per 100 tons of daily production, while most mines using conveyors average one trackman per 500 tons of daily production.

Where mobile loaders are used the tendency is to have seven or eight working places for each unit. Where conveyors are used, one working place per unit is all that is required. One small operation working only 4 feet of coal averaged 400 tons per day out of two rooms for a six months period. Added concentration with its consequent saving can be gained with conveyor mining over the mobile loaders.

It would seem that the ideal working plan of the future would be caterpillar mounted mobile loaders loading onto conveyors. Delays incident to car changes have always been the greatest drawback with mobile loaders. These delays are entirely eliminated with the use of conveyors, as the entire trip or train goes past the loading station with no uncoupling or switching to do.

Development can be advanced so rapidly with conveyor mining that there is no longer any excuse for a mine, where pillars are extracted, not being worked on the full retreat system. Twenty days at double shift will be sufficient time to develop 40,000 tons in 6-ft. coal. While the rapid extraction increases the ventilation problem to some extent, it practically eliminates the old roof control problem.

The greatest need of the industry today, is a means or method of breaking down the coal at the face at no greater cost than using powder, but without the fumes and other hazards incident to the use of powder.

In the west it is almost an axiom that as the coal seam decreases in thickness it becomes much cleaner, is better quality and has better roof conditions. One mine recently transferred its operations from an 8-ft. dirty seam with poor roof to a 4-ft. clean seam with good top and increased its realization and lowered its costs, by going to 100 per cent conveyor loading. When this change was made the preparations plant was discontinued, as there was no need for surface cleaning.

As short a time back as five years ago a seam of coal under 5 ft. in height was considered unworkable in Utah. One mine with over 20 ft. of coal and fully mechanized, is now opening a 5-ft. seam. One small mine with only 3 ft. 6 in. of coal, due to its high percentage of large size coal has a 68 cents per ton higher realization than another mine that has a seam five times that height.

Under the National Bituminous Coal Act advantages enjoyed in the past by some mines have been eliminated and now the only inducements the operator can offer the trade is clean coal, high quality and good service. In my opinion there is going to be much more tonnage mined from thin seams in the west, in the future, than has been the case in the past.

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DISCUSSION ON PROBLEMS TO BE CONSIDERED BEFORE INSTALLING MECHANICAL LOADERS

RANDOM OBSERVATIONS OF THE TREND OF LOADING IN THE WEST

By DR. J. J. RUTLEDGE
Chief, Maryland Department of Mines

Mr. Schultz has brought out one matter to which I think you mining men will have to pay some attention. Back there is my good friend, Mr. Hagenbach. Over in the Somerset field he used to drive seven places, narrow ones, in about a 4-ft. seam of coal and then they wondered why they couldn't get sufficient ventilation through. We get a good many good ideas from Utah, and this idea of requiring a certain height on main headings is a good one. I know you won't agree with me, but when a mine inspector has to crawl on his hands and knees in as many places as some of our men do, if you were in *their* place you would agree on a little better brushing height. You cannot ventilate the big mines that you have today, gentlemen, with these narrow headings. You will have to do some brushing, or else widen the places. It is inevitable.

I was very much interested in what Mr. Schultz said about their mining the thin seams and leaving the thicker seams. Well, it is a blessing that they are doing that if they waste 60 per cent of the thick coal seam. The time is fast approaching when the matter of recovery is going to seriously affect mining. We are mining in the state of Maryland coal which was supposed to be worked out many years ago. We are going back and remining the big vein coal for the fourth time. We are also mining in some places a seam 2 ft. thick, 90 to 110 ft. above the big vein, after the big vein beneath has been pillared and is supposed to have been worked out and taken off the tax books. One good man came in there, from out west somewhere 10 or 12 years ago, and in three years produced from one of those worked-out areas, supposed to be exhausted, 600,000 tons of valuable big vein coal. The railroads got a million and a quarter dollars in freight rates out of it. The community got something like $900,000 in labor and supplies. This particular area was supposed to have been exhausted and had been taken off the tax books.

Mr. Wilcox, of Illinois, comes from a region which I know very well because I worked there in my younger days. The No. 6 seam is about 7 ft. thick and has one of the best roofs; in some places with 20 ft. of limestone over the coal, and in other places a black slate roof. So the conditions are ideal, but nobody else, unless he has been back there, knows what these people have gone through. Mr. Taylor, chairman of the meeting and also from Illinois, is the second generation, or perhaps the third, that I have known there, and I know the difficulties they have had.

The only contribution that I want to make to the discussion is that you mining men seriously consider this increase in size of your main air courses, whether you do it by brushing or by widening, because you are inevitably going to be brought up against that condition.

There is another phase—and if R. Dawson Hall is in the room I am sure he will bear me out—that this matter of 100 per cent recovery is going to come up to you folks some day. So while you are mining, get all of the coal.

(Reprinted from American Mining Congress 1938 Yearbook)

THE PREPARATION OF COAL BY CRUSHING AND SCREENING

By HENRY F. HEBLEY
Commercial Testing and Engineering Co., Chicago, Illinois

In the preparation of coal for the market a great deal has been published of late regarding the cleaning of the raw fuel, and the difficulties encountered in such preparation. Crushing and screening are to a great extent taken for granted, and the selection of equipment for different applications has been based on previous installations whose problems were similar to the one in hand.

However, one of the interesting developments in the preparation of coal in recent years has been the growing demand for small coal. In many cases the natural breakage brought about by mining methods has been insufficient to meet the demand, and it has been necessary to resort to crushing to provide the requisite sizes.

Many influences have brought about such a condition. Notable among these influential factors is the efficient utilization of the smaller grades in place of the more expensive large coal. This is especially true in the use of small coal for steam generation. Efficiency of combustion in the boiler furnace requires close, intimate contact of the fuel and air in the furnace, a condition that is attained only through the use of the smaller sizes of coal. Numerous boiler tests have indicated that a coal within certain upper and lower limits of size, with the correct percentages of the different fractions, will yield greater uniformity of combustion and will allow greater ease of adjustment of the coal-air ratio.

The installation of coal cleaning plants has also increased the demand for small coal due to the ability to produce fuel whose fine sizes are much cleaner than the raw coal from which they are obtained.

There are a number of cleaning systems that perform efficiently on the finer sizes.

Admittedly in many instances moisture is added during the washing process, but a reduction in ash affects the boiler efficiency three times as much as 1 per cent of moisture.

In the manufacture of coke a good coking coal may yield an excellent product if crushed to ¼-in. or ½-in.; but coals of poor coking characteristics may require to be crushed to a size that will pass a large percentage through No. 6 mesh.

Fuel for the production of gas is usually smaller than 2-in., and some gas plants may specify a maximum size of from 1¼-in. to 2-in.

For domestic and semi-commercial uses the advent of the small residential stokers has set a limit of 1¼-in. top size for coal being used in this equipment, and in many cases the maximum size is ¾-in.

Naturally these new outlets for small coal have increased the demand, and crushing and screening of lump coal help to meet the same.

During the mining of coal the explosives used for shooting are selected to yield a heaving rather than a shattering effect, in order to obtain the largest proportion of lump sizes. It may be considered as unnecessary to continue to strive for a large percentage of lump, inasmuch as it is ultimately going to be crushed in the preparation plant on the surface.

Such is not the case, as the coal should be mined to provide sufficient feed for the crushers. These will have to be flexible enough to meet the daily variation of the market demands.

Most degradation during the handling of the coal in the mine and surface plant is brought about by the chipping of the lumps against their neighbors. This results in the material finding its way into the cheapest grade. Therefore, in the majority of cases a crusher that will shatter the coal with a minimum of attrition will, as far as practicable, avoid the degradation and tend to concentrate the different coal constituents in the different size fractions. The tough Durain or dull coal will be found in the larger sizes; while the more brittle Clarain and Vitrain (bright coal) will concentrate in the smaller sizes. The Fusain (mother coal) because of its usual friability, will be found in the fine mesh sizes or dust.

The rational crushing of lump coal is dependent on the type of fuel required for various uses. Considering first stoker coal, it can be considered under the following divisions:

Type of Use—Commercial, semi-commercial, domestic.

Type of Stoker—Underfeed ram type, underfeed screw feed, chain or traveling grate.

In the commercial field, where the boiler rooms are under the supervision of a trained personnel, the cost per 1,000 pounds of steam, maintenance, boiler outage, and other pertinent factors influence the selection of the fuel.

If large coal is supplied to the grate, it ignites slowly because combustion is a surface phenomenon.

In the case of multiple retort underfeed stokers, 1½-in. or 1¼-in. screenings with about 30 per cent minus ¼-in. size will give satisfactory results, provided the proximate analyses of the different fractions of coal particles are substantially the same. To obtain this uniformity in the different sizes of the same coal the installation of a crusher is effective.

In burning such coals, if there is ample agitation to prevent caking, the percentage of fines can be increased slightly; but if the fine sizes are of different characteristics, of a poor quality, or are present in large quantities, then trouble will be experienced.

With chain or traveling grate stokers, running at a given speed, coal that is too large will be incompletely burned and will cause a high loss of combustible to the ashpit. Smaller coal will be consumed more completely; yet if too fine, will sift through the grates. Segregation, which is accentuated by a large range of sizes present in the fuel, causes uneven burning, and a spotty fire with the resulting excess air.

Slagging difficulties arise with coals containing a large percentage of fines, especially if they are high in sulphur and ash, and have a low fusion point.

Such troubles are increased if the furnace temperatures are high (High CO_2 and no water-cooled walls).

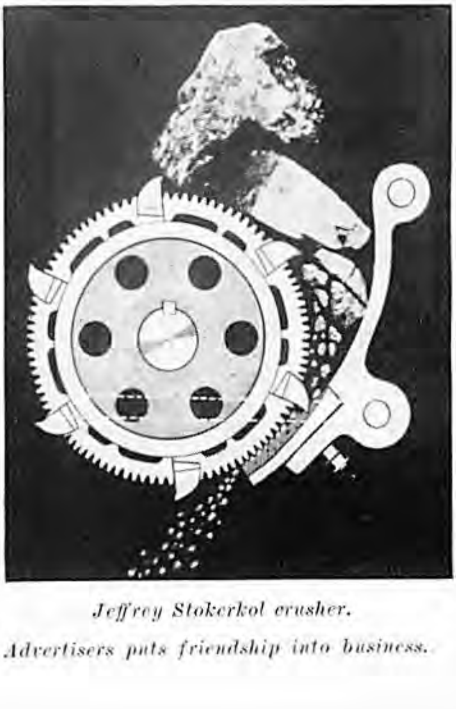
Poor screening with a large percentage of over size, say 2½-in., in the fuel, causes a demand for excess air with its consequent loss. These chain grates generally work best with 1¼-in. or 1-in. size coal, with the fines controlled.

Therefore, for good economy, coal should be of uniform size as delivered to the grate, as most of them are designed for a definite range in fuel sizes.

In regard to fuel for domestic stokers, different requirements are necessary. Generally speaking, efficiency is not the major factor. Cleanliness, noiselessness, dustlessness, ease of handling, and uniformity are also important.

In a survey conducted by Mr. K. C. Richmond in *Coal Heat*, stoker manufacturers, fuel engineers, etc., gave their recommendations regarding the size consist. A summary is given in Table I.

Another pertinent factor generally brought about by the poor sizing is the influence of the occasional large pieces that may be shipped with the stoker product. Pieces of 3-in. coal will tend to hold back the coal from the feed worm and starve the stoker. Smoking back will be experienced and finally, when the pieces are gripped, the crushing



Jeffrey Stokerkol crusher.

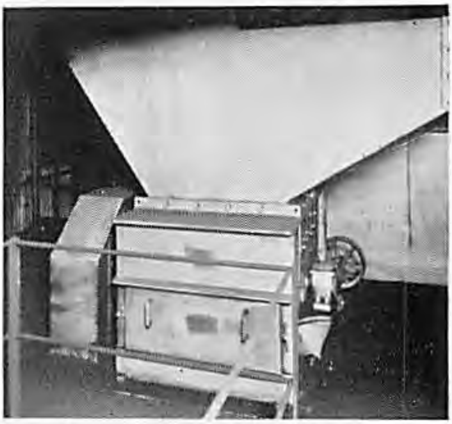
that takes place creates a noise nuisance. Such requirements again stress the necessity for crushing and efficient screening, and the specifications for accuracy in sizing are becoming more rigid.

With this brief outline of the modern requirements in coal being prepared for various uses, some consideration may now be given to the methods of accomplishment.

In the reduction of lump coal to the requisite sizes, crushing or breaking machinery is used. These can be conveniently divided loosely into classes, dependent on the principle adopted to accomplish the size reduction.

Crushing Due to Impact—
Bar hammer mills (pulverizers).
Ring type hammer mills.

Crushing Due to Rolls—
Single roll crushers.
Double roll crushers.
Multiple roll crushers.



Pennsylvania granulator.

Breaking Due to Needling—
Various types of pick breakers.

Breaking Due to Shattering—
Bradford type breakers.

In many designs the principles enumerated overlap. Therefore it is rather hard to separate one action

TABLE I

Number	Top size	Bottom size	Per cent Fines
1	⅝"	¼"	
2	1¼"	¼"	Fines below ¼", not over 30%.
3	¾"	5/16"	
4	½"	⅜"	
5	1½"		Small per cent of minus ¼" x 0.
6	1"		Small per cent of minus ¼" x 0.
7	5/16"	10 Mesh	
8	1"		Not more than 35% fines.
9	¾"	¼"	
10	1¼"		
11	1¼"		40% fines.
12	1" or ¾"	¼"	
13	1¼"	⅜"	Not to exceed 25% fines.
14	1"		¼" x 0, not to be excessive.
15	1¼"		Containing from 30% to 50% fines.
16	1¼"	⅜"	
17	1"	10 Mesh	
18	1¼"		Maximum of 30% fines.
19	1¼" to ⅜"		20%, 1¼" x 1".
			30%, 1" x ⅛".
			50%, ⅛" x 0.
20	1¼"	⅜"	
21	1¼"		Not over 30% fines.

from the others, as all may be taking place simultaneously in one machine.

One of the units of the impact type is the ring type hammer. It is used for reducing run of mine and lump to stoker sizes or commercial screenings. In some cases, by omitting alternate grate bars, the machine can be applied for crushing middlings obtained from the primary separation in a coal cleaning apparatus. The crushing of such material releases the intergrown coal from the accompanying refuse, and facilitates the recovery of good coal when the crushed product is returned to the cleaning plant for further treatment. The machine is of simple design and construction, and is dependent on centrifugal force for holding the rings outward. The rings have the advantage of wearing uniformly. Provision is made for adjusting the manganese grinding plate to take up the inevitable wear.

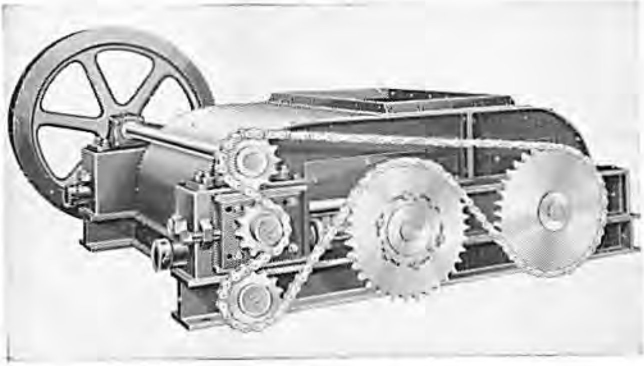
In crushing from 4 x 2 down to stoker sizes about 5% would stay on 1⅛-in., 50% on 7/10-in., and 90% on 1/16-in.

When used for crushing washery primary refuse for unlocking the intergrown coal from the refuse, a plus 2-in. feed would be reduced to minus 2-in. with 72% of the material over 5/16-in.

Roll Crushers

Roll crushers, as indicated, may be either single, double, or multiple roll. The single roll units, as the name implies, possess a rotating roll and a breaker plate against which the material is wedged due to the rotation of the roll. Size reduction in a properly designed single roll crusher is accomplished mostly by compression, but partly by impact between the teeth of the roll and the breaker plate. The concave breaker plate gives a wedged shaped opening to receive the feed, with a small angle, which, combined with the action of specially designed teeth on the roll, makes it possible for this machine to seize and break large lumps of coal. The unit is simple in design, and generally more reasonable in cost than the double or multiple roll units for the same capacity.

This machine is very adaptable to the many demands made on coal breaking equipment. The breaker plate is generally mounted on a shaft, and provisions are made for holding the plate in the proper adjustment in order to produce the



Link-Belt double roll crusher.

requisite size coal. This position is held through the use of compression springs. Should foreign material or hard lumps of iron pyrite find their way into the crusher, the foregoing springs are compressed, allowing the breaker plate to move away from the roll, and thus relieve the stress.

Double roll crushers, as their name indicates, consist of two rolls generally equipped with teeth rotating in opposite directions. This class, while not entirely restricted to the production of small sizes, is, in general, best suited to a finer product, say 2-in. and less.

Roll crushers therefore find their widest application in the production of small coal for the gas industry, coke ovens, and stokers. They are also useful for certain phases of coal preparation in which intergrown material must be separated from the coal. The choice of the correct roll crusher is governed principally by the size of feed and the required reduction ratio. The limit of size reduction possible with a given breaker is influenced by the question of seizure by the roll and the material to be broken. Seizure depends upon the coefficient of friction, the surface of the rolls, and upon the roll dimensions. To insure the seizure by the rolls, the wedge angle, that is, the angle subtended below any piece of coal when resting on the rolls, must be less than the "angle of nip."

Multiple roll breakers are equipped with three or four rolls. They were developed for accomplishing a greater reduction ratio than that obtained with double roll crushers. For instance, reducing from run of mine coal, which may contain lumps up to 20 in. or more, to about 1½ in. in size, and less. Such machines are usually of the 4-roll type, and may be regarded as comprising two double roll units working in series and incorporated in a single housing.

No one particular type of crusher can be applied to all the different conditions and requirements.

One general statement can be made regarding reduction equipment as applied in the coal industry and that is with the same size and kind of coal that the percentage of fines in the crushed product is directly in proportion to the speed of the crushing unit. In other words, the higher the speed the higher the percentage of smaller sizes that will be in the product. Like every general rule this has a number of exceptions, the main exception being the particular physical characteristics of the coal, for with some coals that are rather brittle a higher speed might be desirable to give a sharp blow to the coal, shatter it and let it pass quickly from the machine. A slow-speed machine might have a tendency to grind and thus produce a higher percentage of fines.

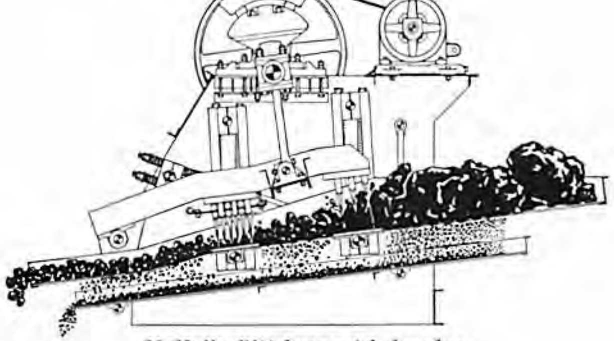
The proper application of a machine for the coarser grades of crushed coal is not as difficult to make as when the desired product is in the smaller ranges. Where it is required to reduce lump and block coal to egg sizes the reduction unit is practically limited to the pick-tooth type, the single roll type and the double roll type. As a general rule the cost of the reduction unit in comparison to the tonnage that it can handle and the space available is the determining factor in the selection of one of these types. The flexibility of the reduction unit should also be given consideration since it is highly possible that although the reduction unit might be put in to make a high percentage of egg size the market conditions might make it necessary or desirable to be able to change the reduction unit to give a smaller sized egg or a nut or stove coal.

When a comparatively coarse product, say down to and including a 2-in. ring size is required, the double roll and single roll crushers are available. Since a single roll unit of an equal diameter roll to a double roll crusher has a maw that is a little more than two times as large as the maw of a double roll crusher and thus is able to readily handle larger sized lumps and the ratio of reduction is considerably larger, the single roll type is generally preferable. Because of the more positive nip or bite due to the larger sized maw of the single roll crusher, the product from the single roll crusher generally contains less fines than the product of a double roll crusher when large sized lumps are fed to the reduction unit. When lumps of such a size that they can be readily gripped and crushed in the double roll crusher are fed there is very little difference in the size of the product secured from either type.

When a product of approximately 1½-in. and under down to and including 1-in. and under ring size is desired with a minimum amount of fines, the application of the proper type of crusher will depend a great deal upon the size of coal that is to be fed to the crusher. If the feed is to contain large sized egg, lump or block coal the single roll type of crusher equipped with fine crushing segments, in most instances, is the proper type to use for the reason mentioned previously of the large sized maw.

When a small sized egg or nut is to be crushed the physical characteristic of the particular coal should be given very careful consideration since in one case the single roll crusher with all sharp, short teeth, restricted maw to prevent boiling of the small size feed and plain breaker plate shoe will give the best results where as with another type of coal the double roll crusher might give a better product. Although the slow speed flextooth crusher or slow speed ring roll crusher of the cam type can sometimes be applied to meet these requirements, these two types are generally better applied where the desired product is somewhat smaller than specified above, that is where the product desired is about a ¾-in. ring or smaller.

When the desired product is ¾ in. and under ring down to and including, say ⅜-in. and under ring and a very small percentage of fines



McNally-Pittsburg pick breaker.

is desired, the slow speed similar to the flextooth or slow-speed ring roll of the cam type generally gives the best sizing of crushed product. If the coal fractures readily and does not have a tendency to pack between the teeth, a double roll type of crusher with short, sharp teeth can be used for a product of approximately ¾-in. ring and under. If a product of approximately ½-in. or smaller is desired it is then generally necessary to equip the double roll crusher with segments of the corrugated type which have a tendency to mash and grind the coal and thus increase the percentage of dust in the product.

For reducing coal to the smaller sizes required by some of the more improved commercial stokers and for domestic stokers, where only a small percentage of fines or dust is desired the fine crushing single roll crusher, the Stokerkol sizer, generally gives the best results and is a more flexible machine due to the fact that the ratio of reduction is highest in this type when taking into consideration the low percentage of fines in the product.

When it is necessary to furnish a certain size of coal with the guarantee that 100 per cent will pass a certain specified size the economical way to crush and furnish such a size is to install the reduction unit in closed circuit with a screen. If an attempt is made to reduce the coal so that 100 per cent will pass the specified size in one pass through the crusher and without screening it is necessary to set the crusher much closer than is economical from the standpoint of fines. If the crusher can be set so that the product will contain a comparatively small percentage of oversize, this oversize screened out and recirculated, the total percentage of fines in the crushed product will be considerably less than when the crusher is set so that 100 per cent would pass through the desired size of screen. Whenever it is possible, irrespective of what the desired size of product might be, a crusher installed in a closed circuit with a screen and set so that there will be a small per cent of oversize, say 15 per cent to 20 per cent oversize, which can be recirculated, will make the most economical installation. Although such an installation will have a somewhat higher initial cost, the saving in fines over several years operation will more than pay for the additional expense of equipment and its maintenance, when it is necessary or desirable to screen out fines and either discard them or sell them at a low price.

Where a mine is furnishing coal in the smaller sizes to power plants that are equipped with fine grinding units for pulverized fuel, the percentage of fines in the product is not generally given as serious consideration as when the coal is furnished for stoker use. The manufacturers of most fine grinding pulverizers used for preparing pulverized fuel do not, however, want too large a percentage of fines or dust in the product going to their reduction unit and prefer a reasonably low percentage of dust in the feed to their unit to secure a maximum grinding efficiency. For crushing coal for feed to fine grinding pulverized fuel units, the comparatively higher speed rotary ring roll crusher can be applied. Because of the fact that this type of unit is designed so that the ring type of crushing elements are held out in effective working position by centrifugal force, a comparatively high speed is necessary. With the higher speed the screen bars can be spaced farther apart and the open discharge area is greater than in the slower speed or cam type of ring roll crusher, a larger capacity can be secured from the high speed ring type of crusher than can be secured from the same size slow speed unit.

When installing the higher speed unit, the purchaser should recognize the fact that the product will contain a higher percentage of fines than would be secured from a slower speed unit. Careful consideration should be given to this point, due to the fact that although at the time the installation is made the purchaser might believe that the percentage of fines in the product would give them little concern, it is highly probable that before long these conditions will be changed so that it would be highly desirable to make a crushed product with a minimum amount of fines. As a general rule no user of crushed coal will object to a product containing a very small percentage of fines, whereas in many cases users do object to products containing a comparatively high percentage of fines. For this reason it is generally wiser to purchase a reduction unit that will make a product with a minimum percentage of fines even though it is not necessary at that time to give serious consideration to the fines in the crushed product.

Comparatively few years ago the reduction of coal for coking purposes was not given any serious consideration with the exception that the top size was generally specified. The percentage of fines in the crushed product was a point that was seldom mentioned. For this product the high speed rotary ring or hammer type of crusher was applied satisfactorily. In the last few years some consideration has been given as to the percentage of fines in the coal prepared for coking purposes and some operators, especially of the more improved coking plants, are of the opinion that a minimum percentage of fines is desirable. In this case the slow speed unit or ring roll of the cam type makes the most desirable product.

Where a product of about minus $\frac{1}{4}$-in. square mesh or a product of approximately 80 to 85 per cent minus $\frac{1}{8}$-in. square mesh, for some coking operations, briquetting, etc., is desired the high speed rotary ring or hammer type mill are the types that should be applied.

Tyler Ty-Rock screen.

It is not always possible to apply the machine of the best design since there are other points that must be given consideration. Although as previously stated a slow-speed machine will give a more granular product with a lower percentage of fines, it is generally necessary to use a somewhat larger and therefore more expensize slow-speed machine than would be necessary with a high-speed machine. It is therefore necessary to balance the saving that might be made by making a product with a small percentage of fines against the initial cost of the reduction unit. The amount of moisture present in the coal fed to the reduction unit must also be given consideration where comparatively small sized products are desired. Since the slow-speed machine must be equipped with bars spaced closer together than in the higher-speed machine, the moisture content of the coal might be sufficient to cause trouble in plugging the comparatively smaller screen bar openings and for this reason a higher-speed machine with bars spaced farther apart might be more satisfactory from the operating standpoint.

Pick Breakers:

In an effort to avoid making a large percentage of degradation or dust when breaking down lumps to the requisite size, there has been developed a type of machine known as the vertical pick breaker. For the most part these consist of an arrangement whereby a series of picks substantially supported is driven down through a layer of lump coal in such a way that the lumps are split into smaller pieces. Generally the picks are arranged in two sets, the primary picks being spaced at a greater distance center to center than the secondary.

Sometimes the feed to the machine is on a conveyor of the apron type, so interlocked with the mechanism of the crusher that the coal is stationary during the time the picks are performing the breaking operation.

In other designs a reciprocating feeder, which moves the coal into position ready for the next operation, is adopted. Anvils are located under each set of picks in order to take the blow. For safety measures the whole of the breaker plate will be depressed, should a foreign substance come underneath the pick points. Arrangements are made in some instances for an oscillating screen built in conjunction with the feeder deck so that coal that has been reduced to the requisite size is immediately removed from the action of the picks, and in so doing, degradation is kept to a minimum.

Bradford Breakers:

In the Bradford Breaker use is made of the difference in shattering effect on coal and associated iron pyrite or hard shale. The machine consists of an octagonal drum of large diameter equipped with lifting flights, attached internally. The material to be broken is fed at the center, and the rotation of the drum causes the material to be lifted by flights, and when in the topmost position the material is dropped, shattering the coal from the associated refuse. The rotating drum is perforated with the requisite size openings, and material passing through those openings will be found to have been freed in great measure from the refuse. The refuse itself works its way toward the end of the drum and is removed. This machine has its greatest application in the removal of good coal from associated iron pyrite or hard shale.

Screens:

Having reduced the coal in size, it becomes necessary to size the same, ready for the market. For such a duty screens of numerous types have been used.

Generally, the primary screen is practically always of the shaker type. This equipment is familiar to all, and requires no description. Generally in a cleaning plant it divides the coal that is to be hand picked from the material that is to be sent for mechanical cleaning. After passing through the cleaning equipment, the cleaned coal is sent to classifying screens. These are generally of the shaker type supported on ashboard hangers, commonly known as the Parrish type screen. More recently there has been a trend toward the use of vibrating screens for material up to 2-in.

Classifying screens in many cases are used as dewatering and rinsing screens in order first to free the washed coal from adhering particles of small size; and then to provide sufficient drainage in order that the sizes prepared may be loaded directly into railroad cars. The fine material, for instance the ¾-in. x 0 size, is further treated on screens of the vibrating type. These may be actuated either mechanically or electrically.

Allis-Chalmers double-deck vibrating screen.

Universal double-deck vibrating screen.

A third type of screen used for the removal of moisture from the very fine sizes consists of screens of the high speed oscillating type, equipped with a deck of wedge wire, or screens of the vibrating type previously described, but covered with specially woven wire cloth.

No further description will be included here regarding the primary and secondary or classifying shaker screens.

Turning then to screens of the vibrating type, and considering, first, those units that depend on electrical energy for the vibrations, the Type 400 is arranged with a vibrating unit in each of the four corners of the deck. The screen cloth is stretched tautly over the screen frame, with a slight rise in the center to facilitate placing the cloth in tension. These units are being used for fine sizing.

When used for this purpose the moisture in the feed to the screen has a great effect on the efficiency of screening. Provided the coal is dry, good results are obtainable. If the coal is damp, however, there is a tendency to blind. This can be overcome by screening the coal wet. Such an installation, that is, screening wet with the use of sprays, has been successful in the Indiana field.

In substitution of electrically vibrated screens, the mechanical effect of an unbalanced fly wheel, rotating at a high rate of speed, provides the necessary whip to cause vibrations in the screen deck.

When used for dewatering purposes the screen deck is often operated approximately 2° uphill. Such an arrangement has the benefit of being able to move the coal upwards and effectually prevent the water from following. Many vibrating screens of the unbalanced type have been developed for medium and fine coal screening and rescreening, all of them performing in a fairly satisfactory manner.

A screen that is supported on wooden stilts, set at an angle to the vertical, and given an oscillating motion, which is effectively balanced by two heavy steel weights moving in position to the screen deck, has been developed. It follows to a great extent the original design of German dewatering trays, Zimmer or Ferrarris screens. These units have the advantage of being able to be placed practically anywhere in cleaning or preparation plants, without causing undue dynamic stresses in the structure. They have been used for secondary and fine screening, as well as dewatering. They have also been applied for rescreening purposes in the huge coal docks at lake transport points such as Duluth, Minn., Superior, etc.

At this point it may not be out of place to discuss the measure of efficiency of screen performance. In this connection tribute must be paid to Mr. O. O. Malleis for the painstaking work he has carried out in conducting sizing tests on coals emanating from the Appalachian field. Quoting from his paper he states that "usually about 500-lb. samples were taken, covering an entire day's run. The procedure used in making the screen test was to screen the entire sample over a ⅜-in. round hole screen. The sample was then screened in two directions, upwards and downwards. The Minus ⅜-in. round material was first riffled down to 25 sizes, air dried, and screened over the necessary mesh testing sieves."

In reporting his screen analyses Mr. Malleis adopted the ⅜-in. round hole as the critical size. For instance, coarse screen tests had the following size consist:

FEED: ELKHORN SEAM 2-IN. x 0 COAL

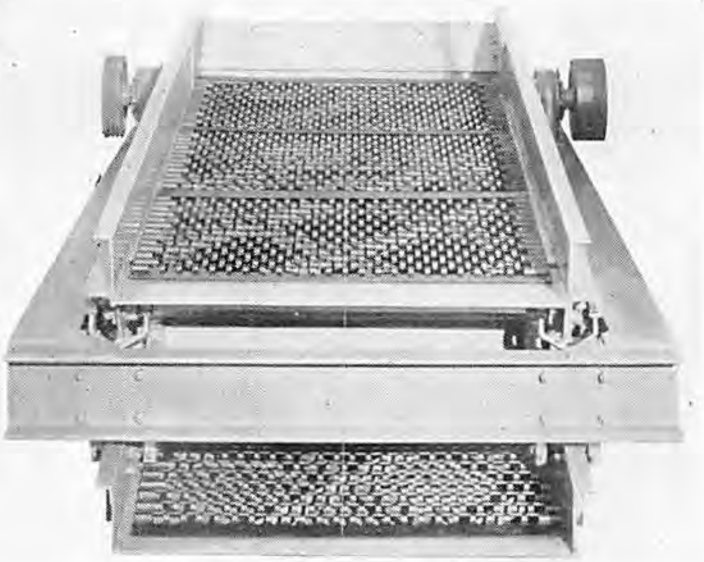
Size	Per cent
Plus 2"	0.0
2" x 1½"	12.1
1½" x 1¼"	21.4
1¼" x 1"	29.6
1" x ¾"	39.9
¾" x ½"	53.0
½" x ⅜"	59.7
Minus ⅜"	100.0

FEED: ELKHORN 2¼" x 0 COAL

Size	Per cent
Plus 2"	5.2[1]
2" x 1½"	21.9
1½" x 1¼"	30.3
1¼" x 1"	42.8
1" x ¾"	54.1[2]
¾" x ½"	66.2
½" x ⅜"	73.0[3]
Minus ⅜"	100.0

[1] Approximately 5% on 2".
[2] Approximately 50% on ¾".
[3] Approximately 73% on ⅜".

It will be noted that three critical points have been marked, one running approximately 5 per cent oversize; then the midway point of 50 per cent of the product; and finally a lower limit. This method of reporting screen analyses, when considering stoker coal, has been found



Hendricks flanged-lip screens on shaking screen.

to have merit. It is one of the methods adopted by the Midland Institute of Mining Engineers, and yields an indication of the closeness of sizing existing in various screening plants. When the upper and the lower limits are wide apart, and the position of the mid point varies greatly, it is an indication of inefficient screening. This method of test was applied to many coal preparation plants. The method of sampling consisted of cutting the stream of coal in the same manner each time. Sufficient material was taken at each cut or increment to be sure that the size weight ratio was not violated. The sampling receptacle was never allowed to fill completely so that spillage, with its consequent inaccurate results was avoided.

Samples were collected by hours, and each hour's sample was set aside and screened separately. Samples were taken throughout the day. This method allowed the hourly fluctuation in sizes of coal coming from the screening plant to be detected. From a study of the figures available it was noted that if the results of three hours' sampling are averaged, then the variation between one day's production and another was very little.

Nordberg-Symons screen.

(Reprinted from American Mining Congress 1938 Yearbook)

DISCUSSION ON THE PREPARATION OF COAL BY CRUSHING AND SCREENING

CRUSHING AND SCREENING FOR STOKER AND SPECIAL FUEL USES

By W. J. BORRIES
General Manager, Dawson Daylight Coal Co., Dawson Springs, Ky.

The preparation of stoker and special fuels to meet the exact requirements of the power plant customer and the whims of the "small stoker coal" dealer and household consumer is a difficult and perplexing problem to the coal producer.

The producer may crush his coal to several sizes, he may screen his coal to many sizes, and the job may be well done. It is after the product reaches destination and is put into the coal bin that it proves all wrong, and the consumer comes back to the operator for another size or another mixture.

The usual complaint about oversize, too many fines, not enough oil, are all familiar to the producer. The producer's attitude when faced with these complaints is that the "customer is always right," and he immediately resorts to plant reconstruction and additions to fulfill the desires of the customer. As a result of this situation the coal producer's plant today has assumed large proportions and is equipped with complicated crushing, screening and rescreening machinery.

The demands of the consumer for stoker and special fuels are manifold, and the producer and consumer are often equally as perplexed as to the particular product necessary for his stoker and special fuel purposes. The producer's plant therefore becomes a laboratory. We have come in contact with dealers who require for their small stoker coal a certain amount of fines, down to 10 mm. and below as bottom size, and as high as 1¼ in. for top size. Some dealers will not accept stoker coal with less than ⅜ in. for bottom size, and top size 1¼ in. Others demand top size 1 in. or ¾ in. and bottom size ⅜ in., ¼ in. or ⅛ in.

In large industrial plants for underfeed stoker we find the top size range up to 2 in. Certain types of stokers and feeders require specific sizes for their best performance, determined by combustion investigations made at individual plants. It is also true that specially sized fuels are adaptable only to certain equipment. The producer feels that it is the combustion engineer's problem, after tests have been made, to specify the proper size fuel for each individual plant or type of equipment. The producer now is placed where he must expend considerable money for plant equipment and reconstruction to meet all of the various ideas which come to the mind of the coal dealer, the stoker manufacturer and plant fireman. The consumer little realizes that his demand calls for additional equipment, thus increasing plant and labor cost, which likewise increases the coal cost.

The producer, when making stoker coal, is also confronted with the disposal of the resultant carbon. The disposal of carbon at many plants is difficult, due to the limited demand for this product, requiring storage on the ground, subject later to reloading in railroad cars at an additional cost when market is secured.

The combustion engineer would certainly be a god-send to the producer if he would standardize the size and preparation of both stoker and special fuels to meet all requirements, thereby reducing the necessity of expensive equipment and excessive cost of preparation.

Is the coal operator going to continue making annual plant alterations to meet the demand for a multitude of sizes and mixtures for stoker and special fuels, or is the combustion engineer going to establish set standards?

Description of Dawson Daylight Coal Company Plant

The crushing and screening plant of Dawson Daylight Coal Company has experienced yearly reconstruction and additions to meet the demands for small stoker, industrial stoker and special fuels for domestic and commercial purposes. Our crushing plant consists of three crushers. One 30-in. x 30-in. Jeffrey single roll crusher is placed to receive the coal from the end of the lump loading boom. Another 30-in. x 30-in. Jeffrey single roll crusher is placed to receive the coal from the end of the egg loading boom. These two crushers are elevated in the tipple so as to discharge either directly into railroad cars as straight crushed coal, or, with valves closed, onto a 24-in. drag conveyor under the crusher. The third crusher is placed under the discharge pan of the nut loading chute and the crushed coal directed into railroad cars. With this primary crushing plant we are able to load 2-in. or 1½-in. straight crushed coal. Due, however, to the slabby nature of our No. 6 coal, there are pieces of coal going through the crusher of larger size than desired by the customer, thus creating what the customer terms oversize in his crushed coal. We have corrected this condition by conveying the entire crushed product from the crusher by drag conveyor to a Jeffrey Traylor double-deck vibrating screen. The top screen cloth is changeable with 1½-in. or 1¼-in. square perforations, and the bottom screen cloth is changeable with ¼-in. to 10 mm. Thus the raw crushed coal discharging onto the top screen of the vibrator takes out the oversize, which is returned to the shaker, and the bottom screen the minus ⅛-in. or 1/10-in., or whatever bottom size is desired. The middle product is returned to the bottom strand of the drag conveyor, which delivers a finished, sized, crushed stoker coal to the railroad car. If a straight crushed coal of uniform top size is desired, with the fines included, a valve is closed in the bottom pan of the vibrator which permits the fines to be re-mixed with the top size coal for delivery into railroad cars.

We have no facilities for the sizing of the coal from the nut crusher. Due to the small volume which this crusher is required to handle, and on account of the natural sizing of the nut coal itself, there is a tendency to produce a fairly uniform size of crushed coal that usually satisfies the customer.

Stoker coal is also made from screenings. Either 2-in. or 1¼-in. screenings are diverted from our shakers to a secondary screening plant. In order to reduce the load on the secondary fine screening plant we double-deck the shaker screen to take out 2-in. or 1¼-in. on the top screen plate, and 1-in. or ¾-in. on the bottom plate. The minus 1-in. or ¾-in. product is diverted by means of a chute to a belt conveyor which discharges the minus 1-in. or ¾-in. product onto a Robins Eliptex double-deck screen. The load to the screen is divided, allowing thereby approximately half the entire minus 1-in. or ¾-in. product to be screened on the top deck and bottom deck. Between these two decks is a collecting pan to catch the carbon from the top deck. The screen cloth on each of these decks is either ⅜-in. or ¼-in., according to demand. The stoker coal which is therefore made from this primary vibrator screen in the rescreening plant is a 1-in. x ⅜-in. or 1-in. x ¼-in. product, or may be mixed with the minus 1¼-in. x 1-in. or minus 2-in. x 1-in. and resolve itself into a 2-in. x ⅜-in., 2-in. x ¼-in., 1¼-in. x ⅜-in. or 1¼-in. x ¼-in. stoker product, or a ¾-in. top size.

The minus ⅜-in. or minus ¼-in. product from the primary vibrator screen is conveyed by drag conveyor to a bucket elevator which elevates it to a sufficient height for discharge onto two Wright vibrator secondary screens. These are single-deck screens having a 3-in. x ⅛-in. elongated opening. The product therefore made from this secondary screening is a ⅜-in. x ⅛-in. or a ¼-in. x ⅛-in., which we term "baby stoker coal." This product has a special fuel use and the demand for same is increasing.

When there is a demand for 1¼-in. x ⅛-in. stoker coal, diverting chutes are so arranged that the ¼-in. x ⅛-in. can be mixed with the 1-in. x ¼-in. from the Robins screen, and the 1¼-in. x 1-in. from the shaker screens into the same railroad car, thereby making a resultant 1¼-in. x ⅛-in. stoker coal.

The carbon either from the primary Robins screen or the secondary Wright screen may be diverted to the carbon storage bin. This carbon is then discharged in front of a Sauerman drag conveyor system which disposes same onto the tipple yard alongside the railroad track. By reversing the drag conveyor bucket the carbon can be conveyed back from the storage pile to a loading point where it is conveyed into railroad cars for shipment.

(Reprinted from American Mining Congress 1938 Yearbook)

DISCUSSION ON THE PREPARATION OF COAL BY CRUSHING AND SCREENING

CRUSHING AND SCREENING FOR STOKER AND SPECIAL FUEL USES

By GEORGE R. DELAMATER
Assistant Vice President, The W. S. Tyler Co., Cleveland, Ohio

Mr. Hebley made mention particularly of the fine mesh screening. You might be interested to know that we are screening now down to 20 or 28-mesh, that is, taking coal at the normal moisture content and making screening efficiencies up around 80 and 82 per cent. One of the problems, of course, when we undertake a job of that kind is the free or surface moisture content of the coal. If the moisture content of the coal is high periodically, that is, sufficiently high to cause a complete binding of the cloth, it can be bypassed at such a period, but if it is quite constant, then it is necessary to supply sufficient screening equipment to take care of that condition.

I would not lead you to believe that it is possible to dry screen at 28-mesh where the moisture content is so high as to cause a stickiness of the coal. At such times it will form a coating over the surface of the cloth, and in some instances would necessitate brushing of the cloth after that wet coal has passed. The effort that we have been making in the last few years has been to develop a screen which would self-clean afer the wet coal is passed, and we have been quite successful in accomplishing that result.

Some of the pictures that were shown on the screen, one in particular, a double-deck type 600, as referred to by Mr. Hebley, is a southern Indiana installation, in which the coal comes from a strip mine, exposed to weather conditions and the moisture is very high at times. It was found necessary to wet screen first at 5/16-in separation and then to dewater the ¾-in. x 5/16-in. coal on the top deck of that machine and the 5/16-in. x 0-in. coal on the lower deck.

Both decks of the machine were equipped with 28-mesh stainless steel facing cloth over a backing cloth, each independently stretched. One of the problems we ran into in that work was the life of the stainless steel decks. Frankly, when we first started, if we got two 7-hour shifts we were doing pretty well. We have improved that now so that we are running up to 8, 10 and 12 and even as high as 14 months in the life of the facing cloth. In that particular instance the coal that passes through the 28-mesh deck with the water is a very high ash and a very high sulphur material, so that it is entirely wasted.

The type 400 screen which was shown on the screen and was mentioned as a typical installation, is a 28-mesh dry installation in southern Illinois. Those are 4-ft. x 8-ft. decks. The stainless steel facing cloth is supported on a 2-mesh rolled backing cloth, and the capacity of a screen of that type, at 28-mesh separation, is about 30 tons per hour of feed.

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MINE LOCOMOTIVES

By CARL LEE
Peabody Coal Co., Chicago, Illinois

The subject of "mine locomotives" is more or less familiar to all mining men, so it is difficult to offer much that is entirely new.

The first electric mine locomotive was put in service about 1887, or just about a half century ago, which is within the memory of a number of those present. Of course, the first locomotives were somewhat crude, both electrically and mechanically. The electrical art was very young at that time so that the power units were inefficient and unreliable as compared to those of today. The mechanical art, though much older, was not nearly so perfected as today.

The tracks and rolling stock were quite different from that of today.

There are a number of locomotives running today which were built some 30 or 35 years ago, but they are generally found on light-duty work.

The modern locomotive is a product of evolution in that many changes of smaller details have been made in the course of years, rather than any one general major improvement. Even today those minor improvements are being continued.

In the following, an attempt will be made to enumerate some of the items on which the manufacturers have made improvements in recent years.

Controllers

Controllers with improved blow-out coils, automatic oiling device for contacts, removable arc deflector, hinged arcing chamber, renewable fingers and contact tips and non-stubbing fingers, etc., offer quite an improvement over earlier controllers.

One company has developed the "ground potential control," which enables large locomotives to be handled with a drum controller, with the final break made by means of a contactor.

Otherwise most locomotives from 15 or 20 tons up make use of full contactor control on account of the limitations of a drum controller for this service.

One manufacturer makes use of semi-electro-pneumatic control as a variation of ordinary electric contactor control.

Improvements have been made on the explosion-proof control. One detail is the elimination of the nitrous acids within sealed enclosures, by means of a small ventilating unit, with the air passing through special labyrinth chambers to make that path non-explosive. This should reduce the trouble and expense on maintenance of this type of equipment.

Terminal Blocks

One manufacturer makes use of terminal blocks on the motor shells, rather than connectors, with the object of simplifying, testing, and disconnecting.

Cable Ducts

One manufacturer has laid out ducts along the frame of the locomotive to carry the wiring rather than use the bundles of cables ordinarily found.

Rheostats

The majority of the modern locomotives are equipped with continuous ribbon rheostats. In fact many of the older locomotives with cast-iron rheostats are being changed over and equipped with the continuous ribbon-type rheostat.

Headlights

The matter of headlights has been given considerable thought. The arc headlight is the most powerful but has some drawbacks such as maintenance and flickering light and no light on low voltage. The incandescent light using 275-v. lamps is quite fragile and does not stand up. The use of a low-voltage lamp such as 32-v. provides a rugged filament and less replacement cost. There is a lower efficiency due to the series resistance required. A number of installations have proven quite satisfactory.

Other Electrical

The manufacturers continue to improve the motor itself with better parts such as brush holders, brushes and coils and connections. For severe duty grade "B" insulation is being used, despite the increased cost and the complaint about the effect of moisture on asbestos coils.

Tests are in progress on a new insulation which may to some extent displace asbestos. This is glass which has been blown to microscopic threads and then felted or woven into insulation fabrics. The tests are not yet old enough to make any sure prediction as to the ultimate usefulness.

Mechanical Frame

One manufacturer points out improvements in strengthening and streamlining the frame itself. Another mentions improved structural steel welded bumpers.

Brakes

Two or more manufacturers point to the advantage of lever brakes for gathering locomotives, where frequent and quick stopping is desirable.

Equalizers

Nearly all the manufacturers now realize the importance of a good spring suspension to permit the locomotive to go over rough spots in the track without trouble. To provide the above and the maximum in stability on the track, and provide smooth riding, use is now generally made of some form of equalizer. Depending on various features, these may be transverse or longitudinal in type. If conditions permit it appears that the longitudinal are simpler in construction.

Gears

The gears and pinions have been improved so that under favorable conditions long life may be expected. Solid gears, split gears, or solid center removable rim gears may be obtained.

Gear Case

A three-piece gear case is offered which facilitates inspection and simplifies removal of the armature.

Axle Caps and Linings

One of the weak points in most of the older locomotives is the maintenance of the gear centers. This is due to wear on both the armature bearing and the axle bearing. For a number of years the manufacturers have been equipping the armatures with ball bearings. This served a double purpose. One to maintain gear center, and the other to keep the lubricant off the armature, particularly off the commutator. However, until recently the axle cap bearings have been plain brass or alloy liners with both ends open to abrasive dust. As a result of the lubricant and abrasive dust combining, an effective grinding compound formed, and as a result the linings and the axles themselves were worn rapidly.

Nearly all the modern locomotives now have improvements on this item. One improvement is the long axle cap; that is, the axle cap extends the full length of the motor shell and is bolted at both ends, taking the place of the two separate caps. Another feature is in providing labyrinth seals at each end of the long axle cap to much better exclude the abrasive dust.

This combination should give much better service and life than the older method.

Some applications of anti-friction bearing to axle caps have been made on new designs, where it is possible to do so, but adoption to old or existing motors is questionable.

Anti-Friction Journals

Quite considerable progress has been made in application of anti-friction bearings to the journals. This is possible on old as well as new locomotives. The result should be a saving in maintenance, lubrication, and power.

Demountable Tires

Tires which are demountable by means of bolts are obtainable and should have some advantage, particularly when used with the improved axle caps and journals, which eliminate frequent changes of liners or axles.

Air Brakes

On some of the larger locomotives use has been made of air brakes.

Blowers

Mine locomotive motors have been manufactured under the basis of one hour rating. This is nearly twice the rating on a continuous-duty basis. The one hour rating applies very well to gathering locomotives and even main-line locomotives on short hauls or variable grades. In the latter case there are limiting grades which determine the maximum size trips which can be handled, and hence the motor is underloaded on other sections of the run.

However, when a locomotive is placed on a long haul which is nearly level, the limiting load is increased and is more continuous. In such a case the mine management is inclined to continue to add to the size of the trips with a result that the motors are overheated due to continuous load greater than one-half the hourly rating. The improved coils of Class "B" are used to offset this limit to some extent.

Another method is to apply forced-draft ventilation by means of blowers. When this is applied to totally enclosed motors it serves to materially increase the continuous capacity, depending on the volume of air put through the motors. With sufficient air the capacity for continuous service is almost doubled. However, the one hour rating is only slightly affected, as that is dependent upon hot spots in the coils, and upon brush capacity and commutation.

Slow Speed Locomotives

Several years ago it was realized that the duty for gathering was quite different from haulage. In gathering the work requires many starts and stops, and very seldom any high speed. With the conventional rated locomotive of trolley and reel type a large per cent of the power is wasted in the rheostat, due to acceleration. Seldom does the locomotive reach its full speed at rated load. From theory and by actual tests it has been proven that a gathering locomotive with a full load rated speed of 4 miles per hour will gather, under certain conditions, as much coal as one rated $6\frac{1}{2}$ miles per hour, and take 25 per cent or better less power from the line than the faster locomotive. Furthermore, both locomotive and track maintenance is reduced.

Storage Battery Locomotives

Following the reference to slow-speed cable reel and trolley locomotives it becomes apparent that the usual rating for a battery locomotive just about meets the desired requirements, also the absence of trolley poles and reel make the operation simpler for the motorman. Furthermore, in concentrated mechanical mining the presence of trailing cables offers some difficulties which are eliminated with use of battery locomotives.

Considerable trouble was encountered with early battery locomotives due to the batteries being too small. Apparently the jobs were engineered too closely, or without due regard to the absolutely limited power supply available from a given battery.

One company has paid particular attention to this angle of design and have engineered the locomotive around the battery. The object is to give maximum traction at or near standstill with a minimum drain from the battery, and also to then provide proper traction at average speeds with reasonable efficiency. Certainly if these latter conditions can be fulfilled, then it is easier to accommodate some excess battery capacity which is essential for successful use, to take care of accidents and other contingencies.

Conclusion

Thus we see that modern locomotives are a result of many different features of improvements, each made to bring about adaptability, reliability, accessibility, efficiency in operation or economy in maintenance.

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SAFETY TRAINING FOR EMPLOYES

By JOHN LYONS

Safety Engineer, Bell & Zoller Coal & Mining Co., Zeigler, Illinois

It is not my intention to direct or suggest how you should train your employes in accident prevention work, but to outline the methods which our company has used with an appreciable measure of success.

Our first problem in the program was to convince all of our employes that "Safety First" was not merely a phrase, but was an essential part of their day's work. To accomplish this, it was first necessary to sell "Safety First" to our bosses, and one of the best arguments we used in this connection was to be able to show them the relative standing of our company in frequency and severity rates of accidents as compared with other companies in our field that have adopted safety programs. The computation of these rates are in accordance with the standard methods as prescribed by the U. S. Bureau of Mines and the National Safety Council. We have found that this system will give fairly accurate comparisons.

An unbiased report of the accidents at our mines such as made by a representative of the U. S. Bureau of Mines, after an extensive survey of the mines in question, revealed many unsafe practices that needed elimination, and also brought to light the incorrect attitude of some of our foremen towards "Safety First," which had to be changed, and it was obvious that training was needed under two headings, as follows:—

1st—Training of Foremen.

2nd—Training of Other Employes.

The training a foreman receives, prior to his going before the Mining Examination Board for his mine examiner's or mine manager's certificate is excellent, but not enough. This training includes such fundamentals as good ventilation, proper gas testing and rock dusting, and if properly learned and applied, are sufficient to prevent major accidents, but it does not, however, take in that training necessary to prevent the individual accidents which take heavy toll on our men. Therefore, additional and continuous training in these phases are of vital importance to any program of safety training.

We believe the training of the foreman comes first because it is he who must carry to the workman the safety policy of the company.

Training of Foremen

In order to make them safety conscious, they should be taught that they have, in some part, a responsibility for every accident that occurs to any employe under their supervision. This is stressed at our monthly Foremen's Safety Meetings, where they describe how the accidents occur and what is being done to prevent a recurrence. In serious accidents, they are questioned by the Superintendent, Mine Manager and Safety Engineer. Supplementing this, the report of the Safety Engineer on the accident is used as a basis of the questioning. This report shows circumstances, causes, recommendations and, if possible, the responsibility for the accident.

For example: "A" was a gang machine runner. He backed his cutting machine out of a panel entry on to the cross entry, then reversed the machine to go down the cross entry. Traveling a short distance, he noticed the switch ahead was lined in the wrong direction. Throwing his hot hook on the machine, he jumped off and attempted to run ahead of the moving machine, and in so doing, he slipped on gob that was on the side of the entry, fell on the track and the machine ran over his foot.

Causes: (1) Man falling while attempting to pass a moving machine.

(2) Gob left too close to the track, which should have been cleaned, even for efficiency.

Recommendations: (1) That men do not attempt to run past moving machines.

(2) That gob be cleaned up on both sides of the entry around the switches.

Responsibility: In this case it was about equally divided between man and management. Either of the causes, if removed, would have prevented the accident. From the foreman's viewpoint, it was the man's fault entirely as he should not have run past the moving machine. He did not look at the accident from the angle that if he had cleaned the gob off the side of the entry, the man would not have fallen on the gob, even though he did attempt to pass the moving machine.

Necessity of Foreman knowing Unsafe Practices which he should prevent employes from practicing—such as:

Riding cutter bars of mining machines in transit.

Coupling cars on the inside of curves.

Men getting on or off moving man-trips, or at points where trolley wire is not guarded.

Stepping on bumpers of motors or cars moving towards them.

Allowing tripriders to couple cars on the fly.

Loading between car and face without car being securely blocked.

Sumping cutting machines on fast feed.

Switches not re-lined, and blocked to prevent run-away cars from entering the place in which they are working.

Trappers leaving doors open causing methane to accumulate, which may be ignited by electric drills or cutting machines.

These and many other practices, if allowed to continue, eventually lead to accidents simply because the foreman was lax in his duty.

The Illinois State Department of Mines publishes a monthly bulletin on mine fatalities, a copy of which is furnished to each of our foremen. We also furnish them with an operating manual which covers:

(1) General safety rules.
(2) Man-trips and riding on haulage motors.
(3) Locomotives and track.
(4) Cutting machines.
(5) Face preparations.
(6) Loading machines.

It is essential that the foreman have a heart to heart talk on safety with his new men, explaining the hazards of his occupation and any particular hazard that he has in the geological formation in the seam working in his section such as facings and slips, hills and the number of cars a motorman can safely handle on such grades. Several years ago a motorman was sent into a strange run. He brought out more loads than he could hold back on a hill. The cars jumped the track due to the speed and the trip rider was killed.

Safety Standards

Foremen should follow closely the safety standards of the company, such as: Clearances between track and concrete piers, props or ribs, especially where loading machines are used; double bridle bars on main haulage switches; refuge holes at switch throws, and so on.

Safety Rules

Foremen must be familiar with and enforce safety rules. This is essential for safety and for the protection of the company where the violation of such rules has resulted in an accident. We post the rules and also give each employe a copy of the rules.

Training of Employes Other Than Foremen

At the beginning of our efforts to put "Safety First" in effect at our properties nothing helped us more than the Bureau of Mines 100 per cent First Aid training classes. At these meetings we were able to gather the men together and candidly discuss our accidents, not omitting to show our own responsibility in the accidents discussed. Safety was talked to show the necessity of prevention rather than having to use first aid later, without, however, depreciating the value of knowing what to do in the case of an accident.

In conjunction with our safety rules and a campaign to eliminate unsafe practices, we used colored posters especially drawn for us illustrating the rule and how accidents were caused through unsafe practices, showing also the safe way. In addition to these we use the National Safety Council posters and give to each employe one of the Council's safety calendars. Whenever possible, scenes of accidents were photographed and reports on such were posted on our bulletin board.

We publish an eight-page Safetygram monthly and give each employe a copy of it. This Safetygram describes accidents, gives ratings of the mines and bosses, and general safety news concerning our employes.

We also use a loud speaker system to reach our men while in the man-trips on the shaft bottom or in the wash houses, giving safety talks over the system. This underground radio system was described in the 1936 Coal Mine Mechanization Yearbook of the American Mining Congress.

One of the educational exhibits which we have used for a year and which creates a great deal of interest in Safety is the Tru-Tu-Life Safety Dramalogue. This consists of a glass fronted box which is constructed to represent a stage. The background scenery is that of some part of a coal mine. In front of this, stationary cut-outs of men, cutting or loading machines, motor, etc., are placed on the stage to visualize some accident that may occur through unsafe working. The safe way is also shown. There is also a moving belt on which is printed an admonition pertaining to the scene being shown. The whole scene is well lighted by inside lighting. Scenes, figures and belts are changed weekly, picked from a variety of 90 different scenes which are now available, while new ones are also being added. This service has separate lists to cover mechanized or hand loading mines.

We have also conducted study courses for students seeking Certificates of Competency as mine managers or mine examiners and I believe firmly that the degree of success obtained by any company in promoting a safety campaign over an extended period depends entirely upon the combined efforts of the supervisors and executives. Interest in the campaign must be maintained and occasionally revived through new ideas presented to the employes. A let down on the part of the executives will be directly reflected in the results obtained by the local supervisors in daily contact with the men. Keeping the safety programs constantly alive can be compared with an advertising campaign. The same thing must be presented in numerous ways and at each presentation must be so phased as to command renewed attention.

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DISCUSSION ON SAFETY TRAINING FOR EMPLOYES

SAFETY METHODS AND PRACTICES AT SEVERAL MINES IN THE STATE OF UTAH

By W. N. WETZEL

General Superintendent, United States Fuel Co.

Because of the fact that we have not had the opportunity to read Mr. Lyon's paper, "Safety Training for Employes," we cannot attempt a discussion but will briefly describe methods and practices at several mines in the state of Utah.

It is our belief that a successful safety program must be based on training, supervision, tolerance and discipline. The supervisory force must first be well trained in all the essential safety measures, and it must be made up of men with ambition, initiative and courage. It is perhaps best that these men be developed within the organization which expects to use them as foremen or supervisors.

In Utah the production per mine per day will average about 1,750 tons and in order to supervise the underground working force it is usual to employ the following:

(1) One safety engineer who may have supervision over a group of mines.

(2) One superintendent, who has general charge of one or group of mines.

(3) One mine foreman, who has charge of all underground work and is held responsible for the safety of the entire underground force.

(4) One assistant foreman who is second in charge of all underground work.

(5) One fire boss, who examines all working places prior to the time that the working force goes into the mine.

(6) Two or more shot inspectors, whose duty it is to deliver electric detonators to the miners, examine undercuts and drill holes to eliminate the danger of solid shooting, check all men out of the mine at the end of the shift, then fire all shots by electricity from the surface, after which they again enter the mine to examine all working places to locate misfires, fires, or any dangerous condition.

(7) One crew foreman with each loader unit.

(8) One pillar foreman with each 25 to 30 pillar miners.

It is the duty of all of the above to use care in the selection and placement of the men on their crews, this with special reference to each man's qualifications for the type of work which he will be called upon to do. Instructions are given as needed, and every place must be made safe before work is allowed to proceed. Monthly foremen's meetings are held which are attended by all of the foremen, and by the safety engineer, the resident engineer, and the superintendent, with occasional attendance by the general manager.

At these meetings accidents which occurred during the preceding month are discussed and suggestions are made as to how a recurrence may be avoided. General safety practices are analyzed and all are expected to criticize any method or thing which they may feel is not conducive to safety.

Bonus payments are made to all foremen with perfect accident records extending over a period of a month or more. These payments vary in amount from $5.00 per month to $25.00 per month for a perfect record of six or more months. These payments have proven to be of help in reducing the number of accidents.

Workmen are trained by receiving instructions from the foreman, while at work, and in general employe meetings which are held about four times each year. Since it is our belief that every employe must be fully safety conscious, if frequent accidents are to be avoided, every possible means is used to promote this end. Safety bulletins are posted in conspicuous places, with regular changes of bulletins once each month.

Once each year 100 per cent first aid training is given by the United States Bureau of Mines. It is our opinion that this training has done more to help in our accident prevention program than has been accomplished by all of our other efforts combined. At some mines this training has been given each year for the past eight years and as the employe turnover has been quite low we now have a group of employes who are fully safety conscious and who are well trained to act in any emergency.

All men are carefully checked into and out of the mine on each shift. Men are hauled into and out of the mine on regular man trips. Powder is taken into the mine in an insulated powder car. This is done during an off shift period. Electric detonators are carried into the mine by the shot inspector who must walk to and from the working places. All shots are fired, electrically, from the surface, after all men have been checked out of the mine.

A spray of water is used on the cutter-bar while undercutting, and where the coal is dry a similar spray is used on the gathering head of mechanical loading machines. Every working place is well ventilated and rock dusting is done on all main and gathering haulage roads. Room faces and pillar places are wet down as needed with a water spray applied under pressure through a hose. Timber is placed when and as it is needed.

Electric cap lamps are used by all underground men and no matches or smoking materials are permitted underground. Electric trip lamps are used on all trips on the main haulage roads. Care is used in the placing of trolley wire and it is guarded when necessary.

The use of hard hats and hard-toed shoes is compulsory. These items have proven their worth to our employes and we no longer have any trouble regarding their use. However, it can be said that this was not always true and a certain amount of tolerance, as well as discipline, was needed to bring all of our employes to the point of favoring these articles.

The use of goggles is also compulsory, but we have not yet succeeded in securing 100 per cent cooperation in their use. When needed, prescription goggles are provided, and as we have already had ample proof that the use of goggles will save eyes we find resistance to their use gradually diminishing. We expect that in the near future all of our employes will consider goggles as a necessary part of their regular equipment.

Although our safety record is not perfect we have made progress and hope for still better results in the future, since we now know that accidents do not just happen and that many can be prevented by an alert, conscientious, and when necessary, hard boiled, supervisory force. Following are the 1937 accident statistics at one of the Utah mines with which the writer is most familiar:

Man hours worked	237,090
Tons mined	273,259
Lost time accidents	3
Man days lost due to accidents	56
Accident rate per million man hours	13
Accident rate per 1,000 tons	0.011

Underground safety in the State of Utah is under the direct supervision of the State Industrial Commission. This body has promulgated rules and orders which are in accordance with the best known safety practices. The inspectors who are employed to enforce these regulations are men who have had practical operating experience and they use good common sense when issuing orders or demanding that certain things must be done. For these reasons we have found their suggestions helpful and we try to cooperate with them in every way possible.

(Reprinted from American Mining Congress 1938 Yearbook)

DISCUSSION ON SAFETY TRAINING FOR EMPLOYES

SAFETY METHODS AND PRACTICES AT SEVERAL MINES IN THE STATE OF UTAH

By EUGENE McAULIFFE
President, Union Pacific Coal Co., Omaha, Illinois

I can only recite our own experience, which has been repeated a great number of times. I came to the Union Pacific properties 15 years ago, and while a great deal of work had been done toward reducing accidents, the end results were not very flattering. The first five years I was with the property we developed but 15,617 hours of exposure to each lost-time accident. May I say the next five years were almost equally discouraging. They gave us but 16,329 man hours, and then, through a change in our program, we effected in the third five-year period ending December 31, 1937, an average of 61,165 hours per accident. In the year 1936 we got 92,680 hours and the first three months of this year show 121,838 man hours of exposure per lost-time accident. So far this year we have had no fatal accidents. That represents a most extraordinary increase in accident reduction, and the number of accidents both fatal and non-fatal has been reduced in the same relative proportion.

The point is, how did we accomplish that? I think in the first 10 years I was with the properties, the organization displayed all the genius it was in possession of. We tried to move our men toward accident reduction. We spent in those 10 years on accident work alone—I am speaking now of direct expenditures—something over $1,019,000, with but negligible results expressed in accident reduction.

We live in a country where a very important and a very efficient church organization largely dominates. The basis of that religion is founded on Revelation. Somehow, in some way, we developed a revelation, and the thought was to offer awards to our men, cash or something else that would appeal to them. So in the last half of 1931, we offered two automobiles of rather substantial value, fully equipped with every known gadget that was sold to glorify the automobile of that time, and these machines were awarded through the medium of a lottery, carefully conducted, a ticket given to every man who did not suffer a lost-time accident in the six months' period. To our joy, our accidents went down and the man hours of exposure per accident bounced up, and since that date we have been making a continued improvement, I think very largely through the medium of the prizes offered.

We are all gamblers. A man who drives an automobile takes a chance or two every day he drives. We don't go into a business proposition without taking a chance. Some of us save a thousand or two thousand dollars and thereafter invest it in stocks or bonds. We know that we are taking a chance. So I think there is something inherent in the human animal that makes him partial to chance taking, and that is the characteristic that we have attempted to capitalize on.

We still give one automobile annually, and we give cash prizes monthly. I won't go into that in detail, but the point is that we all feel that it is these prizes that have won the interest of the men. The most remarkable thing that we have experienced, perhaps separate from the reduction in accidents, is the fact that our men turn out cheerfully now to the safety meetings, which are always run in connection with the awards. Human nature is a peculiar quantity, and I think one of the troubles of the mining industry, and perhaps a lot of other industries, is that we don't try to get down into the souls of the men whom we employ. They are tremendously sensitive, sensitive to good treatment and equally sensitive to indifference.

To illustrate that, we found that when under our system a mine was cut out of the prize contest for the month by reason of a man's receiving an injury on the third or fourth or fifth of the month, there was an unconscious let-down on the part of everybody for the remainder of the month. A kind of "what is the use," "we are out for the month" attitude. That hurt us.

Then we went ahead and undertook to beat that situation by establishing another series of awards consisting of merchandise, of a novel and perhaps rather seasonal character. Every man, regardless of whether or not he had had an accident, was privileged to attend and participate in that award. Strange to say, that improved the situation. The men apparently lost that indifference that sometimes came after the first accident in the early part of the month.

So above all the things that Mr. Lyons talked about—and I think we tried them all and tried them assiduously and conscientiously—we won our first real betterment by winning these men through a lottery and a prize award.

All mining men are interested in the cost of workmen's compensation. Just a word on that subject. We maintain a close record on total cost of workmen's compensation and also the actual payments made to injured men and their dependents. Suffice it to say that during the year 1937 the amount paid in awards to our employes and dependents was but 51 per cent of the amount paid during the first five-year period, 1923 to 1927, inclusive. The measure of the awards provided for in the revised compensation act approximate 25 per cent higher in 1937 than was provided in the five-year period referred to.

May I attempt to stress another point—that is you cannot pull up your safety record without pulling up your general mine efficiency. I think that much of the reduction we have made in our mining costs over the period have been due to our safety campaigns although such was not directed to that end.

(Reprinted from American Mining Congress 1938 Yearbook)

REDUCING HAULAGE AND MACHINE ACCIDENTS

By DAVID W. JONES
Superintendent, Princeton Mining Co., Princeton, Ind.

To reduce haulage and machine accidents, two factors must be taken into consideration. These are the human element and the material element. Thinking mathematically, we would say the product of these two elements is the answer to our problem. If the product has a positive result, the answer will be a reduction in accidents. If negative, the opposite answer will result in an increase in accidents. To insure that the product will be positive and accidents will be reduced, we must analyze the two essential elements.

The first one, the human element, is a variable in every sense of the word. We cannot predict what any human will do in an emergency or even under normal conditions. The best we can do is to surround a man with material conditions conducive to safety. Working conditions are of a material nature. Therefore, the second factor of our product is a material element, and it can be dealt with as a constant. Material conditions or setups may be changed in different ways and when found right, can be reproduced and continued. In other words, when a formula for some working condition is developed over a period of time and no accidents occur, we have reason to believe that the human element and the material element are in proper balance or continued safety would not be the result. The surrounding conditions must be suggestive to safety or, in time, reactions will have a tendency to become negative and result in accidents.

So far, we have been thinking and dealing with men and equipment in an abstract and general way. Now, we will apply these thoughts to real conditions and consider, say, a motorman and a haulage locomotive. These two elements, one human and the other material, are a formula which must be put in balance. If the locomotive is of the gathering type and has two trolley poles there will be three knife switches, ordinarily, for the motorman to operate in order to connect the controller to either one of the trolley poles or the gathering reel. The variable in this formula is the motorman. The three switches are constants and will operate correctly indefinitely if the motorman makes the mistake of attempting to transfer power from one pole to the other or to the reel with the controller open. When this oversight occurs there will be a flash, the switch may be destroyed and the motorman perhaps badly injured. Such accidents do happen and frequently. The setup in this case is not right for safety. We do not have Divine power to alter human elements but we can change the material layout so there will not be a personal injury when a mistake is made. Eliminate the knife switches by the use of magnetic contactors, fully enclosed, then the damage will be to material and not men.

In locating trolley poles on locomotives, they should be placed in a definite and not haphazard position, within convenient reach of the motorman. When this is done, the

Goodman loader with track cleaning head.

trolley wire must be hung in a systematic and uniform way. If a motorman must continually guide the trolley pole on the wire, he is not getting an even break towards preventing haulage accidents. The placing of the trolley wire should be determined by the height of the roof and the size of the mine car. When the proper location has been established, there should be no variation in position.

Locomotive controllers and resistances can be maintained in better and safer operating condition by the use of the continuous steel strip wire instead of the old conventional cast iron grids. Resistors should be built for the type of service required, and if continuous use is necessary to operate the locomotive, the material should be suitable for continuous duty and not for the intermittent duty usually expected of them. The controllers should be designed for most rugged service on a mine locomotive. The primary type of controllers, for breaking heavy currents, should be limited to locomotives under 15 tons, and the secondary type of controllers, for operating magnetic contactors, should be used to break the secondary small current in order not to expose the motorman's cab to unnecessary electrical hazards.

Brake riggings on a locomotive are subject to constant wear. Continuous inspection and adjustments are advisable to keep them effective. Looseness in takeup caused by pins wearing, linkage holes becoming enlarged, and worn journal box guides account for many haulage wrecks when brakes fail to hold.

For the triprider's safety and convenience, suitable steps, grab irons and seats should be provided. The triprider has a hazardous job under the best of conditions and anything done for his safety and protection will eliminate accidents.

When laying track switches, it is the best practice to include the regular switch throws and not economize falsely by incomplete instal-

Loader cleaning track.

Track cleaned with mechanical loader.

lations. Where throws are not installed, someone should be assigned to keep the switch points cleaned out in order that they can be moved with little effort. If a triprider must kick a switch point several times or even use a tie to pound it over, a serious hazard exists and eventually an accident will occur.

Tripriders should not be permitted to jump on and off locomotives or cars while they are in motion, and certainly they should not attempt to make car couplings on the "fly." Any mine which permits such operations will in time have an accident record reflecting outstanding recklessness in haulage.

Mine haulage has developed along the same lines followed by steam railroads. The first cars were of wooden construction and accidents to trainmen in coupling cars increased in direct proportion to the number of cars built. In time these accidents resulted in the compulsory use of automatic car coupling devices on all railroad cars. Later, after many lives were lost in train wrecks by pasengers riding in wooden coaches which collapsed like egg shells, legislation forced the building of steel cars. Even automobiles have been benefited by developments made in steel car construction. In the last few years, steel mine cars have demonstrated their value in coal mines and now this construction is considered standard for new installations and replacements. Automatic mine car couplers have been perfected along with the steel cars and have proven their worth in efficiency and safety of operation. Larger types of mine cars may have all of the advantages and improvements of railroad design, even to the use of trucks and journal springs. By applying railroad standards to coal mine haulage construction, it should be possible to make haulage wrecks in coal mines the exception instead of regular occurrence.

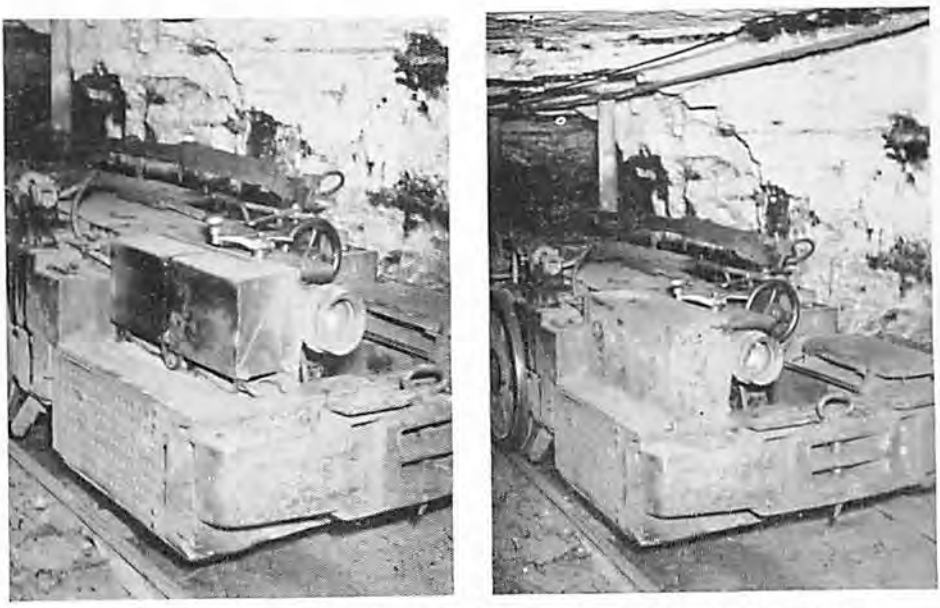
Trolley pole on loading machine.

After all precautions have been taken to design the rolling equipment for safe operation, the roadway, ribs and roof must be maintained in condition to prevent accidents. For a given weight of locomotive and cars the rail must have sufficient size for rigidity. The ties and roadbed must be adequate for the speed of trips and density of traffic to be handled. Curves and grades must be reduced to a safe minimum and sufficient power made available to meet the rated horsepower of locomotives for efficient and safe operation.

Trolley feeders and return must be of ample size to carry the capacity of the generating equipment without excessive voltage drop. If the rails do not have current carrying capacity equal to the trolley wire and feeder, a return feeder should be installed to parallel the track.

Precautions should be taken on grades to prevent an accident should

Locomotive showing location of knife switches.



Two views showing knife switches eliminated and enclosed contactor switches installed.

a trip break in two. If the grades are steep, a trailing locomotive is the most reliable means to insure safety, but for slight grades a trailing drag on the last car will suffice to stop a detached trip.

Rear end markers should be placed on ends of trips for the protection of anyone following the trip. Illumination of haulageways is well worth while, and although it is not necessary to place lights along the entire way, the swags, hills and curves should be lighted at strategic points so that the motorman will have assurance that the right of way is clear within his safe stopping distance.

If stationary car hoists are used for the assistance of locomotives in pulling trips up severe grades, spring throw switches should be placed at suitable places and set to derail a trip should it run backward due to a coupling failure or lack of power.

The roof along haulageways should receive equal or more safety consideration than the roadbed. If cross bars are used the legs should be set into the ribs in such a way that a derailed car could not knock them out. For a long stretch of bad top where cribbing is necessary, stringers, supported on stub rails set into the ribs, will provide excellent support for the cross bars, permitting them to be placed at any desired spacing. If height is limited, cross bars can be placed solidly against the roof over the track and supported on stub-mounted stringers along the ribs, eliminating the use of wedges over the cross bars.

Ribs should be made for suitable clearance along haulageways. If men are required to work in places where the ribs are close, refuge holes should be made at frequent intervals and lighted for the safety of timbermen, trackmen and haulagemen.

Clean roadways are essential to safety in haulage. It would be profitable to clean roads often enough to recover spilled coal before it becomes crushed and unfit for commercial use. In mechanical mines the road cleaning problem is solved by the use of loading machines equipped with a shovel on the loading head, fitted to the rails so that cleaning can be accomplished down to the ties and beyond the ends of them along the ribs.

Eye protection is of major importance in reducing haulage accidents. Close fitting rubber goggles have been found to be well suited for the use of motormen, especially when a clear vision ahead is essential for safety. A motorman requires all of his attention to operating the locomotive, watching for signals and possible obstructions

Electric drill mounted on locomotive.

Stub supports for roof stringers.

along haulageways. Any irritation caused by foreign particles in the eyes could result in distraction which might lead to a disastrous haulage wreck.

Tripriders and motormen should have a clear understanding of all signals given, and in most cases it will be found that mechanical whistles are preferable and more reliable than the varieties of tone and volume given by the mouth and tongue.

Safety caps and safety toe shoes have demonstrated their worth and benefit. In the future they are bound to be standard wearing apparel for motormen and tripriders. The full value of a safety cap is appreciated when once worn and the head is struck by a cross bar or the roof sufficiently hard to jar a man from head to foot. Safety shoes are not built for the purpose of protecting feet from injury when run over by mine locomotives and cars but many men today have toes on their feet saved from being cut off, by the use of safety shoes.

A motorman endeavors at all times to anticipate the movements of his triprider but many accidents happen due to the triprider stumbling and falling down or catching a foot in a frog or switchpoint. The triprider should make every effort to be within signaling distance by his light to the motorman in addition to the whistle signals given.

In mechanical mines, when serving loading machines, the motorman should not be coupled to more than two or three mine cars unless he has full control of the slack between cars and can observe the operation of the loading machine. In spotting cars under the loading machine, the car to be loaded should be moved in carefully and not allowed to strike the loading machine. Under usual loading conditions, the noise of the machine prevents the men at the face from hearing the movement of the cars and it is the duty of the motorman and triprider to protect them from injury which might result from the rough handling of cars.

Serious accidents happen to machine men, drillers and others working at the faces due to cars being dropped in on them without warning. Double protection, that of leaving the room switch open and a derailing device of some kind on the track, will prevent accidents,

Safety hat after protecting against roof fall.

and lessen the danger to men working at the face ahead of mine tracks.

Shortwall and track mounted undercutting machine chains and electric drill augers take regular toll of life and limb on account of being unguarded. Many ideas have been suggested for telescoping guards to prevent men getting in contact with the revolving parts but no practical solution has been found. Something must be done to guard this type of machinery before machine men and drillers will have the protection necessary to prevent these accidents, which are usually of serious consequences.

After every effort has been made to make operating conditions suggestive to safety, we must use means to make the men safety conscious. First-aid training classes provide the vehicle for discussions along safety lines and should be encouraged. Regular safety meetings and gatherings are essential for presenting safety ideas. Unfortunately, it usually is necessary to encourage attendance by some means of bank night awards.

Joseph A. Holmes Safety Association meetings held once each month are a sure means of conducting safety along organized and planned lines of procedure. At these meetings the routine business is conducted and then operating hazards are discussed. A description of each lost time accident since the last meeting is given by someone who has investigated the accident or was a witness to it. The cause of the accident is developed and action suggested to prevent a recurrence. A prepared paper on some subject in which the men have a direct interest will keep discussions along desired lines, or a moving picture of educational value will be the means of making the men think that the time spent at the meeting has been well worth while.

It is true that accidents cannot be prevented at such meetings but the afterthought of some discussion or suggestion, carried away from the meeting by the men, might at some future time be the means of making a man safety-conscious when he is about to do something likely to cause an accident.

In the final analysis, to reduce haulage and machine accidents, men must be made safety conscious and kept that way by safety suggestions and education. It is equally essential that the equipment and machines the men operate and live with must be built along lines suggesting safety. Then, each individual will feel that he will be the one responsible if an accident occurs.

Presented at Silver Jubilee Safety Congress and Exposition, October 12, 1938, Chicago.
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MECHANIZED MINES vs. NON-MECHANIZED MINES: THEIR RELATION TO SAFETY

By PAUL WEIR
Consulting Mining Engineer, Chicago

At the very beginning, it is perhaps desirable to attempt to set forth just what particular phase of such a broad subject will be discussed in this paper. It is hardly within the experience of anyone to speak with any degree of authority on all types and kinds of mining, hence some arbitrary limits must be established. The term "mechanization" as commonly used in coal mining has to do with the loading operation at the face. When mechanical loaders and/or conveyors are used at the face the mine is said to be "mechanized." Almost without exception, when the face operation is mechanized, the coal is cut and/or sheared mechanically, shot holes are drilled mechanically and transportation is by mechanical means. In the usual non-mechanized mine, coal is cut and/or sheared mechanically, shot holes are drilled by hand and transportation may be mechanical or animal. In general this paper is based upon experience with completely mechanized bituminous coal mining in Franklin County, Illinois. However, the experiences of any one may be profitably applied with modifications to the problems of others. Because of the possibility of controversy and to prevent triteness, the accident records of that county for the past 18 years will be presented and discussed, after which some general observations will be made.

Franklin County is selected for a "case history" for many reasons. It is a district with which your speaker is thoroughly familiar. It represents a large, closely knit unit of production. All mines are shaft operations, work in the same vein, are large, modern and well equipped. There are no local or truck mines in the county. Management through the years has changed but little. The large majority of production comes from companies operating the same mines through the years. Practically all of the present personnel has been in the district for many years. Practices and systems of mining are similar in all mines. The vein which is being mined is the Illinois No. 6 which is from 350 to 600 feet below the surface of the level prairie. The total thickness of the vein is approximately 7½ to 15 feet. Natural conditions are unusually uniform over a wide area. Perhaps the most pertinent reason for selecting this county is that it pioneered in mechanization and today is one of the largest units of almost completely mechanized production in this country. In addition to this, data on accidents and production is readily available. In 1937 the mechanized production in this one county alone approximately equaled the mechanized production in the whole state of West Virginia, which state ranks number one in total production in

FRANKLIN COUNTY, ILLINOIS
ACCIDENT AND PRODUCTION RECORDS BY YEARS
1920 to 1937 inc.

Year	NUMBER OF — Operating Companies	Mines	Employes	Days of Operation (a)	PRODUCTION IN TONS — Loaded By Hand	Loaded Mechanically (b)	Total	FATAL ACCIDENTS — Other Than Gas Explosions	Gas Explosions	Total	NON-FATAL — Loss of 30 days or More (c)	(c) Total
1920	14	26	12,261	178	11,299,280	—	11,299,280	38	0	38	681	—
1921	13	26	14,264	195	12,723,700	—	12,723,700	32	1	33	834	—
1922	13	25	14,840	123	9,999,917	—	9,999,917	27	—	27	678	—
1923	12	27	16,231	162	12,845,459	—	12,845,459	27	—	27	663	—
1924	11	24	15,816	146	12,240,925	—	12,240,925	22	3	25	674	—
1925:												
(6 mo.) (d)	9	17	13,727	107	8,463,095	—	8,463,095	12	—	12	316	—
(fiscal year)	10	20	15,007	160	13,082,622	—	13,082,622	19	2	21	713	—
1926	9	18	14,543	183	15,741,550	—	15,741,550	39	5	44	—	2,111
1927	10	19	15,234	118	10,026,181	334,700	10,360,881	19	—	19	—	1,113
1928	10	19	14,259	168	12,457,400	1,621,523	14,078,923	30	21	51	—	1,631
1929	9	18	12,287	194	7,993,273	6,826,175	14,819,448	28	7	35	—	1,801
1930	8	16	10,670	171	4,422,788	7,574,559	11,997,347	18	4	22	—	1,214
1931	7	15	10,064	139	2,309,108	7,222,452	9,531,560	12	1	13	369	916
1932	7	14	9,441	110	1,752,262	5,312,097	7,064,359	10	—	10	230	624
1933	9	14	7,900	115	2,189,962	4,513,921	6,703,883	11	—	11	238	570
1934	9	15	8,407	130	2,414,568	5,365,594	7,780,162	20	—	20	183	578
1935	7	12	6,907	147	1,386,890	6,598,265	7,985,155	14	—	14	191	459
1936	7	15	7,697	144	624,172	8,807,968	9,432,140	19	—	19	203	486
1937	7	13	6,795	170	153,644	9,955,003	10,103,647	17	—	17	166	428

(a) Arithmetical average of all mines.
(b) Amount of coal loaded mechanically prior to 1927 is negligible.
(c) Data for certain years unavailable.
(d) July 1st to December 31st. Prior years are on fiscal year basis July 1st to June 30th.
(e) Based on number of employees times number of days of mine operation.
Compiled from Annual Reports of Department of Mines and Minerals, State of Illinois.

FRANKLIN COUNTY, ILLINOIS
ACCIDENT AND PRODUCTION RECORDS BY YEARS
1920 to 1937 inc.

		MAN-DAYS PER (e)			PRODUCTION IN TONS PER			
Year	Production Tons per Employee Per Day	Fatality Other than Gas Explosion	Non-Fatal Accident (c)	Non-Fatal Accident Loss of 30 Days or More (c)	Fatality Other Than Gas Explosion	Non-Fatal Accidents (c)	Non-Fatal Accident Loss of 30 days or More (c)	Percentage of Mechanized Production
1920	5.18	57,433	—	3,205	297,349	—	16,592	—
1921	4.57	86,921	—	3,335	397,616	—	15,256	—
1922	5.48	67,604	—	2,692	370,367	—	14,749	—
1923	4.89	97,386	—	3,966	475,758	—	19,375	—
1924	5.30	104,961	—	3,426	510,951	—	18,162	—
1925:								
(6 mo.) (d)	5.76	122,399	—	4,648	705,258	—	26,782	—
(fiscal year)	5.45	126,375	—	3,368	688,559	—	18,349	—
1926	5.91	68,240	1,261	—	403,629	7,457	—	—
1927	5.76	94,611	1,615	—	545,310	9,309	—	3.23
1928	5.88	79,850	1,469	—	469,297	8,632	—	11.52
1929	6.22	85,131	1,324	—	529,266	8,228	—	46.06
1930	6.58	101,365	1,503	—	666,519	9,882	—	63.14
1931	6.81	116,575	1,527	3,791	794,297	10,406	25,831	75.77
1932	6.80	103,851	1,664	4,515	706,436	11,321	30,715	75.20
1933	7.38	82,591	1,594	3,817	609,444	11,761	28,168	67.33
1934	7.12	54,646	1,891	5,972	389,008	13,460	42,515	68.97
1935	7.86	72,524	2,212	5,316	570,368	17,397	41,807	82.63
1936	8.51	58,335	2,281	5,460	496,428	19,408	46,464	93.38
1937	8.75	67,950	2,699	6,959	594,626	23,618	60,895	98.48

(a) Arithmetical average of all mines.

(b) Amount of coal loaded mechanically prior to 1927 is negligible.

(c) Data for certain years unavailable.

(d) July 1st to December 31st. Prior years are on fiscal year basis July 1st to June 30th.

(e) Based on number of employees times number of days of mine operation.

Compiled from Annual Reports of Department of Mines and Minerals, State of Illinois.

the United States. There is ample reason to believe that a study of mechanization in this county may furnish the basis for some conclusions.

Table 1 presents by years the accident and production records from 1920 to December 31, 1937. All of the data is compiled from the Annual Reports of the Department of Mines and Minerals. Through the years, consolidation of companies, purchases of properties and business failures have reduced the number of operating companies from 14 to 7 and the number of mines from 26 to 13. No new mines have been developed since 1923. Prior to 1927 mechanization was confined largely to experimental units. The growth of mechanization was largest in 1928 and 1929. During 1937 less than 2 per cent of the production was still being loaded by hand.

As noted on Table 1, days of operation as shown represent an arithmetical average of mines. The number of employees shown represents the average number on the pay-rolls. There has been and still is some sharing of work. For this reason for 1937 the actual number of man-days is slightly less than the number indicates. This same thing applies to some of the other years subsequent to 1928. In taking man-days as the product of number of employees times days of operation nothing is included for idle-day work. The data may not be suitable for comparison with other districts but within this district it permits the comparison—before and after mechanization. Whatever the errors, they are small and are constant in nature.

Frequency Rates in the Table have two bases, man-days and production. In calculating these rates, fatalities due to gas explosions are not considered because they can hardly be attributed to the state of mechanization. Data for certain years on non-fatal accidents is not available but what is available is sufficient to show trends.

Charts A, B, C, and D show graphically the data on Table 1. These charts may facilitate a quick understanding of trends.

Chart A

This shows a Frequency Rate for non-fatals based on exposure. The differentiation between 30-day accidents and the total of non-fatals comes through a change in manner of presentation in the Annual Reports. For sake of completeness both are shown where available. There has been a rather steady decrease in the frequency of non-fatals from the last year of non-mechanized operations to 1937, the year of almost complete mechanization. Likewise there has been a similar decrease in 30-day non-fatals. These decreases show unmistakable trends.

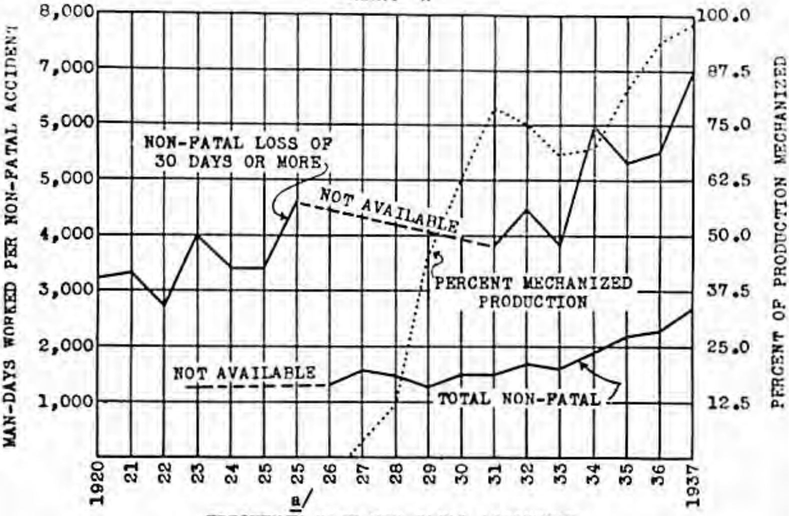
Chart B

This shows a Frequency Rate for non-fatals based on tons produced. As with Chart A, the trend towards an improved performance is unmistakable. Because of the increased production per man-day arising out of mechanization, the improvement is more pronounced than it is on an exposure basis.

Chart C

As previously explained fatal accidents resulting from gas explosions have not been considered. In passing it might be said that there have been no fatalities from this cause during the past six years. This chart shows that on an exposure basis the frequency of fatals has increased with mechanization. On a production basis, there has been little change.

CHART A

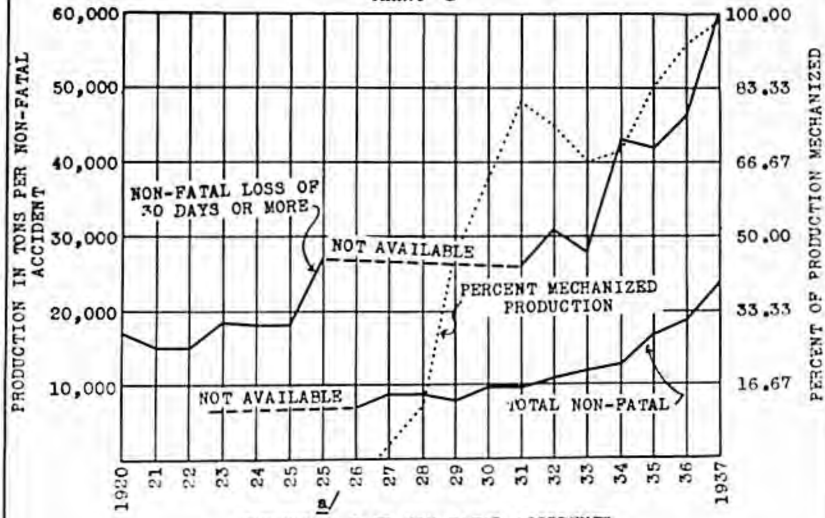


FREQUENCY RATE NON-FATAL ACCIDENTS

BASED ON MAN-DAYS WORKED

a/ Last 6 Months 1925 - Prior Years on Fiscal Year Basis

CHART B



FREQUENCY RATE NON-FATAL ACCIDENTS

BASED ON PRODUCTION IN TONS

a/ Last 6 Months 1925 - Prior Years on Fiscal Year Basis

CHART D

This chart shows the gradual increase in productivity of the individual employee. It may be pointed out that the 7-hour day succeeded the 8-hour day on October 1st, 1935. All calculations are based on days. The exposure on an hourly basis since October 1st, 1935 would show some changes but not sufficient to disturb general conclusions.

Avoiding the question of which is safer, mechanized or non-mechanized mines, we can say based on this study that the frequency rate on non-fatals in Franklin County has very materially improved since the mines have been mechanized, also that the frequency rate on fatals has grown slightly worse.

The improvement in the frequency rate of non-fatal accidents is probably the result of a combination of causes, some of which will be pointed out. A contributing factor is the more aggressive safety work being done in the whole field.

A study of the individual fatal accidents reveal an increase in frequency rate among those men whose work is at the face. Falls of coal and rock are responsible. With mechanical loading, the difficulties of face timbering are multiplied. Temporary props must be set, removed, and then replaced to obtain necessary space for maneuvering the machines. Failure to use temporary posting frequently results in accidents.

There are many reasons why mechanized mining can be and should be made relatively safer than non-mechanized mining. Failure to take advantage of this opportunity for greater safety lies at the door of management. While it is true that the mechanization of any individual operation on the production line introduces new hazards, frequently such mechanization eliminates existing hazards. In any event these new hazards represent problems to be solved. The solution usually comes through one's own experience or the experience of one's neighbors.

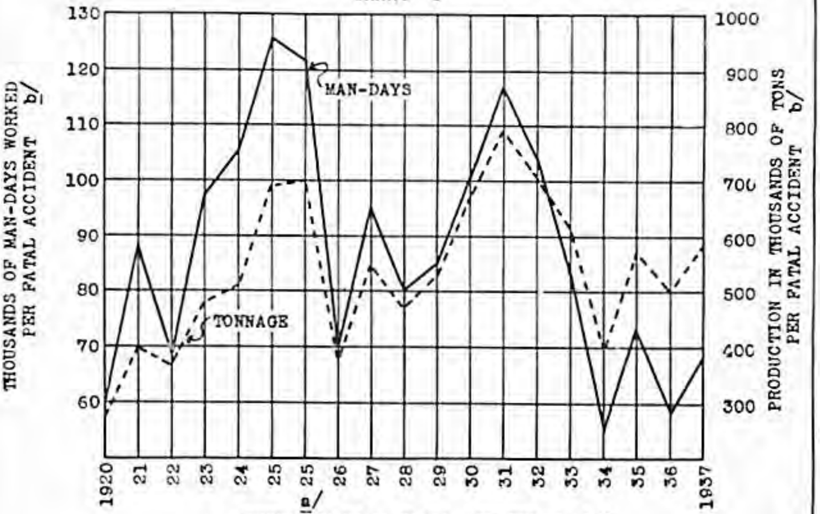
The chief purpose of the mechanization of any operation is to decrease the amount of labor required for that operation. The result of this is the reduction in the number of miners required for any given quantity of production. Whether the reduction is gradual or immediate, the men eliminated are those who for various reasons are more or less unfit to become operators of machinery. Those remaining possess more than average ability and intelligence, hence should be better and safer workmen.

In non-mechanized mines, many of the miners are paid on a piece-work basis. Interruptions to production are not so costly to the operator as they are when all employees are paid on an hourly basis and when costly machinery is standing idle. To hold interruptions to a minimum, more and better supervisors are employed. This increased supervision does tend toward increased safety.

To prevent costly interruptions to production in a mechanized mine, in addition to better supervision there invariably is an improved maintenance of equipment. Outages of equipment are anticipated and prevented wherever possible and instead of repairs being made after a breakdown occurs. This improved maintenance does have a beneficial influence on safety.

To improve performance of machines, time study engineers are constantly at work. Out of their studies, together with studies of the safety engineers, come standard practices for loading machine oper-

CHART C

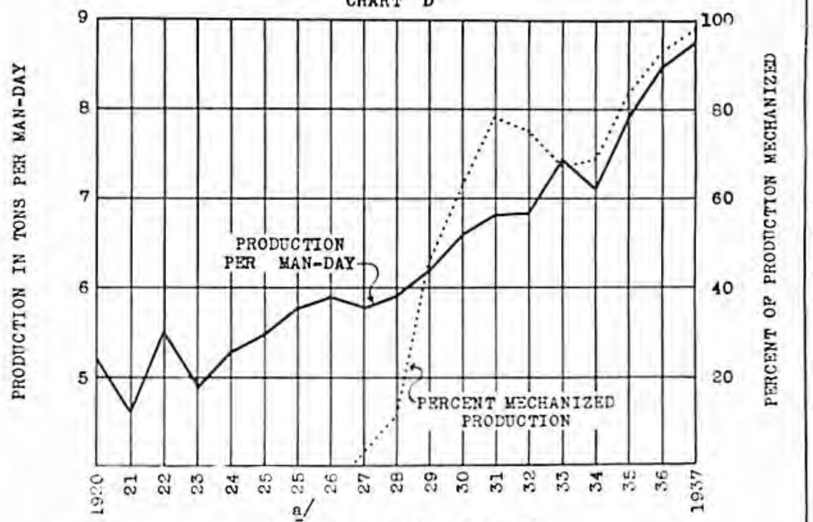


FREQUENCY RATE FATAL ACCIDENTS b/

BASED ON MAN-DAYS AND TONNAGE

a/ Last 6 Months 1925 - Prior Years on Fiscal Year Basis
b/ Does Not Include Fatalities From Gas Explosions

CHART D



PRODUCTION PER MAN-DAY AND

PERCENT OF PRODUCTION MECHANIZED

a/ Last 6 Months 1925 - Prior Years on Fiscal Year Basis ation, timbering, cutting, track laying, drilling, shooting, etc. These standard practices eliminate usual hazards and minimize the unusual hazards. Standards in non-mechanized mines are more difficult of enforcement because of the greater number of men affected and the greater number of working places necessary for the same production.

Those companies that have mechanized their mines are almost invariably leaders in their industry. As such it is to be expected that their safety policy is in keeping with their other policies. Effective accident-prevention work requires leadership. Efficient mechanized production requires leadership. These two things interlock.

Mechanized mines have no monopoly on safety. Many non-mechanized mines have outstanding safety records. The point which has been emphasized is that mechanized mines have an opportunity for an increased measure of safety. When mechanization comes to any mine, it is to be expected that the quality of safety work existing before mechanization will carry over. The basic problems are similar in both types of operations. Both require safe workmen and safe practices. The solution of these problems rests with proper leadership. Policies that produce outstanding safety records in non-mechanized mines will produce similar or even better results in mechanized mines.

NEW METHOD IN ROCK DUSTING

By JOHN E. JONES

Safety Engineer, Old Ben Coal Corporation, West Frankfort, Ill.

I regretted non-compliance a few weeks ago with your program committee's request to have a paper upon this new system of rock dusting for this Institute meeting. I explained at that time my reticence in giving public address upon the subject prior to completion of government tests at the U. S. Bureau of Mines Experimental Mine, and receipt of their report. These tests have been made and report was received two days ago. I, therefore, feel free to make public an explanation of the system, the Bureau tests made and the results. In addition, I am glad to report that the Bureau of Mines will publish explanation of the system and their findings in an illustrated report that will be mailed on their regular mailing list. Those of you on this list will receive copies. Others may obtain copies by application to the Director of the Bureau of Mines, Washington, D. C. for R. I. (Report of Investigation) 3411. This will be copy of report I have received except that names of persons and company will be omitted.

Since our development of the rock dusting machine in 1918 the rock dusting of passages in which track is maintained is a simple procedure. The rock dusting of trackless passages is more difficult, and occasionally neglected. Especially is this latter true where there are three or more parallel entries. The blowing of rock dust into an adjacent parallel entry to a haulage entry, or the rock dusting of such adjacent entry by hose from a high pressure machine is far less difficult than crossing an entry or two to do such work. In recent years we have adopted the multiple entry system ranging from three to six entries in parallel.

Adequate rock dust protection in these trackless passages has been a problem of vital importance in this safety measure. The rock dust on roof and ribs originally installed by machine when track was in them eventually diminishes below safe requirements due to rashing or spalling of the ribs and roof and due to accumulation of fine coal dust on the rock dust surface unless the rock dust is re-installed by hand dusting or by high pressure machines with hose.

Another factor worthy of consideration is an increase in the time that rock dust is of value after installation. Installation of safety equipment is usually of a permanent nature. This is not so with rock dust coating; continual redusting of roof and ribs is required some two to four times per year due to lessening of the ash content by coal dust settlings, by removal with passing trips and by rashing or spalling.

Still another factor is the very small percentage of bituminous coal mines of the nation that have adopted rock dusting. This is approximately 10 per cent. Unquestionably this small percentage includes those mines recognized as being of the greatest explosion hazard; however, many of those not being rock dusted are recognized as explosion possibilities from mine dust analyses. There is need of a more permanent and inexpensive method of rock dusting to include that large percentage of coal mines not recognized as especially gassy mines but of mine dust combustibility as to propagation of explosion started from any cause.

Many of you will recall Old Ben Coal Corporation's early experience with rock dusting. When we began its use it was largely a theory in this nation except that the Bureau of Mines in its Experimental Mine near Pittsburgh had shown its effectiveness in stopping explosions. Our first efforts were with dust from the highways. Men gathered this dust into cloth bags and we installed this on shelves and by hand dusting of roof and ribs in one section of one mine. There was not as much fine dust on the dirt highway as one would assume from the dense clouds arising from the horse and buggy traveling of a quarter of a century ago. It was not sufficiently fine, it soon caked and the quantity available was too limited. This source of dust was a complete failure and we endeavored to purchase limestone dust. There was none available so we purchased a railroad carload of the finest from a quarry some one hundred miles away where fertilizer lime dust was a by-product. We sifted the finest of this and installed it, but it was too coarse and, therefore, unsatisfactory. The purchase of rock dust at that early stage seemed impossible so we built a shale dust mill at one of our mines after ascertaining from the U. S. Bureau of Mines that the shale above our coal seam was of very good quality for rock dust; hence, the name "shale dust" which we used for many years.

My purpose in this brief history is to explain why the idea of keeping the shale dust in containers until the explosion liberated it did not occur to us. The shale dust was loaded in bulk in pit cars for the mine where the mill was located, in railroad cars for all of our other mines and later likewise for neighboring mines as they began rock dusting. Getting it in bulk obliterated the idea of prolonged life in the use of containers, other than its installation in trough and concentrated barriers. These latter, of course, were open for the settling of coal dust on the shale dust. I am very glad to report to you, as I have on frequent occasions, that the flame of explosions never in our experiences passed beyond these barriers. Explanation of this is given in the Story of Seven Explosions in an article entitled "Coal Dust Explosions" reprinted in the March, 1924 issue of the American Labor Legislation Review, New York City. This address was given in Washington, D. C. before the American Labor Legislation on December 28, 1923.

As shale dusting of mines rapidly increased limestone quarries and lead mines began to produce limestone dust as a by-product. This was shipped at first in 100 lb. paper bags and later in 80 lb. paper bags. The purchase of this dust in the paper bag containers plus the freight to our mines was considerably less than our cost to make shale dust. The limestone dust from the variable sources was passed as acceptable by the Bureau of Mines. We, therefore, changed from shale dusting to limestone dusting and our $40,000.00 shale dust mill became obsolete. It was only a part of the one-third million dollars, however, spent by Old Ben Coal Corporation in the early development of successful rock dusting. In addition to less cost of rock dust per ton the new method of rock dust in bags was added saving because practically 100% of the rock dust purchased reached final installation whereas considerable loss resulted in bulk transportation and especially in final installation from shale dust piles in the mine. However, we had just begun the use of cloth bags in an effort to solve this latter problem prior to our change to the purchase of limestone dust in paper bags.

It is strange that for nearly ten years apparently no thought was given to keeping the rock dust in the bags, using the manufacturer's container to preserve the rock dust until it was needed to stop an explosion or extinguish a mine fire. Not until 1935 or 1936 did this thought occur to us, and especially for use in trackless passages. The use of rock dust coating on track entries, as I have mentioned, is easily and efficiently done. In addition it is of value in illumination on the haulage roads. But for trackless passages and added safety on haulage roads some installation of the rock dust in the paper bags, the rock dust to be liberated by the pressure wave preceding arrival of the explosion flame, seemed plausible to us. Those of us who have been in a mine at time or times of explosion, and came out alive, can vividly recall that rush of air and our effort in the turbulance of high pressure to get face down on the floor knowing that if flame didn't fill the passage where we happened to be, that part unfilled with flame would be closer to the floor. It is this preceding rush of air in a non-rock dusted mine that gives a dense cloud of combustible dust to propagate the explosion, or in a rock dusted mine gives a dense cloud of non-combustible dust to stop the propagation. I wish to call your attention to the probability that there are so-called rock dusted mines insufficiently kept in rock dusted condition for that cloud of mine dust to stop the explosion propagation. Also I wish to state possibility of the rock dust coating in the summer or in damp locations becoming caked giving retarded cloudiness of the non-combustible dust in relation to the fluffiness of the coal dust in the same damp environment. Such experiences have been noted in a foreign country, the explosion probably propagated by the coal dust arising in time to feed the explosion flame while the caked rock dust was too slow in rising for immediate extinguishing value.

My first consideration regarding the new method was installation close to the mine roof of an 80 lb. paper bag at each 10 ft. of interval along the mine passages, the bags alternately to be on opposite sides of the passage. I designed a simple device for the preceding air wave to permit the bag to fall eight inches, such fall to permit a wire sewed through the top of the bag to tear open this top thus having an opened bag of clean dry rock dust in process of flowing and resulting in a dense cloud of rock dust upon arrival of the flame. In December, 1936, this plan was tried at the Experimental Mine of the U. S. Bureau of Mines. The flame was completely extinguished. Results were so successful and gratifying that the same test was made after reducing the weight of dust in each bag to 50 lbs. This test was also successful. The flame was completely extinguished in both tests before the outby end of bag installation was reached. My purpose in reducing the weight of dust per bag was greater ease in the labor of installation. This has proved to be of value since thousands of bags have been installed.

From success of these tests installation of the paper bags was at once begun in our mines. To get maximum of value per unit quantity of rock dust, entry intersections were chosen thus insulating each panel from explosion exit or entrance. Upon completion of such barrier system consideration will then be given to continuous installation in possible preference to the barrier system. For the intersections four bags are installed for the same distance in which one was installed at the original Bureau of Mines' tests in 1936. Each entry intersection is given a 48 bag installation. This is in addition to the machine dusting at time of entry development and in addition to the maintained machine dusting of the parallel haulage entry or entries. In a four entry system one entry is usually a track entry machine dusted when necessary and the other three are trackless entries having been machine dusted when track was in them and now having in addition 48 bags of rock dust in each of them extending from the panel intersections. The tripping device is the same in principle to that tested in 1936 with slight improvement in ease of manufacture and only one location of installation for tripping device.

It was understood following original tests in 1936 that a more complete set of tests would later be made by the U. S. Bureau of Mines. The report which I referred to at beginning of this talk is upon this latter set of tests, from November 29, 1937 to April 18, 1938. As explained it is available to each of you so I will dwell but briefly upon the findings.

A summary is shown in the graph opposite page No. 12 in the Bureau report and reprinted here.* All types of tests were successful except 1640. In these four tests the bags were installed beginning at the explosion source and, as explained in the report "the barrier being too close to the source of ignition." It was agreed that no matter how rock dust was installed for

* Reprinted from Bureau of Mines Report of Investigations 3411.

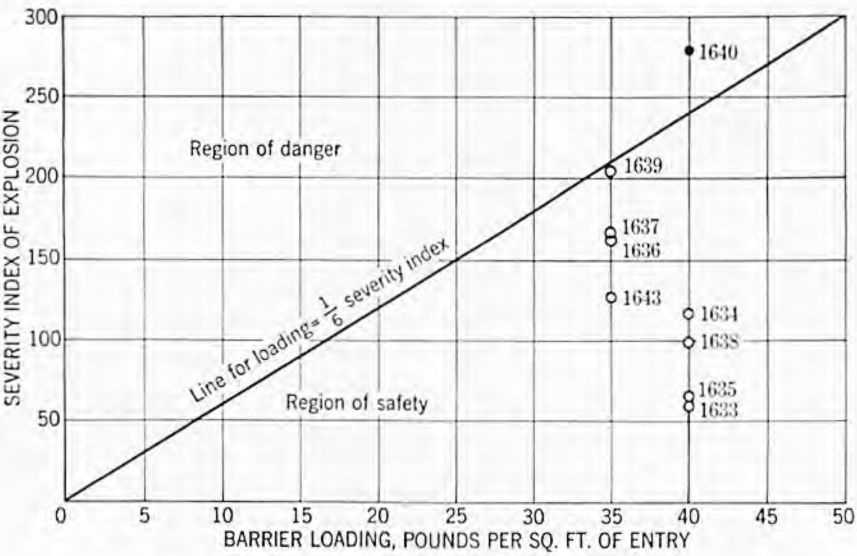


FIG. 1.—*Correlation of data from double-entry tests.*

FIG. 2.

the short distance of the length of barrier the coal dust beyond the barrier would be ignited since the time factor was too short.

The results shown in the graph (Fig. 1) are more encouraging when one considers the high hazard factor of the Experimental Mine conditions as compared with an operating mine. The floor, roof and ribs are smooth as compared with the roughness of an average mine. The 100% Pittsburgh seam fine coal dust is a maximum of immediate propagation hazard with no other loose material present. The authors pronounce the new system successful against strong and moderate explosions. Experiments with weak explosions have not been successful in the Experimental Mine since explosions tend either to develop strongly or to become extinguished before barrier is reached. This, too, would result in an operating mine.

"The tests showed that the units will be operated by the shock waves in advance of a weak explosion . . . the barrier appears to be a little too sensitive rather than not sensitive enough." *

A possible important factor with respect to this new system is not only more permanent protection in mines recognized as highly hazardous, but also for mines closer to but not reaching the safe borderline of non-explosibility. Such mines hesitate in the relative costly rock dusting of the whole mine as is done in those recognized as hazardous. I feel certain that Bureau of Mines tests under actual conditions of such mines could establish the number of bags required at panel intersections of both haulage and aircourse, such installation costing little if any more than a fire extinguishing station at that location and serving to stop explosions and fire. It is regrettable that the Experimental Mine is not supplied with sufficient finance to carry on in various types of tests that would be of value in safety relative to explosions.

I have here photographs taken in our mines showing first (Fig. 2) the individual bags installed and again (Fig. 3) the same bags tripped. It is impossible to show the flow of dust in a still picture. You will note some of such dust on the floor. You will also note the instability of the rock dust remaining in the bag. That on the floor and that in the bag would have been in a cloud of rock dust had an air pressure wave done the tripping. The third photograph

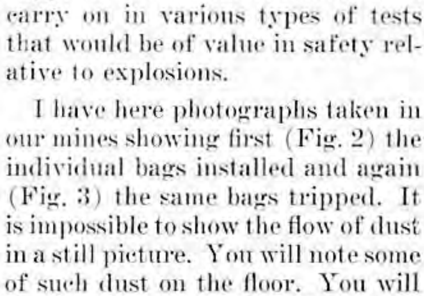


FIG. 3.

* Reprinted from Bureau of Mines Report of Investigations 3411.

Fig. 4.

(Fig. 4) shows many bags installed. Fig. 5 is a drawing showing installation on trackless entry in double entry system.

As I have mentioned, present rock dust installation is of short life. Redusting is essential frequently. This new system is of a more permanent nature. Of course, bags are occasionally accidentally and mischievously tripped. However, in such tripped position some 40% of the rock dust remains. They can be left in that position or may be reset. Preferably a new bag should be installed to keep the rock dust clean and that from the occasional opened bag be thrown on the roof and ribs by hand.

In closing I am happy to express my appreciation to the U. S. Bureau of Mines for the excellent job done on this occasion. I have always found this to be our experience and I am well able to judge since my lot has been with them at various times since 1915. I wish they were financially able to carry on and ascertain more and more facts regarding explosion hazards and explosion safety in their Experimental Mine.

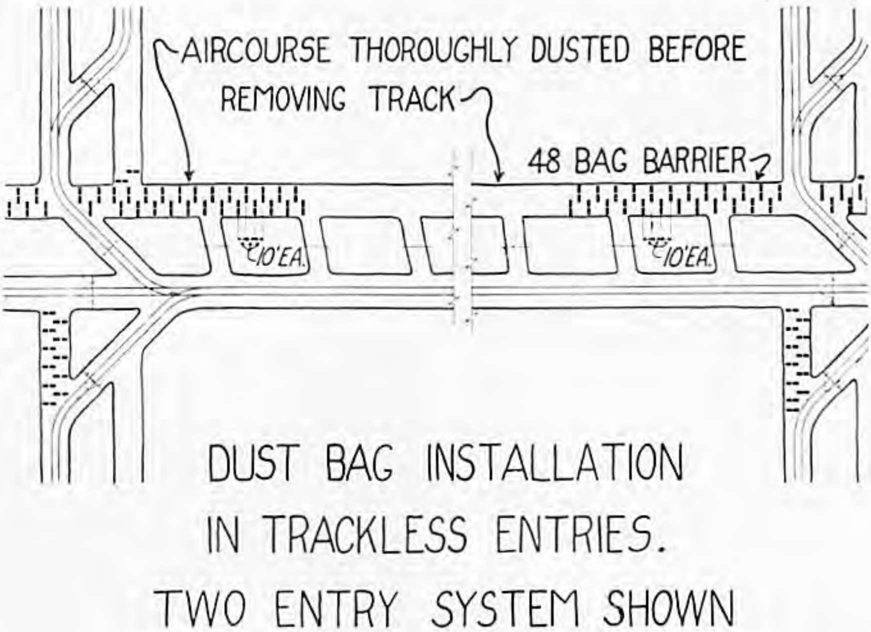


Fig. 5.

PROCEEDINGS OF ILLINOIS MINING INSTITUTE FORTY-SIXTH ANNUAL MEETING

Held in Springfield, Illinois

FRIDAY, OCTOBER 21, 1938

MORNING SESSION

10:00 O'clock A. M.

President Taylor: The meeting will please come to order.

Unless there are objections, we will dispense with the reading of the minutes. There being no objection, I will call for the report of the Secretary-Treasurer.

Secretary-Treasurer Schonthal: Mr. President and members, I am going to make this a very short report. There is not a whole lot to the report. The activities of the Institute during the past year have been about the same as in the past. Our membership has been maintained in good shape, and quite a bit has been done by the Executive Board. You will probably see the results all during the meeting.

During the year, we had the misfortune to lose seven of our members, two of them life members:

Mr. E. L. Berger on May 27, 1938.

Mr. J. I. Thompson, Life Member, on June 24, 1938.

Mr. P. W. MacMurdo, on July 11, 1938.

Mr. J. A. Ede, on July 26, 1938.

Mr. M. C. Mitchell, on September 11, 1938.

Mr. C. F. Hamilton, Life Member, on September 22, 1938.

Mr. H. C. Longstaff, on October 12, 1938.

Suitable communications were sent to the families.

The Secretary-Treasurer reports:

Cash in the bank on November 1, 1937	$2,646.81
Receipts for the year	5,709.00
Total	$8,355.81
Disbursements	6,880.02
Balance	$1,475.79

We hold in the treasury:

One C. B. & Q. Bond	$1,000.00
One Missouri Pacific Bond	1,000.00
Eight U. S. Government Bonds	8,000.00
	$10,000.00

The bonds were increased $2,000.00 during the year. Submitted by W. J. Austin, Chairman of the Auditing Committee.

That is all.

President Taylor: Is there a motion that the report of the Secretary-Treasurer be accepted as offered?

A Voice: I move that the report be accepted.

(Which said motion was duly seconded and unanimously adopted.)

President Taylor: I will call for a report of the Nominating Committee. In the absence of Harry Treadwell, Chairman of the Committee, I will ask the Secretary to read the report.

Secretary-Treasurer Schonthal: October 10, 1938.

REPORT OF THE NOMINATING COMMITTEE

The undersigned, constituting the Nominating Committee of the Illinois Mining Institute, have unanimously agreed to the nomination of the following members for the positions shown, for election at the annual meeting in Springfield, Illinois, on October 21, 1938:

OFFICERS

President:
Paul Weir

Vice President:
Roy L. Adams

Secretary-Treasurer:
B. E. Schonthal

If you will recall the By-Laws of the Institute, they were amended so as to elect four members of the Executive Board each year for three years. In order to start, we were to elect four for three years, four for two and four for one year.

EXECUTIVE BOARD

ONE YEAR TERM
C. T. Hayden
F. S. Pfahler
C. J. Sandoe
T. J. Thomas

TWO YEAR TERM
M. M. Leighton
James McSherry
B. H. Schull
Louis Ware

THREE YEAR TERM
D. H. Devonald
L. D. Smith
L. A. Wasson
W. P. Young

H. A. Treadwell,
Chairman
John A. Garcia
W. J. Jenkins

President Taylor: You have heard the report of the Nominating Committee. Are there any further nominations? A motion is in order to elect the members to the various offices read by the Secretary. Do I hear such a motion?

A Voice: I so move.

(Which said motion was duly seconded and unanimously adopted.)

President Taylor: Is there any unfinished business to come before the meeting?

Secretary-Treasurer Schonthal: I have a communication from Dr. M. M. Leighton and Dr. Frank H. Reed, sent from St. Louis:

> "Greatly regret that due to conferences with Missouri State Geologist we cannot attend meeting of Illinois Mining Institute tomorrow stop Very Best wishes for most successful meeting and kindest regards to all stop Must tell you all that foundation work on our new natural resources building began yesterday. We urge you to come to Urbana next fall and help dedicate our new unparalleled facilities for research. Our gratitude to the Institute for their aid and encouragement at all times."

That is all of the communications, Mr. President.

President Taylor: Is there any additional unfinished business? Is there any new business to come before the meeting?

I think, at this time, it is appropriate that we give a vote of thanks to the Program Committee and the Advertising Committee for the work done this year.

(Whereupon a rising vote was given with applause.)

President Taylor: Mr. Secretary, do you have an announcement to make?

Secretary-Treasurer Schonthal: Yes, I have a short announcement. Mr. Louis McCabe of the Geological Survey brought over a few tickets for the football game tomorrow, and if any of you want any of the tickets, see me or Mr. McCabe. They are in the same section that the other tickets are and are very good seats.

I would like to call the attention of the members to the fact that there is a strict parking rule in Springfield, and should any of you get a ticket, I am informed by our good friend Mr. Wills to give it to him and he thought he would be able to work it out.

I would like to request that if you have not registered, please do so. I think it goes without saying that if you think the meetings worth while coming to, you should register. Anyone connected with the mining industry should register and become a member of the Institute, whether salesman or operator.

The banquet tickets are on sale at the desk outside the door. We should like to know as early as possible how many we will have so we can tell the Hotel. Last year we had around 300 and I would like to get as many sold as possible.

In connection with the lucky number: The number appearing on your membership ticket is your number, and unless you are in the room when the number is called, you will not be eligible.

In connection with the program this afternoon, we will have some movies.

President Taylor: Which will take ten to fifteen minutes.

Secretary-Treasurer Schonthal: And I think they will be well worth while for you to see. That will be after the last paper is discussed this afternoon. It will take ten to fifteen minutes and will be well worth your while.

President Taylor: If there is nothing further to come before the meeting, we will declare our business meeting adjourned and go on with the program.

Mr. B. H. Schull, of the Binkley Coal Company, will be the chairman of the program. Mr. Schull.

Chairman Schull: Our first paper this morning will be "Problems in Reopening Closed Mines," by Mr. Howard Lewis, Assistant General Superintendent, Old Ben Coal Corporation, West Frankfort, Illinois. Mr. Lewis.

(Applause.)

Mr. Howard Lewis (Assistant General Superintendent Old Ben Coal Corporation, West Frankfort, Illinois): Mr. Chairman and members of the Illinois Mining Institute:

PROBLEMS IN REOPENING CLOSED MINES

By HOWARD LEWIS
Underground Supt., Old Ben Coal Corporation, West Frankfort, Ill.

The title of this paper "Problems in Reopening Closed Mines" is an interesting subject for me to discuss. Naturally in reopening a mine that has been closed over a long period of time, many difficult problems will confront whoever is engaged in managing the reopening. There will be problems of safety, ventilation, timbering, drainage, organization of the working force and many others, and it will be necessary to solve them with efficiency, economy and safety. In this paper I shall briefly relate some of the problems and experiences that were encountered in reopening a mine in Franklin County, owned by the Old Ben Coal Corporation, for whom I am employed.

During the period following 1929, at the beginning of the depression when many mines in Illinois were closed because of market conditions, the Old Ben Coal Corporation decided to close one or more of its mines and Mine No. 11 at Coello, Illinois was chosen as one. Because of its good roof conditions it was expected the mine could stand a long shutdown with but little damage to the property. All mining and haulage equipment was stored on the load and empty bottoms. The mine was sealed leaving a small ventilated area around the mine bottom open. This mine was inspected weekly and the slight accumulation of water in bottom sumps was pumped during the inspection period.

On June 25, 1932, when fan was not operating and no one in the mine, an explosion occurred, the cause of which has never been definitely established. The initial explosion was followed by subsequent explosions. These continued several days but became weaker, and stopped only when ninety feet of clay had been dumped into each shaft, sealing them at the bottom.

Early in February, 1936, it was decided to reopen the shafts, remove the mud seals and make an inspection of the shafts, both to determine the damage done by the explosions and with the hope of permanently reopening the mine for production. On May 2, 1936, five and one-half years after the shutdown, work was begun excavating the mud from the airshaft, using sinking buckets, and on June 2, 1936, the mine was entered and an inspection made of the load and empty bottoms, the bottom of the hoisting shaft, Main East and West sections for a distance of one thousand feet from the shaft bottom, and conditions were found as follows:

- On South Bottom—a fall of 2,500 tons of rock;
- On South Empty Bottom—a fall of 2,500 tons of rock;
- On East Empty Bottom—a fall of 7,000 tons of rock which was not cleared;
- On East Main Entry at Bottom—a fall of 3,000 tons of rock;
- On West Main Entry at Bottom—a fall of 2,800 tons of rock;

and on the load bottom there was a fall of 4,600 tons of rock. This fall was about halfway between the air-shaft and hoisting shaft and was 160 ft. in length, 22 ft. in width and 43 ft. in height. Under it were five large haulage locomotives that had been in use when the mine closed. Large bodies of water had accumulated on the West Empty Bottom and on the Main West Haulage Road for a distance of 800 ft. and the mud used in sealing the shafts had flowed back and completely submerged fourteen gathering locomotives and as many mining machines. The rest of the equipment on the shaft bottom was to a great extent covered by rock falls.

It was found that the force of explosions had done but slight damage to the mine, except that several stoppings near the shaft bottom and the original seals had been destroyed. Fires had occurred at seven different points in the vicinity of the mine bottom proper, and these were responsible for two of the largest falls. A fire had caused the large fall on the load bottom and had burned all combustible material, melted bearings and warped plates and axles on the haulage locomotives under it.

The first problem had been solved. The mine had been entered and inspected. The next problem was to restore ventilation sufficient to rebuild seals on east and west entries, recondition pumps, lay new pipe lines and remove water on the west haulage road. The only possible location to reconstruct the west side seals was in five and one-half feet of water, and it was important that stronger seals be built as soon as possible. It required fourteen days to do the work leading to and construction of permanent seals, and on June 16th work was begun removing mud from the main shaft, using sinking buckets, and on June 30th the shaft bottom was opened. The mine was now in condition to begin clean-up work around the mine bottom. The ventilation current was reversed, the main shaft being downcast and the current split on the load bottom at the east and west main entries. This made it possible to use electric power and work all men on intake air, somewhat eliminating the possibility of encountering gas, as this would have been possible, especially during periods of low barometric pressure.

Three shifts were used. The mud on the shaft bottom was loaded into mine cars and dumped through the tipple into railroad cars and unloaded with a clam shell. All locomotives and mining machines were hoisted to the top, the locomotives to be completely overhauled and the mining machines junked in favor of modern track cutting equipment. 2,350 cars of rock, each averaging 6.5 tons in weight, were loaded in the area about the mine bottom including the east and west entries to the point where seals were installed 1,000 ft. from the shaft bottom. From the large fall on the load bottom 698 mine cars of rock were loaded, approximately 4,600 tons. All rock loading was done by using pit car loaders, the type that was in use in other Old Ben mines, and the use of these machines continued until the installation of loading machines, after which all rock loading was done with them. The loading of these falls around the mine bottom was extremely hazardous both to workmen and equipment because of the height of the falls. The danger of sliding and rolling rock from the top of these enormous falls was ever present. The faces of the falls were kept on a long plane to minimize this danger and it required the best of judgment and the best of supervision to avoid accidents. Cables, ropes and long poles were used to pull the rock from the top and keep the face of the falls on the proper angle to avoid this danger.

No explosives were used in the mine during this period until seals were opened and the entire mine ventilated. All large rocks were broken into loadable sizes by the use of hammer and wedge. Locomotives were used to drag the large timbers and the bent and twisted beams from under falls. It was frequently necessary to use a cutting torch to burn them into short lengths in order to remove them.

Our next problem was the opening of the seals and ventilating the entire mine, an area of approximately $2\frac{3}{4}$ square miles. In this we were handicapped by a fan that was 25% short of its efficiency prior to the closing of the mine. This was caused by the damage done to the fan by the explosions and heat and to the leaky conditions of the air compartment. There had not been sufficient time to do all the necessary repair work, and it was decided to open the mine with this reduced volume of air after clearing the mine sufficiently to permit entrance to the various cross entries, one or more sections on either side of the mine could be sealed and permit adequate ventilation of the remaining sections. The result was exactly as was planned. The Main East and the 1E off the 3NE sections were sealed and we had ample ventilation to permanently keep the rest of the mine open and safe. More than two weeks of day and night work were required to properly restore ventilation as in many places the air current was short circuited by large falls breaking over brattices and also blocking aircourses.

Cleanup work was again started with three shifts. More help was employed and work was carried on rapidly. On roadways where falls were not big the rock and coal was thrown aside, and through the large falls a roadway was cleared sufficient in width to permit safe timbering and the passage of cars and locomotives. This was done to save time and expense as momentarily, the arrival of the loading units was expected, and it was our intention to do the rock loading with these machines, which we did after their installation.

On the west side of the mine no cleanup work was done with the idea of permanency but to recover a great amount of material that could be used in other parts of the mine. No tonnage would be needed on the west side as there was sufficient acreage east to maintain a maximum production for many years. After removal of the material was completed on the west side of the mine it was permanently sealed with concrete and abandoned on September 25, 1936.

About five months after beginning excavation in the airshaft, the first coal was hoisted. Three loading units had been installed and put into operation. It could have been said that our objective had been attained but in reality our work had just well begun. In order to produce tonnage efficiently and safely there was still much to do. Haulage roads were in bad condition, and it was necessary to re-lay practically every foot of road in the entire mine. Temporary timbering had to be replaced with permanent work, aircourses cleaned, feed cables and motor generators installed, and many brattices and seals in every part of the mine rebuilt. In all, to date, the following work has been done:

14,000 mine cars of rock loaded, each car averaging 6.5 tons in weight;

- 8,000 ft. of 70 lb. track; and
- 6,600 ft. of 50 lb. track laid new on grade lines and constructed with the best of material. Also every foot of haulage road and panel road from shaft to face completely relaid.
- Several hundred I-beams on haulageways installed. All these beams were hitched in coal ribs or placed on concrete block walls.
- Seven miles of 1,000,000 CM cable and 3 motor generator sets operating through drill holes installed.
- Seventeen concrete seals built, the largest being of the following dimensions: 24 ft. wide, 35 ft. high and 30 inches thick.
- Many concrete block stoppings were built also.
- One mile of new aircourse had been driven and an additional mile thoroughly cleaned.
- An Aerodyne type fan had been installed on shaft bottom and in use for the past 18 months.
- Twenty-three haulage and gathering locomotives completely overhauled and rebuilt.
- Six loading units and five track cutting machines installed.

All this work had been done and Mine No. 11 operated safely and efficiently with an average daily output of 3,400 tons.

During the period from the beginning of work on the airshaft until production of coal began there had been but one lost time accident and very few minor accidents. The cause of this particular accident was a scratch from a rusty wire infecting the hand of a top workman causing him to lose six days' work. It is needless to state that the very best of cooperation was given by management and employees to avoid accidents. Discipline was strict, safety rules were put into effect and rigidly enforced, with the best of judgment and supervision. Mine No. 11, since the production of coal was begun, has an enviable safety record, more than 75,000 tons of coal has been produced per lost time accident and at one period during 1937 not one employee was being paid compensation. Safety to employees, plant and equipment is a major problem in reopening closed mines. It should be the first consideration and was at the reopening of Mine No. 11. Cost is the other major problem but I believe both were accomplished very satisfactorily. Of the 14,000 mine cars of rock loaded out of Mine No. 11, 3,600 were loaded with manpower on conveyors at a cost of $1.31 per car. The remaining 11,000 were loaded by machinery frequently under the most unfavorable conditions in regard to power, preparation and switching facilities. The cost per car by loading machine was 55¢, resulting in a saving of 76¢ per car on 11,000 cars.

Again at Mine No. 9 in West Frankfort, an Old Ben plant that closed in 1928, considerable cleanup work was done in the early spring of this year under conditions very similar to Mine No. 11 in regard to rock falls. Fourteen hundred 5¾ ton cars of rock were loaded in twenty-two shifts, with a three man crew. The cost per car was 43¢. This cost included temporary track repairs, haulage and bottom labor. However, power and switching facilities were much better than at Mine No. 11 and the abrasive character of the rock was much less. I will add that the policy on safety at Mine No. 9 was the same as at Mine No. 11 and the only lost time accident that occurred at Mine No. 9 during this three month period was a sprained ankle caused by a workman slipping and falling.

As was the case at Mine No. 11 the falls in No. 9 were of great height ranging from 12 ft. to 36 ft. However, the hazard of rolling and sliding rocks was greatly reduced so far as workmen were concerned. As the operator on the type of machine used at this mine stood 18 ft. back from edge of material being loaded, this greatly lessened the danger of rolling or sliding rocks as would effect a workman on a pit car loader or loading directly into a mine car. No workman at Mine No. 9 was permitted to work under exposed roof and all falls were timbered with I-beams before loading was allowed.

It will be interesting to note that during the period of time used in cleaning Mine No. 9 the maintenance cost on this loading machine was small. The usual method of lubrication and inspection in effect at our other plants was employed on this machine, and the only repair work done was on digging chains which had to be partially reriveted weekly. All repair work and time for oiling was done on the regular seven hour shift by members of the operating crew.

In conclusion I think that good morale and cooperation on the part of workmen and management is most necessary and will be the greatest asset in solving the many problems confronted in the reopening of closed mines.

* * *

Chairman Schull: Gentlemen, we have heard a fine paper. We have a lot of mine men here and it is open for discussion. I would like to hear from not only one but several on this paper.

Let's speak up. I don't want to have to pick you out; we should have volunteers.

Mr. John A. Garcia: Mr. Chairman, I had the privilege of going through Mine No. 11, Old Ben, two years ago last Labor Day, just about the time the mine was being put into operation, and I want to testify to the courage, ability, and technique of the men who did that job. I have had considerable experience in that kind of job and I never saw anything like that.

John E. Jones, with whom I had expected to pass a few pleasant moments, knocked on my door around five o'clock in the morning and took me out and wanted to go through that mine. We went into it and instead of having an easy day, I never had a work-out like that in my life.

That mine was just a great big gas bag. It was easy to do the job if it wasn't for the falls and the falling and rising barometer. That calls for the most exquisite brand of mining engineering. Somebody should pin a leather medal on Mr. Lewis and Johnny Jones for what is probably the best kind of a job in the history of mining. No man was even hurt, and it was possible in the development of that mine and its recovery, any minute during the 24 hours of the day, of it blowing the whole thing up. But due to intelligent handling and proper management, no man was even injured, and property worth probably one million dollars and which many mining men, including myself, had figured was a total loss, was 100 percent recovered through not only the labor but the mining engineering experience of Johnny Jones and Mr. Lewis, and I want to pay tribute to these two men for that job.

(Applause.)

Mr. Howard Lewis: I want to express my gratification for the compliment.

Chairman Schull: Who is the next lucky gentleman? Don't everybody speak at once. I saw Dave Devonald back there a few minutes ago. I believe he would like to say something. We would be glad to hear from you.

Mr. D. H. Devonald: I have had experience in coal mines. I started my coal mining experience in Franklin County and I can appreciate to a great extent what Mr. Lewis is talking about. I never had the misfortune to help open a closed mine but I have opened up certain sections in that County and I thought I had a problem. The thing that impresses me most, is the fact that they had no accidents. I never had an experience like that. I have always had them. I think they should be highly complimented.

(Applause.)

Chairman Schull: There are plenty of seats up in front here if anybody back there is not comfortable.

Anybody else?

Our next paper will be "Modern Methods for Design, Construction and Operation of Coal Preparation Plants," (a) "The Importance of Sampling and Laboratory Tests," by John A. Garcia, Jr. Mr. Garcia.

(Applause.)

Mr. John A. Garcia, Jr.: Mr. Chairman and fellow members of the Illinois Mining Institute:

IMPORTANCE OF SAMPLING AND LABORATORY TESTS

By JOHN A. GARCIA, JR.
Allen & Garcia Company, Engineers, Chicago, Illinois

The subject matter of this part of our paper has been discussed at great length by noted authorities and with some slight variations they all agree as to methods of procedure and interpretation of results. Anyone who will take the time can find many technical papers on the subject and by dint of hard study master its intricacies. The object of this part of our discussion, therefore, is not to act as another source of data for the engineer, but rather is directed at the practical operator who wants to know the why and wherefore of the subject in order that he may intelligently follow any discussion of sampling and washability curves. It is to that operator, who has forgotten the definition of "pi" except as something mother made best, that this portion of our paper is addressed.

Now as to the reasons for sampling and compiling washability curves, it would seem self-evident that the more information the operator has about his product, the more coal he can sell. Modern methods of selling, due to keen competition and over-production, bring out still more strongly the need of salesmen and sales organizations with complete, accurate information of what they are to sell. The constant stimulation of their market with new, fresh approaches, based on thorough knowledge has become essential.

There is no doubt now in the minds of the forward looking operators but that washed coal is going to control the market to the practical exclusion of all raw coals. Along with washing will be the blending of different sizes to the point that "prescription counter" or "metered mix" coal will be the order rather than the exception. It therefore behooves the operator to have at his finger tips all pertinent information regarding his coal as to its washability and the characteristics of any mixture the market may demand. Without this he is groping in the dark and will be left far behind in the race for sales. Heretofore, the sales department of many coal companies has sold coal largely on a hit or miss basis. I have known of cases where analyses have been made on the sales manager's desk with due regard in each instance to the requirements of the prospective customer. I believe more sales have been lost through misrepresentation than through poor quality of coal and the reason for this has been, in most cases, a lack of accurate knowledge of the coal for sale. How much more sensible it would be to make the customer list conform to the character of each coal sold than to attempt to make the coal conform in every instance to the varied demands of the customers. I sincerely believe that if the sales departments, including the latest cub salesman, had information at their command upon which they could rely with absolute confidence, many more satisfied customers would be added to their list.

It logically follows that any sampling or tests made upon a coal must be of extreme accuracy and in sufficient quantity to offset small errors which creep in due to slight inaccuracies of equipment. As to quantity, the writer has found a good rule is to insist that a sample weight be at least one hundred times the diameter of the largest piece of coal times the same diameter in question plus one. Thus if a sample of 6x3" is being taken the weight should be not less than 100 times 6 or 600 times 7 which equals 4,200 pounds. If a sample of 3x2" is being taken the weight in pounds should be not less than 100 times 3 or 300 times 4, or 1,200 pounds. In addition to the amount of sample taken it should be collected at equal time intervals over not less than a three days' run in order to get coal that is representative of all sections of the mine. And naturally, it must be taken at points which will give a true cut of the size in question.

One common source of error in this regard is to fill the sampling "dolly" or "pan" or receptacle too full when cutting the flow of coal. If, for example, we are sampling screenings as they discharge from a conveyor to sizing screen by dragging a bucket across the stream of coal, care must be taken not to allow the bucket to fill completely. If the receptacle does fill the large pieces will bounce or roll off, whereas the fines will stay in the openings between the pieces of coal, thus immediately giving us an error in the screening analysis. The sample must be carefully handled and analyzed shortly after collection in order to prevent loss of moisture, or "air slacking." The screening analysis should be made at the end of the day's run and painstaking care should be taken not only in the screening, but in keeping the records as the job is done. The samples should be analyzed by a competent laboratory and the analysis must be complete and thorough the *first* time, as repetition in this business costs money.

Now as to interpretation of results—the screening analysis will be self-explanatory to all of you. It should be accompanied, however, by a description of the mining method used and the mine section or sections from which the coal was taken to be really complete. Also, a description of the type of separating screens should be included. With these data in front of him, the sales manager will know the exact make-up of his screenings and the exact percentage of the sizes the mine is making or can make. Knowing how much coal he is selling he can organize his price structure and try to fit this to his costs and thus be in a position really to *manage* the sales of his company.

The interpretation of the float and sink tests and washability curves is my next heading and really presents a problem to explain completely. You all know the method of making the tests—each size coal is run through baths of either zinc chloride or carbon tetrachloride set at specific gravities such as 1.30, 1.35, 1.40, 1.45, 1.50, 1.55, 1.60 and 1.70. These are the usual gravities used, although in some instances either more or less are employed. The zinc chloride solution is used on coal over 2″ in diameter because it is cheap, practically odorless and may be washed off coal and refuse of this size. Carbon tetrachloride is used for the smaller sizes because it can be removed from the coal and refuse by evaporation, whereas the zinc chloride must be washed off and this presents too difficult a task on the small sized coal. After the clean coal and refuse, or float and sink as they are called in the laboratory, have been progressively made on each gravity for each size, the resulting samples are washed or dried free of solution, then weighed accurately and analyzed individually for ash and sulphur. The actual method of doing all this has been explained before in many technical papers, so no attempt is being made here to describe the routine. However, the client should impress upon the engineer and chemist the need for accuracy and for a complete story since once the process of float and sink testing is started it's very seldom that after thoughts can be included.

After all data have been compiled and curves drawn, the operating man should have no difficulty interpreting the results as far as the ash, sulphur, recovery and refuse curves are concerned. The accompanying graphs may be used for illustration. Each graph and data sheet shows information for an individual size or a composite of sizes and in a report should be on consecutive pages in order to make the graphs easily understood. Each column of figures shown on the data sheet should have an explanation below as to what part the figures play in the graph—either the ordinate (which is the vertical scale) or the abscissa (which is the horizontal scale). You will notice we have also tied together the name of each curve with the explanation of its ordinate and abscissa.

The "A" curve is the clean coal ash content plotted against the amount or percentage of clean coal recovered at each specific gravity. If a certain ash content would be desired in washing, this curve would show the recovery obtainable with that certain ash percentage in the clean coal, and conversely, if a certain recovery percentage is demanded, this curve would show the ash content at that recovery percentage. In either instance, if a horizontal line is drawn through the "A" curve at the point showing the ash content involved and extended to the "S. G." or specific gravity curve, a line dropped vertically to the horizontal scale will indicate the specific gravity to be used. The sulphur curve, designated "S" on our graphs, can be interpreted exactly the same as was the ash curve. You will notice on our data sheets that we have two headings, for the convenience of the reader, one of which is Ash results and the other Sulphur results.

We now come to the "D" curve or elementary ash distribution curve. The abscissa of this particular curve is the elementary ash percentage of each individual float fraction as analyzed in the laboratory. The ordinate of this curve is the cumulative yield percent of the previous float fraction—plus one-half of the original weight of the fraction involved. In other words, this ordinate which is a cumulative weight percentage, is in theory that coal which doesn't quite float or definitely sink in a solution of known specific gravity. It must therefore, be the heaviest piece of coal with the highest ash content in the float. The same horizontal line mentioned before will cut this curve at a point designating the ash content of this heaviest particle.

The specific gravity curve on our graph is the cumulative refuse percentage versus the specific gravity points as shown. It simply shows the amount of reject at each specific gravity, which of course, also gives us the amount of clean coal recovered at each point.

The refuse or "R" curve gives the ash content of the reject. It should be noted that the higher we go in specific gravity the closer the "R" and "D" curve come together.

The final and most difficult curve to understand is the plus or minus 1/10 curve, which serves simply as an indicator. This curve has for its abscissa the specific gravity points as used in the float and sink tests. For its ordinates it uses the amount of coal lying between the specific gravity under observation plus 1/10 and minus 1/10. For example, if we contemplate washing a coal at 1.45 Sp. Gr., because of good recovery and low ash at this point, then the ordinate of the ±0.1 curve for 1.45 gravity will show the amount of coal that lies between 1.35 gravity and 1.55 gravity, those two points being 1.45 plus and minus 1/10. The rule is that if more than 10% of our coal lies between these points, the washing job will be difficult—if less than 5% lie between them the job will be easy. Obviously, the thing to do in determining the washability of a coal is to find that gravity as shown on the graph which has 10% or less as the ±0.1 ordinate.

I believe that in the main, I have covered the high lights of this subject. I realize that for the highly technical man I have merely set out some elementary explanations, but I would like to have the opportunity sometime of going into the subject with those interested with some graphs and data sheets at hand.

* * *

Chairman Schull: That was a nice paper, very interesting. There are a lot of people interested in preparation and here is an opportunity to tell their troubles.

Mr. S. A. Dickson: While the flat piece of extraneous substance will have a tendency to float through the wash box in a see-saw manner which prolongs the sink period for this shaped material over that of the same specific gravity material of a block shape, the shape of the extraneous substance must also be taken into consideration along with the specific gravity methods of sink and float system of washing of coal in order to secure the proper cleaning of the coal as it should be placed in the railroad car.

Chairman Schull: I think that regardless of the analysis given the Sales Department, they will add 25 to 30 percent to it every time. They would not be human if they didn't do that.

Mr. John Griffen: I think the origin of some of this discussion lies in the fact that people have been prone to consider that the coal analysis is the "God's Truth," when as a matter of fact a coal analysis is nothing but approximately the truth and during the past year or so, two or three years, we have had quite a lot of papers and reports on the phase of the matter. In other words it is a heterogeneous matter; for instance the question of taking three days average sampling, that represents the average coal produced in the mine, presumably an average of the coal mined but if you studied the mine section by section, you will find that coal produced in one section may be entirely different in analysis from the average. That coal may be put into one lot and you may even have a situation where you have a different analysis of the float material on a given bench. I have had the experience in strip mines where because of water in the pit and so forth they load the top bench temporarily in order to keep the loading shovel on. The float ash was one percent lower than that of the whole mine. There are times that that creates a misunderstanding between the operating department and the sales department and they are both doing the best they can.

(Applause.)

Chairman Schull: Our next paper will be "The Design, Detail and Specifications for a Modern Cleaning Plant," by Mr. William von Meding.

(Applause.)

Mr. William von Meding: Mr. Chairman and fellow members of the Illinois Mining Institute:

THE DESIGN, DETAIL AND SPECIFICATIONS FOR A MODERN PREPARATION PLANT

By WILLIAM VON MEDING
Allen & Garcia Company, Engineers, Chicago, Illinois

In building a modern coal preparation plant today, it is just as essential to plan every detail in advance of construction as it is in a large building or industrial plant, for today, the preparation plant is truly a factory in which a raw product is manufactured into various finished products to meet the ever increasing demands of the consumer.

Before the days of keen competition, a preparation plant was merely a means of loading several sizes into railroad cars, with little thought to cleaning or to exactness in sizing. Gradually the picture changed, the consumer demanded more and more variation in sizes, better preparation and above all, cleaner coal. The advent of mechanical mining hastened the transformation, because it prevented selective mining and loading at the face and forced the preparation plant to take on this additional burden. Then too, the domestic stoker came into the picture further increasing the equipment required.

So today, the preparation plant has grown into a complicated structure, full of equipment, each part of which must be co-ordinated with each other part, so that the whole will function smoothly and economically to produce the desired results. That this may be attained, requires the services of an engineering organization well versed in the subject.

Let us assume for a moment that we are about to plan a modern preparation plant and analyze the procedure necessary. The first step is to determine the capacity required of such a plant and the character of the coal to be handled. It is easy to find out what the daily tonnage is, but care must be taken to interpret this in terms of the peak capacity that various component parts will be subjected to. A screen analysis of the coal is of first importance so that the percentage of the various sizes can be determined. Then proper allowance must be made for possible variation in such percentages during different periods of the day or in various parts of the mine. This is especially true in the slack sizes, due to machine cuttings or to only part of the mine being mechanized.

A plant rarely has a steady feed. A study should be made of the maximum dumping rate, the duration of such a rate and the time interval between trips. The plant must then be either large enough to take the peaks or proper surge bins provided to smooth out the feed. If a cleaning plant is incorporated in the layout, the surge bins are almost indispensable.

An analysis of the coal must be made and careful study of such analysis to determine what preparation is necessary to meet the market demands. If mechanical cleaning is required, further study is in order so that the best process may be selected to meet the particular problem at hand. Roughly, the choice must first be made between wet or dry cleaning, or a combination of both. Then we must decide between cleaning a sized or an unsized feed. Much has been written on this subject and many controversies have arisen over it. It is not the writer's intention to present any arguments as to the relative merits of the various systems or types of equipment or the claims made for them. It is best to place your problem in the hands of a competent experienced man who is not interested in any particular system or equipment. If your organization does not contain such a man, it is money well spent to employ outside help at least for this part of the work.

After all of the work above outlined has been completed, a flow sheet of the plant should be drawn up and the actual design started. With the duties of each piece of equipment known from this flow sheet, specifications for the various units may be drawn up and the field canvassed for the best available equipment. An early selection should be made so that the designer may have accurate information as soon as possible in preparing the working drawings. Nothing is so disheartening to the designer as to start out on the basis of using one type of equipment and after the detail plans are well along, to find he must make radical changes. Experience has shown that the best and cheapest plants are those where the decisions have been wisely made in advance and the designers allowed to complete their work without change or interference.

Let us briefly review some of the component parts that make up a modern preparation plant. The method of bringing coal into the plant will naturally vary depending upon whether the mine is a strip, shaft, slope or drift mine. But once the coal reaches the shaker screen, the general outline of the plant will be the same. While vibrating screens have been much improved in recent years, the shaker screen still reigns supreme except in sizes under 1¼″. Even in the smaller sizes the efficiency of the sizing shaker has been greatly enhanced by the use of stainless steel plates of thin gauge, screening down to ⅜″ or even 5/16″. Such plates have been installed in existing screens by building in an egg crate of steel bars to support the light plates. The success of any dry screening depends largely on the moisture content of the coal. Even the best of the vibrating screens will not handle excessively moist coal and wet screening for moist coal should be resorted to.

The preparation of stoker coal has brought the problem of crushing to the front. Invariably we are confronted with crushing larger sizes into stoker sizes with a minimum of fines. The sizes to be made vary widely with the top limit usually at 1″ or 1¼″ and the bottom limit at 10 mesh or larger. All types of crushers have been greatly refined and improved in the past year or two to accomplish this result. The choice lies between double roll, single roll, or ring roll. Coals vary to such an extent that it is advisable to have a crushing test made in each case to determine the best type for the job in hand. Recent work has demonstrated that what may be best in one case will not hold true in the next. Generally speaking, the two stage crushing has not given results to justify the increased investment and the generous recirculation of oversize greatly reduces the amount of fines.

An interesting new development in crushers is the combination of a Bradford breaker shell with a faster moving rotor inside, similar to the rotating element of a pulverizer or granulator. Tests show this combination produces a much smaller percentage of fines than the average crusher and there is no oversize to be recirculated. The first commercial installation of this piece of equipment for bituminous stoker coal is now being made in Tennessee.

Stoker coal must be free of tramp iron, and where the coal is not washed, magnetic separation is essential, not only in the finished product, but to protect crushers to avoid damage. A wide variety of equipment is available for this purpose.

Stoker coal especially, and other sizes generally, must be treated for dust and you are all familiar with the oil chloride or wax treatment for this purpose. It is safe to say that the greater percentage of dustless coal is oil treated today. Some few plants are equipped to treat with either material.

With increased mechanization continuous running time is more and more important. Where the nature of the coal will permit the storage of coal should be considered. Recent installations involving the use of sectional and portable belt conveyors and belt stackers have proven successful.

The subject of cleaning will be more thoroughly discussed in the paper to follow. Wet washing brings with it the necessity of drying at least the finer sizes. This is accomplished by means of centrifugal or heat dryers, or a combination of both. Time does not permit of a thorough discussion of this interesting subject.

A properly designed plant should take into consideration the maintenance of the mechanical equipment. Ample headroom and accessibility around all units that require attention should be provided. It is a good plan to provide supports over major units for hoisting parts and a trolley beam system is still better. Where several floor levels are encountered, wells should be provided so that material can be easily taken in and out from the various floor levels. A rigid structure to support the mechanical equipment is absolutely necessary if excessive maintenance is to be avoided. Structural steel or reinforced concrete are to be preferred and a combination of both has been used to good advantage.

With the advancement in the art of steel alloys, the designer can well afford to take advantage of the same in cutting down weight in moving and reciprocating parts and in preventing corrosion and wear. Stainless steel plates for instance, in spite of their increased cost, have proven economical because of the increased efficiency, reduction in weight and long life. Heat treated alloys are likewise a good investment in conveyor chains, wearing bars and similar parts.

The electrical work and power transmission should receive proper attention. Centralized or group control of various units is highly desirable, providing for proper sequence of starting and stopping. The control board of a modern plant has grown to sizeable proportions, but is well worth its cost.

The selection of motors is important. Ample power should be provided to take care of overloads and difficulties in starting after shutdowns in cold weather.

The use of V-belt drives is now an established practice, providing for easy and quick speed changes and relieving the motors of shock. A very good combination is a V-belt drive from a motor to the high speed shaft of a speed reducer, the low speed shaft being connected directly to the head shaft. This arrangement does away with necessity of a base, and eliminates bridge trees for countershafts and the necessity of continuous attention for lubrication, especially if ball bearing motors and anti-friction bearings on the head shaft are used.

Last but not least, safety provisions should be incorporated throughout the plant. All electrical work should be properly protected and guards installed around all moving machinery. Hand rails with top and center rails and toe guards should be placed around all openings and passageways. In spite of our rigid regulations today, the writer's observations are that much can still be done to increase the safety of the worker in a modern preparation plant. This part of a mine should receive the same careful attention that is directed to the underground workings.

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Chairman Schull: We are having some good papers here this morning, very interesting. I would like to hear some discussion on this paper.

We have a third paper along the same line so we will finish and then get a general discussion on the two.

The next paper is "The Construction and Operation of a Cleaning Plant Considering Minimum Investment, Operating Cost, Minimum Degradation and Maximum Efficiency," by Mr. Louis von Perbandt.

(Applause.)

Mr. Louis von Perbandt: Mr. Chairman and members of the Institute:

THE CONSTRUCTION AND OPERATION OF A CLEANING PLANT CONSIDERING MINIMUM INVESTMENT, OPERATING COST, MINIMUM DEGRADATION AND MAXIMUM EFFICIENCY

By LOUIS VON PERBANDT
Allen & Garcia Company, Engineers, Chicago, Illinois

The subject of the construction and operation of a cleaning plant, considering minimum investment, operating cost, minimum degradation and maximum efficiency, can lead one into many different channels and the writer will try and co-ordinate the various phases included in the acquisition of a cleaning plant, without going into too much detail.

The first problem that confronts the operator when considering an installation of any kind, is naturally, what investment is required, how far will one be justified in going and, as is so often requested, what is the absolute minimum.

In this connection, it is first necessary to establish what the object of cleaning is and what it is expected to accomplish. Why are cleaning plants built? First, and most important in this day of efficiency, is to provide a consistently uniform product at all times and under the varying conditions of a fluctuating natural product to be treated. Second, the maximum recovery of our natural resources. Third, the disposition of waste products at the mine and its attendant evils. Last but not least, the reluctance of the consumer to pay freight on and for ash and its disposal.

The common practice to date employed for the removal of impurities at the mine, has been hand picking. It has been determined by experience that this does not have any appreciable effect upon the raising of B.T.U. content nor does it aid in establishing a uniformity of product, but on the contrary, results in a decided loss of good coal. Added to this is the difficulty of pickings disposal and the nuisance of burning refuse dumps which in some cases have resulted in litigation to recover damages. All of this must be added to the cost of coal and may be used as an offset to washing costs. The actual amounts involved per ton varies with each mine and can be applied accordingly.

Having determined the object, the next question is how far should the cleaning be carried. Here our float and sink analysis provides the data for making comparisons and for determining the lowest economical ash content of the coal after cleaning; the sizes that must be cleaned; the specific gravity which gives the best overall results and at which the separation of coal and refuse can be most economically accomplished.

It has been found that in some coals the cleaning of the finer sizes is too costly and the results too negligible to pay for the cleaning equipment. However, it is sometimes still necessary to clean these fines in order to establish a uniform product and to be able to dispose of the mine output. It is well known, of course, the sizes below 1½″ cannot be picked and that it is a waste of money to attempt it. The character of the coal above 1½″ size will determine whether the mechanical cleaning shall be carried to the 3, 4 or 6″ sizes and what benefits if any, will result from so doing.

Each case is individual and must be carefully balanced against anticipated market conditions in order to determine how far to go. These vary accordingly as to whether the coal comes from a shaft, slope or strip mine and whether the chief outlets are for steam or domestic fuel.

Having determined what is to be accomplished by the installation of a cleaning plant, it is now necessary to determine what units shall enter into its construction and whether any of the available preparation units can be utilized in the new arrangement.

This is where the layout man can show his worth. If the necessary units can be fitted into the present flow of coal with a minimum amount of additional handling, the result will be economical as well as efficient and with a low first cost. However, care must be exercised not to carry this idea too far, because it might result in a costly maintenance cleaning operation.

It is not intended to go into the various types of cleaning methods as each one has its sphere of usefulness as well as economies and should be selected to fit local conditions. The cost of coal cleaning is not very greatly affected by the cost of the cleaning unit, but is largely affected by the necessary auxiliary units, the material required to house them, and the arrangements which must be made for the installation. Actually, about only 10 percent of the cost of a cleaning plant is represented by the cost of the cleaning unit.

Consideration must now be given to the question of capacity. If only the smaller sizes are to be cleaned, is it possible to include some of the larger sizes without increasing the size of the washing unit? In some cases, this has been done up to the point where the guaranteed capacity has been doubled at a small loss in efficiency. Then again, is it possible to arrange the plant, which may be designed for a small capacity, to operate two or three shifts?

This has been done in many instances and has resulted in a decided savings in investment cost, but with an increase in labor costs. This is due to the fact that the supervisory force remains the same for one or two shifts, but it is only necessary to add labor forces for second shift operation. Therefore, whenever conditions permit, two shift operations can be used and should result in a savings in washing costs.

Comparisons made to cover the advantages of one, two or three shift operation indicated that a two shift operation could be carried on with a decrease of approximately 30% in washing cost per ton while a three shift operation indicated a decrease of only approximately 20%.

In making comparisons of the various possibilities of an installation, it was found that the construction of a washer for the recovery of coal from pickings would pay for itself in approximately two years.

A plant designed to include raw coal with the pickings would do the same job with only a slight increase in the length of time required to pay for itself. A plant designed to wash all sizes indicated that the additional coal recovered would pay for the cost of washing and perhaps yield a profit.

All the above statements are based upon a running time of 200 days per year at full capacity of the mine. Any deviation will affect the results accordingly.

The next feature and one of the prime factors in governing the design of a cleaning plant is that of market demands.

If the main market of a mine demands a preponderance of steam coals, the arrangements for preparation are relatively simple and naturally, do not call for a wide variation in the prepared sizes. In a plant of this type, designed to separate the coal into a small number of sizes, clean it and load it directly into cars, the design should be economical and should not attempt to interrupt the flow of coal from mine to railroad cars.

However, if the market demands all types of coal including railroad and domestic, then it is necessary to go into an elaborate combination of screens, bins, mixing facilities, dedusting and oiling, in order to meet the demands of the sales department. In a plant of this type it is necessary to make a great number of different sizes and to keep them separate so that it is possible through various units of equipment and the use of bins to make prescription counter coal, thereby furnishing any combinations with varying percentages of different sizes of coal.

If such a plant is necessary, then the initial investment must be increased accordingly and will have its effect upon the cost of cleaning.

Other factors entering into costs are,—will the addition of a cleaning plant and additional preparation facilities be possible without the increase of track facilities, and if not, how much will these add to the cost? The available water supply, and how far it is necessary to go to meet the natural conditions, must also be included.

Operating Costs

Much can be said on this subject and many differences of opinion have been submitted on as to what constitutes washing costs. However, it is the consensus of opinion that if we include amortization of the cost of plant, interest, taxes, insurance, maintenance, supplies, power and labor, a definite cost of washing can be established.

In cases it is argued that the cost of refuse represented by the wages paid the miner, should be included in washing cost, it having been more or less successfully sold to the consumer for the same price as coal. These conditions now having been changed and the consumer in many instances refusing to pay for ash, an attempt to fasten the loss of this product upon the cost of cleaning is sometimes suggested, but is rather difficult to justify.

Minimum Degradation

As long as coal has been produced for domestic and steam purposes, it has been the object of the operator to prepare his coal in such a way as to have the least amount possible of by-product, namely slack, which in bygone days started out as being all the product that would screen out when passing over a 1¼″ bar screen. In order to make the miner conscious of the desirability of producing coarser coals, he was not paid for this part of his work, and the operator also had to see to it that he did not cause an undue amount after it was delivered to his preparation plant. Consequently, this part of the production was disposed of by constantly lowering of price to the consumer. Naturally, this resulted in efforts being directed toward the utilization of this low cost fuel and the development of the stoker and powdered fuel ideas.

The result of this development consequently was the lowering of the size ranges and as the matter stands to date, it is only the dust or size below 48 mesh that is really objectionable, and this only because in our desire to compete with other fuels we have picked upon the so-called dust nuisance as being the only objectionable feature of coal and have tried to sell the consumer accordingly. However, for the sake of sales we can still dispose of the dust at a loss and provide a more economical fuel than our competitors.

As far as a cleaning plant is concerned, the elimination of dust is very desirable. The result being to greatly assist the collection and purifying of air in a dry cleaning plant, and the conservation and purifying of water in a wet plant.

The problem of removal must be approached from different angles in each case and at the present time is largely dependent upon the amount of moisture and refuse in the coal. In the case of a shaft or drift mine, it probably can be and has been successfully removed by air or screening methods. However, at a strip mine with its widely varying moisture conditions, such attempts would be likely to meet with failure unless sufficient water was added so that the fines could be washed through a screen.

As to the balance of the sizes, the picture has changed somewhat through the development of markets for the finer sizes and the modern preparation plant must now be equipped to reduce any surplus of the coarser sizes to a grade that can be disposed of. This is leading the manufacturer to the necessity of developing crushers that are capable of reducing the sizes of coal by stages with a preponderance of the desired size range and a minimum of fines or dust. Progress has been made in this direction and we can look forward to the time when we will be able to grind to any degree of fineness upon prescription and by turning a screw to a predetermined point.

This search for elimination of degradation led to a design of preparation plants in the past that frowned upon the use of all bins in its make up, due to their faculty for making fines. Now, however, the elimination of degradation having been somewhat altered, attention has been directed toward an accurate sizing and the removal of smaller sizes with their proper distribution at the point of final preparation.

These conditions and the growing demand for sizes heretofore shunned, has led to the thought that a return of the bin in a preparation plant is not an evil, but an actual necessity so that the greatest flexibility may be had in filling the prescriptions received from doctor salesman.

Therefore, a preparation plant equipped with a series of bins fitted with measuring devices, and mixing facilities, will place the operator in a position to meet market demands with the greatest flexibility.

Maximum Efficiency

Under this heading a great deal may be said, but efficiency as used in connection with the cleaning plant may be termed the accuracy with which the product is prepared and/or the operation of the plant with a minimum cost.

Accuracy in preparation depends upon the adaptability of the units selected for the problems involved and a discussion of this type cannot be general, but must be based upon the problem at hand. It will therefore, not be entered into at this time.

This leads us into the operation of a plant at a minimum cost, and the keeping of maintenance costs as low as possible.

In a plant design, the reduction of the number of units required to accomplish results is one of the goals of a good engineer, but is often overlooked by the plant designer. Maximum efficiency in a conveyor consists of utilizing both the runs for the carrying of material and the proper selection of units entering into its construction.

In the case of belt conveyors, they can only be used to carry material from one destination to another with no intermediate discharge points and the return run is usually useless. They do, however, perform this duty with a minimum expenditure of power and low maintenance costs.

On the other hand, a flight conveyor offers the greatest flexibility and fullest usage at the expense of a greater power and maintenance cost. Which is most efficient depends entirely upon the work to be performed and its proper insertion in the plant design.

When the question of conveyor drives is analyzed it has been proven that the use of a totally enclosed gear train such as the commercial type of speed reducers, are most efficient and while the first cost is from

10 to 20% higher than the conventional type of countershaft and gears, the maintenance and savings in supplies soon balances this difference. There are also several intangibles, such as space, supports, safety, etc., that should be taken into account. An efficient design will produce a plant based upon the use of a minimum number of different sized units having intermediate connections that will provide flexible means of varying speeds as the requirements are changed.

The use of stainless steels in the construction of screens and chutes has done much to increase the efficiency and reduce maintenance and when properly used, result in no appreciable increase in overall costs.

A discussion of the control or operation of a preparation plant would be fitting at this time.

The modern plant equipped to meet the demands of all markets must be provided with the greatest flexibility. This includes the loading into railroad cars, or trucks and the mixing and blending of the various sizes, the dedusting and spraying with oil, the cleaning of the various sizes and the receiving of the coal from the mine as well as the disposal of refuse. Such a plant is necessarily equipped with a considerable number of units, all of which must be operated in proper sequence or the prescription being filled at the time will be a mess. This may be left to a number of operators who by a system of signals, make a success of it as a rule. Plant control, however, may be more successfully accomplished by a centralized control station fitted with the necessary equipment that will permit sequence starting of the various units in accordance with the flow sheet of the plant.

Automatic control of the cleaning unit is also effective in producing maximum efficiency at a minimum amount of supervision. With such a system, namely, centralized plant control and centralized loading stations, it is only necessary to provide a minimum number of attendants throughout the plant and the laboring forces are materially reduced.

One very essential feature in procuring maximum efficiency in a plant is the chemist and his laboratory, who keeps a constant check upon results and catches any deviation from the standard before it has a chance to get to the consumer.

To summarize, it is necessary first, to study all of the factors entering into the individual requirements of a mine. These are then set forth in their proper economical influence upon the design so as to obtain the most valuable product at the least cost. Under these conditions it is the engineer who is most fitted to put together the intricate pattern of these problems. Ability and experience combined can be responsible for obtaining the maximum results with the least amount of expenditure.

* * *

Chairman Schull: Now gentlemen, you have heard two good papers and here is an opportunity to tell what you think about them, don't hesitate; who will be first?

Mr. M. S. Lambert (Robins Conveying Belt Company): What I have to say may be a little on the side of heresy, in this group. Mr. von Meding made the statement in his paper that vibrating screens are not suitable for coal screening above inch and a quarter. The company I represent, Robins, believes, and we have good evidence to back our opinion, that vibrating screens, of proper design and properly applied, are entirely suitable for all coal screening from the smallest to the largest separations.

There are many tipples, especially in West Virginia, Pennsylvania and Ohio, that are doing all their screening with our vibrating screens. Within the last year, two large companies have built vibrating screen tipples that are operating with outstanding success. As a matter of fact, from a start in 1931, we got up to nearly 4,000,000 tons of mine run tonnage on our vibrating screens in 1937.

Vibrating screens used for coarse coal screening might more properly be called "gyrating" screens because the screens we build for this purpose have a relatively long stroke, circular or sifting motion and operate at relatively low speeds. This action lifts the coal out of the screen openings so that the undersize can go through, and it gets away from a disadvantage of most shaker screens that can clear the openings only by shearing the coal lying in them.

Most people have the impression that vibrating screen action will break up the coal and be a source of fines production. Speaking comparatively, the opposite is true. It seems that because it has one of the shearing effect of shaker screens, the vibrator actually makes less degradation. One of our customers who operates several converted tipples says that the vibrators give him 15 to 20 percent more in coarse sizes than he had before and another reports that "while the Gyrex screen action is not violent, it is of a character which eliminates shatter cracks and the lumps remain solid during transportation."

Various industries, comparable with coal in their sizing-preparation requirements, have successively adopted vibrating screens as standard equipment for coarse as well as fine screenings. In the by-product coke industry, and sized coke being a valuable and highly friable product, it was found some 15-18 years ago that vibrating screens had high screening efficiency plus the especial advantage of making a minimum of fines. Coke is screened on vibrators with as large as three or four inch openings and within my experience vibrating screens have replaced practically all other screening equipment in by-product plants and have been the accepted standard for all new installations.

A little later, the crushed stone and sand and gravel industries, also extensive users of screening equipment for a wide range of sizing, adopted vibrating screens as a matter of standard practice. Screens for crushed stone with larger openings than we require for coal and handling chunks weighing up to a thousand pounds have been operated successfully. Iron ore and other metal mining are further typical examples of the movement toward vibrating screen use.

Since vibrating screens have proved so appropriate for these industries and even for coarse coal screenings in recent years, one may wonder why the coal people haven't taken to them more generally and why the many new cleaning plants that have been built were mainly equipped with shakers. As I see it, coal screening has been done with shakers for so long that the shaker has acquired a traditional reputation as the accepted unit for first-stage screenings, bearing in mind that vibrators in the fine range have really only broadened preparation practice and have not displaced shakers. It was simply not worth considering anything else nor was there real occasion to consider another method so long as coarse sizing with shakers gave acceptable results. Our company, while seeing the general possibilities and advocating the use of our vibrating screens for coarse coal screening, was a relative newcomer in the coal field and we had much to learn, both as to adopting our screens to handle mine run coal in large tonnages and to fitting them into the tipple layout. In the meantime, cleaning plant construction and attendant problems have come in for major attention, involving enough headaches in other directions to discourage fooling with a new-fangled idea on the screening end.

But we have reached the point where vibrating screens for coarse sizing are out of the experimental stage. They now have a background of proven performance and we have become experienced with their design and application. Keeping in mind what I said before that they must be properly designed and properly applied, we know their advantages of increased sizing efficiency, high capacity, flexibility, cheapness of installation and low cost of operation. We know how to utilize variations of stroke, speed, slope, screen surfaces and other adjustable factors to insure the best results under given conditions. We know their limitations too and in this connection, it was brought out in one of the A. I. M. E. meetings in Chicago last week that a vibrating screen is relatively short and doesn't convey the coal across several tracks as does a shaker screen. It is true that a standard arrangement of loading tracks requires distribution of the sized coal to the various tracks by one means or another. A vibrating screen layout may require distributing conveyors or a unit such as the new vibrating chute we have developed, to load cars on the far tracks. Practically speaking, these accessories for coal distribution in connection with a vibrating screen involve no penalty to the operation and for the most part can be shown to have definite advantages such, for instance, as for picking or inspection.

You're all familiar with the use of vibrating screens for fine screening and I've talked longer than I ever expected to, trying to give you a reasonably comprehensive picture of their possibilities for coarse screening. I'll be glad to give any other information I can to anybody wanting it, or if you wish, you may communicate with the Robins Conveying Belt Company. I thank you.

(Applause.)

Chairman Schull: I see a lot of people that want to say something but are afraid; speak right up, we want to hear from you.

Mr. John Griffen (Koppers-Rheolaveur Company): Mr. Chairman, I was particularly interested in the paper on the question of the angle of Maximum Efficiency:

I take it that everyone will agree that the best measure of maximum efficiency is the recovery of coal of the desired analysis.

Our study of coal cleaning installations in the Indiana-Illinois fields shows that many installations have failed to attain maximum efficiency because too little attention has been paid to the cleaning, recovery and drying of fine coal. As a result the losses of good coal in the sludge amount to large annual tonnages, the sales value of which would show a very handsome return on the investment for proper treatment and recovery.

We have definite data giving direct comparisons which clearly show this situation and the following is typical.

We installed in Illinois several years ago, a plant to clean 435 tons per house of 3″ x 0 strip coal. This plant includes separate units to clean and dry the carbon. The operating officials of the coal company have kept very complete records of the coal shipped and of the various rejects.

Before this plant was built the coal had been shipped to a cleaning plant equipped with Baum type jigs handling unsized coal, with no separate cleaning of carbon. The conventional sludge screens were used. Careful records were kept of recovery and sludge losses.

The comparison of the sludge losses is as follows:

Total Solids	Rheo Plant	Jig Plant
% Dry Ash	68.6	38.9
% plus 48 Mesh, % Weight	15.2	52.0
T. P. H. of plus 48 Mesh in Sludge	6.1	21.2

This shows a saving of 15 tons per hour or 105 tons per 7 hour shift which on 200 days per year means 21,000 tons of coal which has been shipped with the screenings and therefore at the same price as screenings. Conservatively valued this extra coal recovery paid for the extra plant investment in three to four years.

The carbon produced by the Rheo plant averages 0.5% lower ash than that from the jig plant.

In another instance we installed a Rheo fine coal unit in an existing Baum jig type cleaning plant to clean the sludge from a settling tank and the jig secondary refuse which had been crushed —3/8″. This unit is handling 100 to 135 tons per hour, making a 50 to 60% recovery. The data on the sludge alone shows 30 tons per house with the following screen analysis:

	% Wt.	% Wt. Float 1.45 Sp. Gr.
Plus 28 Mesh	56.3	73.8
28 x 50 Mesh	20.5	75.4
—50 Mesh	23.2	—
	100.0	

Recovery from the plus 50 Mesh sludge is 75% or 17 tons per hour or 120 tons per 7 hour shift. This means 24,000 tons during a 200 day year.

The overall recovery from the total feed amounts to about 60 tons per hour or say 400 tons per 7 hour shift. This property normally produces 3,500 tons per shift. In this instance the extra plant cost is returned in less than a year.

For full details on this last plant see the article on page 14 of June 1938 issue of Mechanization.

Another measure of the efficiency of a coal cleaning plant is the uniformity in analysis of the product. The trade likes and demands coal which is uniform car for car.

The first plant mentioned above gives typical data on the uniformity of Rheo cleaned coal.

Analyses are available on hundreds of cars of raw and cleaned coal and show the following:

LIMITS OF ASH % FROM AVERAGE

	—1½″ x 0—		—5/16″ x 0—	
	Raw	Cleaned	Raw	Cleaned
500 of 1000 cars	±2.25	±0.79	±2.46	±0.51
993 of 1000 cars	±9.00	±3.16	±9.84	±2.04

Generally Rheo cleaning plants in the United States have reduced the variability of the cleaned coal to from ½ to less than 1/6 of that of the raw coal.

* * *

Chairman Schull: Is there any further discussion? If not, I want to thank you for the splendid papers and the good attendance which we have had and all of these gentlemen who were frank enough to get up and tell what they thought. At this time I will turn the meeting back to Mr. Taylor.

President Taylor: Thank you, Mr. Schull. One thing before we adjourn, I want you all to be sure to register and be sure to buy your banquet ticket. We will now adjourn to meet at 2:00 P. M.

(Whereupon at 12:15 P. M., a recess was taken to 2:00 P. M. of the same day.)

AFTERNOON SESSION

2:00 O'clock P. M.

President Taylor: The meeting will please come to order. The Chairman for the afternoon is Mr. Louis C. McCabe of the Illinois Geological Survey.

(Applause.)

Chairman McCabe: We have on the program this afternoon some papers which look on the rosy side of the coal industry. The first paper is, "The Stoker Industry: Its Progress; Its Demands, and Its Influence on Production, Methods and Policy," by Mr. Thomas Marsh. Mr. Marsh is a man whom you all know and I would say is one of the best revivalists of the coal industry that we have anywhere in the country.

(Applause.)

THE STOKER AND COAL INDUSTRIES: THEIR PROGRESS, DEMANDS, TRENDS IN PRODUCTION METHODS AND POLICIES

By THOMAS MARSH

Central Division Engineer, Iron Fireman Co., Chicago, Illinois

Who in thunder is responsible for all this extra work, extra expense and fussiness in coal preparation. Time was when we sold mine run, lump and screenings and everyone was happy, (or were they?). Now we have sized coal, dedusted coal, washed coal, dried coal, assembled screenings, specified consists, oil treated, identification tagged, colored and probably a few more preparations I have omitted. I know many of you on the production end must at times say "curses on the whole thing."

The story is that King Cole was a rather bad dirty boy—so bad that many of those whose income depended on him wouldn't allow him in their houses. King Coal now has taken a bath, bought some new clothes, had a hair cut, moved across the tracks and is mingling in high society all the way from the average home owner to Mr. and Mrs. Millionbucks. And believe it or not, he is making good in this society and fulfilling the hopes of his backers who are the owners of the mines you work in.

This has all been some transformation and it hasn't been easy. Let's take a look at things. Coal held its place in the increasing production of heat and energy in this growing country until 1918. From that time the curve of oil consumption for these sources began a steady rise. Later the natural gas consumption curve began to rise.

Who in thunder wanted this dirty clinkery, laborious fuel called coal for home heating? Frankly, *I* did not, and believe it or not (and I repeat this) many of the coal company executives went to oil for their homes and I don't blame them. I am glad to say that since King Coal himself has reformed and "got religion" he has come back in the homes of these same executives of our coal companies.

I am not going to try to tell you the history of the coal industry but I want to mention some high spots.

In 1933— 90,000 oil burners were installed

1934—100,000 oil burners were installed

1935—140,000 oil burners were installed

1936—196,000 oil burners were installed

1937—193,000 oil burners were installed

—using round figures.

Now, this wasn't done for economy. In most cases in your market territory the oil bill was 50% higher than the coal bill. America was "moving up"—living standards were improving.

Through the first part of this period stokers were fighting an uphill battle in development, public acceptance, improper coals, and apathy and even antagonism of coal producers and retailers.

Now that 190,000 oil burners installed per year took premium tonnage right and came out of the profits. How that picture is changing! Let's look at stokers:

In 1932— 9,000 stokers were installed
1933— 18,000 stokers were installed
1934— 28,000 stokers were installed
1935— 48,000 stokers were installed
1936— 86,000 stokers were installed
1937—107,000 stokers were installed

1937 might have reached 140,000 had not the recession overtaken us. Let's look at the ratios.

In 1932 the ratio of oil burners to stokers was 10 to 1.

In 1937 the ratio of oil burners to stokers was 1.8 to 1.

It won't be long now before the sale of coal burners will exceed the sale of oil burners. Already in St. Louis since October 1937 the ratio of stoker installations to combined oil and gas burner installations is nearly 3 to 1, in favor of stokers burning *coal*, and other localities will be heard from soon with similar reports.

Our own company, the Iron Fireman Company, has in *Chicago alone* reclaimed 120,000 tons of coal *per year* for your industry by replacing oil burners with stokers.

Now, don't overlook this important point. When you had these nice customers on premium hand fired coal you never had a safe business. Your premium output fired inefficiently and with no automatic heat control was always a "lame duck," a cripple for the oil and gas man to knock over. When a stoker is installed you have a coal customer for 15 years at least.

Now, let's look at just one other bracket of your output—steam coal.

In 1919 the average coal per K.w.h. of electric plants was about 3.2 lbs., today it is 1.44 lbs. or less than one-half. What was true in electrical stations was even greater in large industrial plants. Steam coal must produce competitively low cost steam so the increased production costs of coal drove many of these large consumers to oil and gas. Keep that point well in mind. The higher the price of steam coal the lower will be your output. There will be less working days and some mines will shut down. The same is true for every water power that comes in. Water powers reach right into your individual pockets and go after your pay checks.

So, you can see what those who have invested their life's work and life's savings in the coal industry, as well as yourselves, whose income depends on economical and profitable production, have been going through for a number of years.

Now, this steam coal picture looks better too. Central stations and large industrial plants have reached a point of efficiency beyond which it is not profitable to go. Every additional unit of output will from now on be accompanied by an increased tonnage of coal. This is not speculation, it has already started and the return of prosperity will make it very noticeable.

Now what about the coal itself. To consider this, we must break the market down into 3 brackets:

Steam coal
Commercial coal
Residential coal

Steam coal is "on track" coal and is sold wholesale almost entirely on an economy basis. There are as many as 20 items a good buyer should consider, such as the ability to always carry his load, freedom from shutdowns and outages; the producer, uniformity of product, storage qualities, all leading in the end to low cost of production over a prolonged period.

There is a marked tendency toward the use of cleaner steam coal and uniformity of product in steam plants. Cleaner, better coals are gaining this market. This is all relative to costs as there is always a limit. A lower priced short freight rate coal, quite inferior in quality and even burned at 10% lower efficiency, sometimes makes the lowest cost steam. Each case must be analyzed but the tendency is toward cleaner coals and uniformity of consist.

Commercial coal is such as is sold to stores, office buildings, apartment hotels, etc. It is "off track" coal, handled by the fuel merchant and carrying his cost and profit sells at about 40% higher price than on track coal. Due to deliveries in buildings where people live or work in general, the coal must be of a cleaner delivery than is necessary in a power station. Then too, due to the retail price the product must be of higher grade. It costs as much to haul high ash, high moisture, as low ash, low moisture coal. Cleaner better prepared coals are logically capturing this market.

Residential coal is still another story. Residence stokers burn entirely retail coal. The buying motive is *not* economy. It is comfort, convenience and general fuel satisfaction. Dustlessness is paramount; uniformity of size is desirable. The average home owner will cheerfully pay 50¢ more per ton for a coal that he likes and in many cases, it is the housewife that must be satisfied.

You all know what we all went through on this coal. First, the standard steam coal, 1½" or 2" raw screenings—yard screenings from retail yards and what have you. No one really knew best sizes of any coals; few do today, and yet, the solution of that problem is rather simple.

Then came prepared stoker coals and with them this grand realization that home owners will pay premium prices for quality. And what splendid co-operation we have had from your industry during the last 3 years. Your owners and stockholders have invested tens of millions of dollars into preparation plants; you have developed sizes and methods of production and preparation until now one can name any number of the finest stoker coals as to quality and size from your field.

While all this has been transpiring on coals, stokers have undergone a greater development than automobiles. From the crude machines built in little shops, the picture has changed to large production factories with laboratories and research departments and with staffs of engineers to develop the product. The stoker of today is vastly different from the stoker of 1930 or of 1935. There are, of course, scores of minor stoker companies working with small facilities and obsolete designs just as in your industry there are gopher holes with poorly prepared coal. You should back the progressive and developing stoker companies, who are putting over your product. The leaders in the stoker industry have spent hundreds of thousands of dollars to win public acceptance for stokers and *coal.* These leaders deserve your backing and support.

These same leaders will pledge you a continuance of development and research toward better stokers every year just as automobiles have been improved every year.

This has put your industry on a far firmer foundation. It has taken a tremendous amount of courage and merits your 100% co-operation.

The solution does not stop with these big expenditures at the mines unfortunately. What would you do with a lot of well prepared coal down there—you can't eat it—you can't buy clothes with it. It must be sold and at a premium price. It is worth it and fortunately the purchaser will pay for it even in these distressed times.

It has been necessary to do sales research and to make changes in selling organizations. Retailers of the old school know little of coal utilization; many care less. They figure that people must buy coal and they will get their share. That day is past. Producer salesmen of the old school sold on friendship, good fellowship and generalities. That day is over. Sure, there will be many a piece of business taken with the bottle and the big night, and headache in the morning, but the picture has changed.

To sell these premium coals, it has been necessary to train retail merchants who know coals—and coal application—who can talk sizes, consists, fusion temperature, ash content; retailers who can "read a fire," "fit the coal to a plant"—and harder yet, sometimes "fit the coal to the consumers requirements."

This new phase of coal selling has been much more difficult in development than all the costly equipment you see in the mine preparation plants, because it is intangible and requires a long period of education and evolution. It requires the education of those who are in business or, by the law of survival, of their replacement. More and more the new school producer salesmen, engineers and sales engineers are being trained who are in turn training more and more retailers who really merchandise coal on its merits.

This is another development which is working towards your security and your betterment.

Now, there is a problem that has to do with the under size and high ash coal; ¼″ to 0 or 10 mesh to 0, or high ash coal or low fusion ash coal.

I want to tell you briefly of how the spreader stoker fits this field. You know, there are 3 types of stokers:

1—*Underfeed stokers* in which the coal is fed in the same direction as the air supply.

2—*Cross feed stokers*, in which the coal is fed at right angles to the air like on a chain grate.

3—*Overfeed stokers*, in which the coal and air are fed in opposite directions.

The spreader stoker is an overfeed stoker. It fits into the production problem of making better stoker coals and disposing profitably of small sizes. It absorbs high ash tonnage and low fusion ash tonnage.

I present to you a colored motion picture of The Iron Fireman Pneumatic Spreader Stoker.

(Mr. Marsh here presented a very interesting and educational motion picture of burning of coal by the spreader principle.)

CONCLUSION

We have briefly covered some of the high spots of present day coal preparation, coal merchandising and utilization. It has been a great fight but we are winning on the residential front. We are winning on the commercial front. We are holding our own on the industrial front and with returning prosperity, will make a victory of this.

Stay in there doing your stuff. Give your sales department the last word in preparation for residential coals; clean economical coals for commercial coals and economical but improved coals for the large steam plants and you will join me in my optimistic outlook for the coal industry.

* * *

Chairman McCabe: I think we have heard a very good discussion by Mr. Marsh, and his Organization has certainly aided the coal industry. As an example of Mr. Marsh's activities—in Chicago, last week, he told me he was rarely at home, that he was sent out to see certain parts of his Organization, supposed to be gone a day or two, and had been gone a month or two months. He was in my room at the hotel in Chicago and said, "What time will we be through this evening?" and he said, "I will have to call my wife," and he called her and said, "I won't be home tonight."

We should have some interesting discussion on this paper of Mr. Marsh and I will call for discussion from the floor.

We have with us this afternoon, Mr. Ralph Sherman; perhaps Mr. Sherman would like to say a word.

Mr. Ralph Sherman: I wasn't expecting to be called on, really Tom Marsh covered his subject, not only covered the new stoker which you have seen and which I have seen several times and which I always enjoy seeing again, with a thought that here is a stoker that will handle these coals formerly called waste coal, not waste because they don't have heat value; it may be lower but it is heat value, and we should be able to use these stokers, they will certainly handle this coal. Mr. Marsh has covered the great strides we have made in this discussion and we hope shortly that they will be passing the sale of oil burners.

Chairman McCabe: Thank you, Mr. Sherman. Mr. Bentley of Johnson-March Corporation.

Mr. Bentley: There is only one message and one thought. I think the greatest stride that has been made is the aggressive operator leaving the dimensions off the stoker coal and putting a name on it. It has been my experience that the dimension of the coal has caused more customer negative reaction than anything. There is another thought for the operator, each individual mine has a problem in the production of stoker coal. That because a neighbor makes a certain size, that don't mean that this particular mine can duplicate that size and obtain satisfactory results. It is going to be a problem that each operator must work out for himself, work it out for each mine both by mining methods and by preparation methods as well.

(Applause.)

Chairman McCabe: Mr. McCulloch of the United Electric Coal Company, would you like—

Mr. McCulloch: I have nothing further to add to the discussion with the exception of going further on Mr. Bentley's remarks, that individual mines require separate preparation for stoker coal and in that direction I believe that the more northerly Illinois mines can use the larger coal than the southern Illinois mines.

Chairman McCabe: Any questions? If not, we will pass on to the next paper, "Potential Markets for Illinois Coal on the Upper Mississippi Waterway," by Dr. Walter H. Voskuil, State Geological Survey, Urbana, Illinois. Dr. Voskuil.

POTENTIAL MARKETS FOR ILLINOIS COAL ON THE UPPER MISSISSIPPI WATERWAY

By DR. WALTER H. VOSKUIL
Mineral Economist, State Geological Survey, Urbana, Illinois

INTRODUCTION

The purpose of this investigation is to evaluate the usefulness of the Upper Mississippi River as a means of transporting coal from fields in Illinois to markets bordering the upper river in Minnesota, Wisconsin and Iowa. The Mississippi River, when completely canalized above Alton, Illinois, will consist of a 9-foot channel to St. Paul and Minneapolis equipped with locks 600 feet long and 110 feet wide for the transportation of barges past the dams.

This report contains data on the approximate extent of the coal market, the present sources of coal, and the comparative costs of transporting coal from originating fields to the principal market points.

The project to canalize the Mississippi River to a minimum depth of 9 feet between Alton, Illinois, and St. Paul, Minnesota, a distance of 657 miles, will create a highway of transportation which may enable the coal industry of Illinois to take advantage of markets in Minnesota and Wisconsin not hitherto served by the Illinois industry. This possibility depends upon effecting a reduction in freight rates on coal to a level substantially lower than the rail-lake rate from the fields of Pennsylvania, West Virginia, and Eastern Kentucky to the markets of the Upper Mississippi Valley.

There is a coal market, in the counties bordering the Mississippi River in Iowa, Wisconsin, and Minnesota, of approximately 5,000,000 tons of coal distributed as follows:

Use	*Amount (Tons)*
Manufacturing and mining industries	2,200,000
Public utilities	400,000
Domestic heating	2,400,000
Total	5,000,000

The figure for manufacturing and mining represents the amount of coal, coke, and anthracite used by manufacturing and mining industries in 1929 as reported to the Census. (The exact figure as reported was 2,295,667 tons.) The amount of coal used by electric utilities in these counties in 1929 was 434,829 tons. The amount of coal used for heating homes is estimated at 2,400,000 based on an assumption of an average consumption of 1.5 tons per person per year. Detailed consumption data are given in table 1.

TABLE 1.—Coal consumed in Mississippi River counties in Minnesota, Wisconsin and Iowa, 1929

(Net tons)

County	Manufacturing*			Mining all types solid fuel†	Public utility°
	Anthracite	Bituminous	Coke		
Iowa—					
Allamakee	118	585	54	....	....
Clayton	190	7,224	217	....	....
Clinton	710	177,758	1,387	2,000	18,179
Des Moines	118	50,127	2,614	....	2,160
Dubuque	240	55,375	2,412	1,515	55,972
Jackson	244	1,581	504	....	....
Lee	345	132,626	17,163	....	....
Louisa	....	491	....	....	....
Muscatine	16	23,457	641	690	1,162
Scott	675	190,469	6,719	6,286	....
Total	2,650	639,693	31,711	10,491	77,473
Minnesota—					
Anoka	....	11,349	32	....	....
Carver	31	18,499	568	....	....
Dakota	174	139,754	224	....	....
Goodhue	675	31,304	3,242	....	....
Hennepin	9,000	327,795	52,853	2,652	190,798
Houston	....	1,267	40	....	....
Ramsey	2,100	795,729	23,877	1,241	142,339
Scott	95	1,160	350	....	400
Wabasha	380	3,877	1,979	....	....
Washington	520	30,531	396	....	....
Winona	460	46,023	1,554	....	16,519
Total	13,435	1,407,288	85,115	3,893	350,056
Wisconsin—					
Buffalo	7	2,756	....	....	....
Crawford	2,840	1,658	33	....	....
Grant	7	6,819	55	471	....
LaCrosse	696	60,730	1,919	....	7,300
Pepin	....	....	18	....	....
Pierce	....	....	35	....	....
St. Croix	3	9,776	53	....	....
Trempealeau	10	5,324	40	....	....
Vernon	190	7,949	....	....	....
Total	3,753	95,012	2,153	471	7,300

* Consumption of fuel and electric energy in manufacturing industries, Manufactures, 1929, Fifteenth Census of the United States, U. S. Department of Commerce, Bureau of the Census.

† Consumption of fuel and electric energy in mining and quarrying industries, Census of Mines and Quarries, 1929, Fifteenth Census of the United States, U. S. Department of Commerce, Bureau of the Census.

° Consumption of fuel by public utility power plants and production of electric power by fuels and by water power in 1929, by counties and by states, Mimeograph release of the U. S. Bureau of Mines.

At the present time the coal market of the Upper Mississippi Valley is dominated by the lake cargo coal. A general view of the sources and distribution of coal may be obtained from an inspection of coal distribution data prepared by the National Bituminous Coal Commission applicable to this area.*

	1937
Receipts of coal at Lake Superior dock	9,357,000 tons
All-rail coal shipments to Minnesota from:	
Eastern fields	294,425
Western Kentucky	52,721
Indiana	100,779
Southern and central Illinois	491,205
Northern Illinois	65,727

* Distribution of coal shipments, M.C.D. No. 79, April 30, 1938, U. S. Department of the Interior, National Bituminous Coal Commission.

Lake cargo coal shipped to Lake Superior ports is destined to interior points in Wisconsin, Michigan, Minnesota, the Dakotas and minor quantities to states further west. Distribution of coal from Lake Superior ports in 1935 is shown in table 2.

TABLE 2.—Distribution of coal from upper lake ports during 1935*

(Net tons)

Destination	Quantity (tons)	
	All ports	Duluth-Superior
Canada	22,030	22,030
Iowa	42,766	40,454
Michigan	579,526	43,346
Minnesota	4,873,084	4,697,538
Montana	586	586
Nebraska	10,386	10,386
North Dakota	301,893	289,237
South Dakota	339,266	324,936
Wisconsin	1,560,250	1,399,801
Total	7,725,714	6,828,317

* Maher Coal Bureau, St. Paul, Minn., and Annual Report, Chief of Engineers, U. S. Army.

Minnesota, in the year 1935, took about 4,900,000 tons or 63 per cent of the coal received at the Lake Superior docks, and 68 per cent of all coal received at Duluth-Superior, the principal coal port. Of this tonnage, it may be assumed that a large portion was distributed in the counties bordering the Mississippi River and included in this survey. Within the area in question are located the large cities of St. Paul and Minneapolis which include the important manufacturing and public utility industries of the State. These cities are also important railroad terminal points for the fueling of railroad locomotives. Altogether the population of the river border area in Minnesota comprises 40 per cent of the total population of the State. It is not unreasonable to assume that the movement of lake cargo coal into this area may reach as high as 3,000,000 tons yearly. Also, some lake cargo coal from both Lake Michigan and Lake Superior docks probably reaches the border counties of western Wisconsin.

MISSISSIPPI WATERWAY

The Mississippi River from the dam at Alton, Ill., to the dam at St. Paul, is 644.7 miles in length. Between these two points there are 26 dams and locks either completed or in process of construction. These locks have a total lift of 304.1 feet. All locks are 600 feet long and 110 feet wide. The dams are designed to create a series of pools during low river stages. The location of dams and the lift at each is given in table 3. Each dam has a section containing movable gates, which can be raised above extreme flood heights to pass the flow of the river. When water is high the dams will be opened so that at no time will they appreciably increase flood heights. A spillway section is provided over which any flood water in excess of that flowing through the gates can pass. The movable gates are so built that they can be submerged to pass ice and water over the top or raised to pass water under the bottom.

PORTS AND TERMINALS ON THE MISSISSIPPI RIVER

An important element in water transportation is a terminal suitable for the low-cost transfer of freight from railroad to barge or from barge to railroad. Possibility of successful shipment of coal from fields in Illinois to the markets of the Upper Mississippi Valley will be enhanced by careful preliminary surveys of port facilities. At both shipping and receiving end, sites for construction of necessary loading or unloading equipment should be selected after careful consideration of topography and shore line conditions and sources and market outlet of the coal available for this form of transportation.

Generally speaking, terminals for loading coal in barges consists of tipples or conveyor systems emptying into hoppers from which chutes lead to the barge, while terminals for unloading barges usually involve more expensive equipment in the way of cranes and bucket conveyors. If the crane is used the clamshell bucket usually serves as the means for handling the material which is deposited in hoppers. It is then sent to cars or storage, either by

TABLE 3.—Location and lift of Mississippi River dams above the Ohio River*

Dam No.	Location	Miles above Ohio River	Lift (feet)
1	Minneapolis-St. Paul, Minnesota	847.6	33.95
2	Hastings, Minnesota	815.2	14.15
3	Red Wing, Minnesota	796.9	8.0
4	Alma, Wisconsin	752.8	7.0
5	Fountain City, Wisconsin	738.3	9.0
5A	Winona, Minnesota	728.5	5.5
6	Trempealeau, Wisconsin	714.3	6.5
7	LaCrosse, Wisconsin	702.3	8.0
8	Genoa, Wisconsin	679.1	11.0
9	Lynxville, Wisconsin	647.9	9.0
10	Guttenberg, Iowa	615.1	8.0
11	Dubuque, Iowa	583.0	11.0
12	Bellevue, Iowa	556.7	9.0
13	Clinton, Iowa	522.5	11.0
14	Le Claire, Iowa	493.3	11.0
15	Rock Island, Illinois	482.9	16.0
16	Muscatine, Iowa	457.2	9.0
17	New Boston, Illinois	437.1	8.0
18	Burlington, Iowa	410.5	9.8
19	Keokuk, Iowa	364.2	38.2
20	Canton, Missouri	343.2	10.0
21	Quincy, Illinois	324.9	10.5
22	Soverton, Missouri	301.2	10.5
24	Clarksville, Missouri	273.4	15.0
25	Cap au Gris, Missouri	241.5	15.0
26	Alton, Illinois	202.8	20.0

* Corps of Engineers, U. S. Army, Rock Island District, 1937.

gravity or by means of conveyors, or it may be deposited into cars or storage direct. There are many variations of the procedure and, in considering construction of coal loading or unloading terminals, the needs of each port in terms of annual shipments, storage requirements, and connecting railway facilities must be studied.

POSSIBLE SITES FOR THE DEVELOPMENT OF COAL PORTS

The number and location of coal loading ports on the Mississippi River will depend upon the market that can be developed, the source of the coal, and railroad facilities. There are several points on the river where both physical conditions favorable to port development and railroad connections with coal mining districts exist. A brief description of the principal ports on the river together with freight rates from selected coal mining districts is given below.

PORTS OF CHESTER, ILLINOIS

The most southerly port on the Mississippi River to be considered for the transshipment of coal is located at Chester, Illinois. It has two terminals, a paved wharf and a railroad incline. There are two railroads entering Chester: the Missouri Pacific; and the Missouri Illinois Railroad. All have switches along the river front and the Missouri Pacific has an incline. There is practically no interchange of traffic between river and rail, except sand.

Freight rates on coal from representative districts to Chester areas follow:*

From:	*Cents*
Belleville	95
Duquoin	95
Tamaroa	95
Southern Illinois	115
Sparta	80
Percy	80

* Letter from Traffic Manager, Illinois Central System.

PORT OF EAST ST. LOUIS

East St. Louis extends from 1 mile above to 2 miles below the Eads Bridge. The city is served by 27 railroads. Harbor lines have been established along the water front and seven terminals are located along the river bank.

Freight rates on coal in carload lots from representative mining districts to East St. Louis are as follows:*

From:	*Cents*
Belleville	85
Centralia	85
DuQuoin	95
Tamaroa	85
Southern Illinois	110
Mt. Olive	85

* Letter from Traffic Manager, Illinois Central System.

PORT OF ALTON, ILLINOIS

Alton is situated 25 miles north of St. Louis on the channel side of the river making it a favorable location for a river port. The frontage is owned in part by the city and in part by private parties. Dam No. 26 is located immediately above the Illinois-Missouri bridge and provides a still water harbor at Alton for a considerable distance upstream. A coal loading terminal is being constructed above the dam. Alton is served by seven railroads, viz., Alton and Eastern; Chicago and Alton; Chicago, Burlington and Quincy; Chicago, Springfield and St. Louis; C. C. C. and St. L., Missouri, Kansas and Texas; the St. Louis and Alton; and Illinois Terminal Railroad Co.

Freight rates from representative coal mining districts to Alton are as follows:*

From:	*Cents*
Springfield	85
Belleville	85
Centralia	85
DuQuoin	95
Southern Illinois	110
Mt. Olive	85
Tamaroa	95

* Letter from Traffic Manager, Illinois Central System.

The three ports described above are possible terminals for coal produced in southern and central Illinois and in the Belleville district. For the development of northern Illinois coal fields, conditions do not appear to be as favorable as for the southern fields. Possible river points for the development of coal loading terminals are Rock Island-Moline or East Moline, New Boston and Keithsburg. Both Rock Island and Moline are on the channel side of the river and are provided with facilities for handling sand and gravel.

These two cities are served by the Chicago, Rock Island and Pacific; Chicago, Burlington and Quincy; Chicago, Milwaukee and St. Paul; and the Rock Island Southern (to Rock Island only).

Freight rates on coal in carload lots to these cities from northern Illinois coal fields are as follows:*

From:	*Cents*
Fulton and Peoria counties	125
Victoria (Knox County)	120

* Letter from Chicago, Rock Island and Pacific Railway Company.

The development of coal loading facilities at either New Boston or Keithsburg is suggested as an alternative to the Rock Island-Moline port in the event that the latter district is too congested for the development of adequate coal handling equipment. New Boston is located above Dam No. 17, a factor which should aid in providing favorable conditions for a port. This point is served by the C. B. & Q. Railroad; Keithsburg is served by the C. B. & Q. Railroad and the Minneapolis and St. Louis Railroad.

RECEIVING PORTS

The points on the Mississippi River which may be considered as potential markets for river-borne coal are: the Minneapolis-St. Paul district, Winona Minnesota, La Crosse, Wisconsin, and possibly important points in Iowa, such as Dubuque, Clinton, Davenport, Burlington, and Keokuk. In the case of the Iowa cities, it may develop in the course of a transportation analysis that an all-rail haul from Illinois coal fields is more economical than a rail-river haul.

Among these potential markets the Minneapolis-St. Paul area is by far the most important, the market in Winona and adjacent territory is less so, but more important than La Crosse, Wisconsin, which is a smaller community with a less productive hinterland than Winona. River ports in Iowa are important coal consumers but are favorably situated with respect to all rail haul.

PRESENT FACILITIES

Minneapolis.—A municipal terminal owned by the city of Minneapolis and operated by the Inland Waterways Corporation is located just downstream from the Washington Avenue Bridge. There is a concrete wall 1,082 feet long, and 3 feet wide on top with a vertical face on the river side. The equipment consists of a locomotive crane, wharf barge, escalator and warehouse. Direct rail-to-water connections are available with the Minneapolis and St. Louis Railway Company.

St. Paul.—The Municipal Barge Terminal has coal terminal facilities with a present river frontage of 1,400 feet. Of this frontage the original construction is 400 feet of timber trestle, and the remaining 1,000 feet a reinforced concrete dock wall. Extending along the top of this trestle and wall are double railroad tracks and for the operation of electric unloading crane which has a capacity of about 100 tons per hour. In addition, there is a locomotive crane with a somewhat lesser capacity. Behind this trestle and wall the entire area is hard-surfaced to a depth of 200 feet for coal storage.

Winona, Minnesota.—The city has a masonry quay wall, adjacent to the business section, having a frontage of 1,150 feet and a depth of 200 feet. Switching tracks of the Chicago and Northwestern Railway are about 100 feet back of the quay wall.

La Crosse, Wisconsin.—At this city there is a paved embankment having a dockage front of about 1,500 feet, adjacent to the business section. Direct rail and water connections are available by the lines of the Chicago, Milwaukee and St. Paul Railway. No mechanical devices for handling freight are available.

UNLOADING FACILITIES AND EQUIPMENT

A survey of existing facilities for the development of coal traffic indicates that ample dock space is available in the principal cities of the Upper Mississippi River coal market area, but that coal handling equipment and coal storage yards must be provided. The type of coal handling equipment and the size of storage yards will be determined by forecasts concerning the probable growth of river-borne coal traffic.

FREIGHT RATES TO THE UPPER MISSISSIPPI VALLEY

Coal is shipped to the Upper Mississippi Valley by rail and water over the Great Lakes from mining districts in Ohio, Pennsylvania, West Virginia, Virginia and Kentucky, and by all-rail haul from these same fields, and also from shipments from Illinois, Indiana, and Western Kentucky. In table 4 is given the transportation cost from principal supplying fields to St. Paul and Minneapolis by the several routes of transportation, and the difference between these rates and deliveries to the port of Alton from Illinois fields. In column 1 is given the base rate effective before March 15, 1937. In column 2 is given the present rates which include the temporary increase granted by the Interstate Commerce Commission effective until December 31, 1938, unless cancelled, changed, or extended before that date. In column 3 are given differences between the freight rate from several southwestern Illinois mining districts to Alton (85 cents) and the rate from Appalachian fields to St. Paul and Minneapolis. In column 4 the difference between the rate from southern Illinois to Alton ($1.10) and the rate from Appalachian fields to St. Paul and Minneapolis is given.

The differences shown in columns 3 and 4 represent amounts considerably in excess of the cost of river transport from Alton to St. Paul and Minneapolis. This excess, less the river rate, may be sufficiently large to absorb the differences in mine prices of coal between Appalachian and Illinois fields and the price differential due to differences in the quality of the coal. If, for example, the river rate per ton of coal is $1.50, there is a differential of 140.5 cents in favor of coal from the Belleville district in comparison with coal from Massilon, Ohio, or a difference of $3.35 over coal from the Cumberland-Piedmont district of West Virginia.

RAIL-RIVER COAL TRADE AND SEASONAL PRODUCTION TRENDS

In view of the fact that water shipments to the northwest are made in a comparatively short season beginning about the 1st of April and ending approximately on the 15th of November, the coal mining districts supplying this market have enjoyed a summer activity which is not characteristic of mining districts dependent upon all-rail traffic for their market outlets. The monthly trend of production in southern West Virginia and eastern Kentucky fields, both of which are important contributors to the lake cargo trade, show a smaller monthly deviation from the average production than does either Illinois, or the coal industry as a whole. The monthly fluctuation in production in each of these states and in the United States is shown in table 7 and portrayed graphically in figure 2.

TABLE 4.—Rates on bituminous coal from selected coal mining districts to St. Paul and Minneapolis, Minnesota, and differentials between Alton and St. Paul-Minneapolis.

(Cents per short tons)

Field of Origin	Base rate*		Revised Nov. 15, 1937†		Difference, Belleville, Springfield, Mt. Olive, Centralia, (85 cents)	Difference, Southern Illinois (110 cents)
LAKE CARGO COAL:						
Ohio and Pennsylvania—						
Massilon	358		375.5		290.5	265.5
Ohio Number 8	373		390.5		305.5	280.5
Pittsburgh, Pa.-W. Virginia	376		393.5		308.5	283.5
Connellsville	384		401.5		316.5	291.5
West Virginia—						
Fairmont	396		413.5		328.5	303.5
Kanawha	413		428.5		343.5	318.5
Pocahontas-Tug River	426		443.5		358.5	333.5
ALL-RAIL RATES:						
Ohio—						
Ohio Number 8	505		520		435	410
Massilon	480		495		410	385
Middle	495		510		425	400
Pennsylvania—						
Connellsville	540		555		470	445
West Virginia—						
Cumberland-Piedmont and Gauley	555		570		485	460
Meyersdale	555		570		485	460
Roaring Creek and Upshur	540		555		470	445
East Kentucky—						
Hazard	540		555		470	445
Illinois—	Lump	Slack	Lump	Slack		
Herrin, Holidaysboro	375	316	390	331		
Cutler	365	306	380	321		
Belleville	380	306	380	321		
Mt. Olive	360	286	360	301		
Eldorado	390	316	390	331		

* Rates in effect previous to Nov. 15, 1937, in cents per short ton. Includes rate from producing field to lower lake ports plus 8 cents loading charge, 40 cents for lake haul and $1.82 for rail haul from Duluth-Superior docks to St. Paul and Minneapolis. Tariff authorities: Baltimore and Ohio R. R. Tariff I. C. C. C. and C. 2654; Louisville and Nashville R. R. I. C. C. A-16265; Missouri Pacific R. R. Co. I. C. C. A-7988; Louisville and Nashville R. R. I. C. C. 16155.

† Rates in effect beginning Nov. 15, 1937, and continuing until Dec. 31, 1938. Includes rates from producing fields to lower lake ports plus 8 cents loading charge, 40 cents for lake haul and $1.89½ for rail haul from Duluth-Superior to St. Paul and Minneapolis. Communications to the author from: Missouri Pacific Railroad Co., Freight Traffic Dept.; Baltimore and Ohio Railroad, Coal Traffic Dept.; Northern Pacific Railroad, Freight Traffic Dept.; and the Pennsylvania Railroad, Traffic Dept.

TABLE 5.—Rates on bituminous coal from selected coal mining districts in Illinois to river ports at Alton, East St. Louis, and Chester, Ill.*

(Cents per short ton)

Field of origin	Alton	E. St. Louis	Chester
Springfield	85	....	....
Belleville	85	85	95
Centralia	85	85	....
DuQuoin	95	95	95
Southern Illinois	110	85	115
Mt. Olive	85	110	....
Tamaroa	95	85	....

* Letter from Traffic Manager, Illinois Central System.

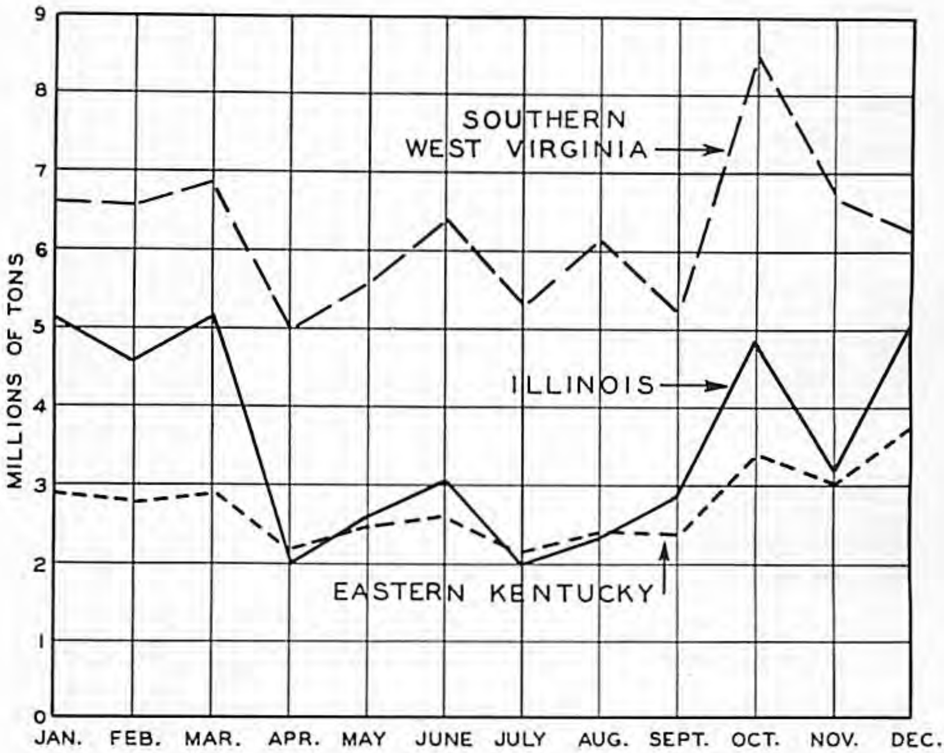

FIGURE 2.—Production of coal, by months in Illinois, southern West Virginia and Eastern Kentucky, in 1935.

The development of a market for Illinois coal in the Upper Mississippi River market area, which is its natural market, would not only widen the market outlet, but would provide summer activity for this additional tonnage created by this market and to that extent modify the extreme seasonal fluctuations of production that are characteristic of the coal mining in this State.

TABLE 6.—Industrial Census*

County	Number of establishments	Horse-power	Wage earners	Wages	Value of Product (thousands)
Iowa—					
Allamakee	22	328	89	74,723	1,314
Clayton	42	1,156	343	401,727	3,750
Clinton	83	16,421	3,285	4,047,030	27,106
Des Moines	76	9,949	3,498	4,163,912	17,244
Dubuque	122	16,622	5,446	5,991,782	34,257
Jackson	33	993	167	171,946	2,125
Lee	89	23,411	3,483	4,046,634	33,053
Louisa	8	248	153	106,369	434
Muscatine	84	6,456	2,872	2,578,037	14,259
Scott	190	33,758	6,334	8,202,291	50,825
Minnesota—					
Anoka	23	4,097	877	1,076,907	10,162
Carver	36	3,481	299	299,329	3,410
Dakota	32	20,475	4,320	5,544,749	126,063
Goodhue	75	8,452	1,440	1,596,097	20,908
Hennepin	1,258	181,028	36,731	47,119,501	371,579
Houston	18	262	38	48,282	1,306
Ramsey	668	106,844	24,097	31,798,139	212,187
Scott	14	954	165	211,755	1,681
Wabasha	24	1,560	290	360,668	7,654
Washington	36	7,588	1,790	2,228,353	27,771
Winona	81	10,425	2,048	2,321,328	23,720
Wisconsin—					
Buffalo	24	608	86	98,221	2,258
Crawford	51	1,430	397	384,985	2,924
Grant	95	1,271	281	307,000	4,684
La Crosse	117	12,095	5,742	6,131,457	27,704
Pepin	10	373	94	87,700	1,974
Pierce	26	446	136	156,567	2,566
St. Croix	49	3,312	544	717,087	6,139
Trempealeau	31	1,461	134	135,720	4,432
Vernon	45	1,241	122	127,758	4,525

* Manufacturing Market Statistics, Domestic Commerce Series, No. 67, U. S. Department of Commerce, Bureau of Foreign and Domestic Commerce, 1932.

TABLE 7.—Monthly production of coal, in 1935, in southern West Virginia, eastern Kentucky, Illinois, and the United States, and index of production for each month* (In thousands of net tons)
(Monthly average = 100)

Month	Southern West Virginia	Index	Eastern Kentucky	Index	Illinois	Index	U. S.	Index
January	6,614	105	2,925	107	5,174	139	37,019	120
February	6,467	103	2,887	106	4,677	126	35,149	113
March	6,962	111	2,945	107	5,191	140	38,970	125
April	5,001	80	2,200	81	2,051	55	22,134	71
May	5,620	88	2,528	93	2,607	70	26,955	83
June	6,458	103	2,663	98	3,114	83	30,260	97
July	5,323	85	2,228	82	2,027	55	22,511	72
August	6,183	98	2,494	92	2,465	66	26,322	84
September	5,200	83	2,461	91	2,955	79	25,321	81
October	8,591	136	3,493	128	4,885	131	38,120	123
November	6,715	107	3,023	111	4,247	114	33,747	108
December	6,329	101	2,776	102	5,132	138	35,805	115
Total	75,463		32,627		44,525		372,373	
Average	6,288		2,719		3,710		31,031	

* Minerals Yearbook, 1937, U. S. Department of the Interior, Bureau of Mines.

TABLE 8.—Population of Upper Mississippi River Counties*

Iowa		Minnesota		Wisconsin	
County	Population	County	Population	County	Population
Allamakee	16,328	Anoka	18,415	Buffalo	15,330
Clayton	24,559	Carver	16,936	Crawford	16,781
Clinton	44,377	Dakota	34,592	Grant	38,469
Des Moines	38,162	Goodhue	31,317	La Crosse	54,455
Dubuque	61,214	Hennepin	517,785	Pepin	7,450
Jackson	18,481	Houston	13,845	Pierce	21,043
Lee	41,268	Ramsey	286,721	St. Croix	25,455
Louisa	11,575	Scott	14,116	Trempealeau	23,910
Muscatine	29,385	Wabasha	17,613	Vernon	28,537
Scott	77,332	Washington	24,753		
		Winona	35,144		
	362,681		1,011,237		231,430
State total	2,470,939		2,563,953		2,912,439

* Fifteenth Census of the United States, Population, Volume 1, pp. 362, 363, 545, 546, 1182 and 1183.

TABLE 9.—Distribution of coal from upper lake ports during 1935* (Short tons)

Distributing ports	Canada	Illinois	Iowa	Michigan	Minnesota	Montana	Nebraska	North Dakota	South Dakota	Wisconsin	Total
Lake Superior ports:											
Two Harbors, Minn.					72,104						72,104
Duluth-Superior, Minn.-Wis.	22,030		40,454	43,346	4,697,538	586	10,386	289,237	324,939	1,399,801	6,828,317
Bayfield, Wis.										250	250
Ashland, Wis.			2,312	30,977	103,442			12,656	10,254	160,199	319,840
Ontonagon, Mich.				27,457							27,457
Keweenaw Waterway, Mich.				229,875							229,875
Baraga, Mich.				2,500							2,500
L'Anse, Mich.				7,064							7,064
Marquette, Mich.				189,264							189,264
Munising, Mich.				49,043							49,043
Total	22,030		42,766	579,526	4,873,084	586	10,386	301,893	335,193	1,560,250	7,725,714
Lake Michigan ports:											
Port Inland, Mich.				1,713							1,713
Manistique, Mich.				20,308							20,308
Escanaba, Mich.				198,168						31,259	229,427
Menominee Harbor, Mich.-Wis.				95,335	300					211,236	306,871
Green Bay, Wis.		1,040	8,781	1,442	15,969				87	1,179,510	1,206,829
Sturgeon Bay, Wis.										17,674	17,674
Algoma, Wis.										3,456	3,456
Kewaunee, Wis.										5,500	5,500
Two Rivers, Wis.										30,493	30,493
Manitowoc, Wis.			4,309		451					279,293	284,053
Sheboygan, Wis.		430	10,959	29	646				173	355,104	367,341
Port Washington, Wis.										70,880	70,880
Milwaukee, Wis.		9,557	18,044	2,762	16,688		107	834	3,813	3,207,446	3,259,251
Racine, Wis.										250,163	250,163
Kenosha, Wis.										17,832	17,832
Total		11,027	42,093	319,757	34,054		107	834	4,073	5,659,846	6,071,791
Grand total	22,030	11,027	84,859	899,283	4,907,138	586	10,493	302,727	339,266	7,220,096	13,797,505

* Maher Coal Bureau, St. Paul, Minn., and Annual Report, Chief of Egineers, U. S. Army Transportation Series No. 1, 1937.

If there are any questions, I will be glad to try to answer them.

Chairman McCabe: Are there any questions or discussion from the floor? No doubt there are some questions that Dr. Voskuil will be glad to answer at this time.

Mr. Paul Weir: Mr. Chairman and Gentlemen: From time to time in Illinois when new methods for doing an old job have come up, the tendency on the part of most of us has been to discount their importance. I refer particularly to strip mining, mechanical loading and mechanical cleaning. About 15 years ago most of us engaged in underground mining did not believe that strip mining would ever be very much of a factor in the state. However, I point out that about 30 per cent of the state's production today comes from strip pits. About 11 years ago the same attitude existed towards mechanical loading. Few, if any, mining men sensed what the next decade would bring. Today about 70 percent of all deep mine production in the state is loaded mechanically and in 1937 there was only approximately 23 percent of the production loaded by hand. Some 5 or 6 years ago there appeared to be little prospect of extensive mechanical cleaning of coal in the state. In 1938 as much as 25 percent of the state's production is being mechanically cleaned. I mention these things in connection with Dr. Voskuil's paper. There is an excellent chance for water transportation to produce changes in the industry in Illinois of equal moment with those resulting from strip mining, mechanical loading and mechanical cleaning. No one should discount the ultimate effect of these changes.

Coal operators have been seriously disturbed by the use of Diesel engines by the railroads, who after all are the industry's best customers. At the same time the railroads have been greatly disturbed by the effects of truck transportation of coal from the mines of their largest shippers, the coal operators. In the final analysis it seems logical that the use of Diesel engines will continue and probably increase if the railroads find that they furnish a better answer to their specific problems. Likewise, consumers of coal are going to insist upon truck transportation when that manner of delivering of coal gives them a lower delivered price. The railroads are not going to discontinue the use of Diesel engines because of the feeling which coal operators may have against them. Likewise, coal operators are not going to ban trucking from their mines if trucking furnishes a cheaper cost of transportation to the consumer. If the inland water ways furnish cheaper means of transportation to consuming points than the railroads can furnish, undoubtedly the Illinois coal operators will use them in an effort to expand their markets.

The big possibility for Illinois coal that I see in water transportation lies in the supplanting of eastern coals which move into the Great Lakes area by rail-water-rail. Dr. Voskuil has pointed out to you possible and probable markets. Rail-water transportation to river destinations presents a real opportunity to expand the production of Illinois mines.

Chairman McCabe: Thank you, Mr. Weir. Any further discussion?

The Program Committee has been very fortunate in getting a film produced by the Mine Safety Appliances Company, illustrating underground mining. Mr. James Fleming of the Mine Safety Appliances Company will now show this film entitled, "Better Light and Better Sight."

(Whereupon a very interesting film was shown by Mr. Fleming.)

(Applause.)

Chairman McCabe: I am sure that we appreciate very much, Mr. Fleming, your bringing this film for us this afternoon. I will now turn the meeting over to Mr. Taylor.

President Taylor: I want to thank Mr. Marsh, Dr. Voskuil, and Mr. Fleming for the successful program this afternoon.

I would appreciate very much your getting your banquet tickets as soon as possible.

We will now stand adjourned until 6:30 P. M.

(Whereupon at 4:00 o'clock P. M., a recess was taken until 6:30 P. M. of the same day.)

EVENING SESSION

6:30 O'clock P. M.

Following the annual banquet the following proceedings were had:

President Taylor: The meeting will please come to order.

I have enjoyed very much serving this past year. I don't know whether to stand on my feet now and let you have it, or sit down and let you enjoy yourselves.

The only thing I can think of to do is to turn the gavel over to our toastmaster of the evening, a coal salesman par excellence, B. R. Gebhart, Vice-President in Charge of Sales, Chicago, Wilmington and Franklin Coal Company; Mr. Gebhart.

Mr. Gebhart: Wait until I get my equipment. I was much ashamed of the address given you by your retiring president. The reason he didn't let you have it is a mystery to me. There are certain things about Herb that should be called to your attention before he gets out of the spotlight. I understand his administration has been a good one, but I was surprised that he didn't introduce me with some enlightening remarks.

I think a toastmaster is supposed to do one of two things, either he should do a great deal of talking and let the speaker do little, if any, or do little talking and let the speaker do some. I promise to compromise; I promise to do a lot of talking and let the speaker do none. I had a good story to tell you about Herb Taylor but I will tell you that one on William Jennings Bryan who was invited to be the toastmaster at a large banquet. It happened that the speaker's name was Bryant, and when Bryan got up to introduce the speaker, he made a few remarks about Bryant being a republican and a well known republican and said, "Of course a democrat introducing Mr. Bryant must give you a great deal of mental emotion and the only thing I can say is, if Bryant was Bryan, I would like it better and," Bryan said, "as to my republican friend, there is but one letter between Bryan and Bryant but between Hill and Hell there is but one letter."

This bell that we have is for the protection of you only. The use of this bell is my prerogative. Assisted by your retiring president, I propose to introduce a few of the gentlemen at this table and at the sound of the bell, they must sit down; when they hear the bell they must stop on the word and sit down. I trust that I will have your co-operation on that. We have a great many speakers and a good many fine speeches to call for.

I think, then, the thing to do is to start this Forty-Sixth Annual Banquet of the Illinois Mining Institute with the introduction of a few of the guests here. I know you fellows work far and wide over the State and don't get to see such a distinguished assembly very often. Just look at the faces up at this table. I propose to tell you who they are and something about them.

I heard a story that I want to tell you that will illustrate how closely we are going to stick to the point.

Three Jewish boys up in Chicago bought a moving picture theatre, Abie, Ikey and Joey. They were all in different businesses and had their own circle of friends. When they bought the house they had a meeting of the Board of Directors, consisting of the three of them, and they looked over the property and found that the seats were in bad shape. Abie said: "Boys, me and my friends are in the cretonne business. We will put cretonne on each seat in the house for $.98 each, and that is a low down price." And Ikey said: "I think that cretonne is all right but that is for curtains, and me and my friends are in the mohair business and we will cover the seats for $1.14 each and that is a low down price." And finally Joey said: "Boys, cretonne is all right and mohair is all right but me and my friends are in the leather business and leather is the thing to use. I will cover each seat in the house with leather for $2.47 per seat and that is absolutely a low down price." The board considered that and after a long consideration Abie said: "We are in the theatre business. We have got to cover these seats with fannies at $.15 each before we do anything else."

We propose to use the bell and stick to the point. I think we ought to have some introductions, and I thought I would introduce to you our honored guests.

We have here some distinguished gentlemen of the press and of course we have in this country free speech and free bells and everything. You all know R. Dawson Hall of *Coal Age* and I want him to stand up and deliver an address.

(Sound of the bell.)

(Applause.)

Mr. Gebhart: Thank you, those remarks were very fine. We come to another distinguished gentleman of the press. This gentleman used to be a professor, another illustration of the fact that professors can make good. He is really a doctor but we call him Butch. We will have some fitting remarks from Dr. C. M. Smith of Washington, D. C.

(Sound of the bell.)

(Applause.)

Mr. Gebhart: Now we get down to a chap whose job I have never been able to figure out. This is quite a distinguished chap and he does a lot of hard work and does it well. Among a few of his jobs are Manager of the Western Office of the National Coal Association, Executive Secretary of the Committee of Ten, Marc Bluth.

(Sound of the bell.)

(Applause.)

Mr. Gebhart: I want to tell you that the professor that you looked at is not the only professor that has made good. We have another good friend who has done a lot for you. We have got to have fodder for the cannon. This man is known for a number of distinguished achievements. He was formerly International President of Kiwanis, Professor Callen of the University of Illinois.

(Sound of the bell.)

(Applause.)

Mr. Gebhart: We come to an old friend of mine and I cannot think of anything but complimentary words for this chap—

(Sound of the bell.)

Mr. Gebhart: You have got me there. This fellow is a member of the industry who is doing more than anything else to keep most of us alive, and if you don't think that is true see how much of the coal is going out in small sizes and how much in big sizes. I have a great respect for Tom Marsh, representing the fire in the Iron Fireman.

Mr. Marsh: Mr. Toastmaster—

(Sound of the bell.)

(Applause.)

Mr. Gebhart: Now we come to a man beloved in this coal industry and we are all fond of him. For a long time, for the longest time any man has held the office, we are happy that he is with us tonight, William J. Jenkins of the Consolidated Coal Company of St. Louis.

(Sound of the bell.)

(Applause.)

Mr. Gebhart: I understand, from the Queen of Quincy, that Mr. Jenkins, perhaps in a light moment before the meeting, announced that if he won the ten dollars he was going to give a party and I wanted you all to know that.

I have been in the coal business for a long time, but I am going to get a lot of pleasure in introducing to you the man that showed me the first coal mine, one of your new officers. He is not much of a drinking man but one night he went to a little Egypt bar and one of his friends telephoned his wife and had the bartender say, "I am sorry to call you, Mrs. Blank, but your husband is here." She said, "That is all right, he can take care of himself," and he said, "Yes, but there are ladies here." And Mrs. Roy Adams came and took Roy home. Roy is the new Vice-President.

(Sound of the bell.)

(Applause.)

Mr. Gebhart: About the next speaker there are certain elements of mystery that I have never been able to solve and he reminds me of a story about President Roosevelt. Roosevelt was fishing in the Gulf of Mexico one time and went out with a colored boy who was supposed to know where the good fishing was. Roosevelt didn't get a fish and the colored boy didn't catch a fish and Roosevelt said, "I am going to demonstrate to you that I can do practically anything. I am going to get out and walk on the water," and the colored boy said, "You can't do that." Roosevelt stepped out of the boat and of course he sank in the water. The colored boy jumped in and saved his life and was kidding him about it, and Roosevelt said for him to forget that he said he could do it and the colored boy said, "All right, boss, if you promise not to tell that I saved you."

Roosevelt brings me to the next speaker on the program, he is quite a mystery to know. So far as I know he will always be Secretary-Treasurer of the Illinois Mining Institute. As I said, Roy showed me the first coal mine, and Schonthal aided me in making my first speech down here in Springfield at the Illinois Mining Institute and at that time we had a membership of 126 and had $226.00 in the Treasury. Now I know why you keep electing B. E. Schonthal—now you have $10,000 worth of bonds and $1,400 in the Treasury.

B. E. Schonthal, your Secretary-Treasurer.

(Sound of the bell.)

(Applause.)

Mr. Gebhart: In order not to offend any of your Board Members, I will introduce them to you in alphabetical order. What could be fairer?

The first man I will call on reminds me of another story. I wonder if you can guess who he is when I tell the story. There was a Scottish fellow out with his girl, out in a horse and buggy one night, and the girl seemed to be very much worried and disturbed and finally the Scottish boy turned to the girl and said, "What is bothering you?" She said, "Nothing much, except the gleam of your eye." One of your Board Members, Mr. Devonald, of the Operating Department, Peabody Coal Company.

(Sound of the bell.)

(Applause.)

Mr. Gebhart: The next chap has a remarkable history. He is a very practical and substantial member of the coal fraternity. I have known this chap a long time and you know, as I know, he is a fine fellow, Carl Hayden.

(Sound of the bell.)

(Applause.)

Mr. Gebhart: The next in alphabetical order is a fellow about whom I shall tell an obscene story. Time, place, circumstances, people don't make any difference to Sandy. Down in Washington, they have a great big building filled with members of the coal industry. Sandy achieved quite a reputation down there. The Chairman of the Coal Commission in the last administration, the Chairman of the Bituminous Coal Commission, had a secretary built in a rather ordinary way. This girl was a buxom lass. One time I followed Sandy into the Coal Commission Chairman's office. There were three or four other men in there, and damned if he didn't walk up to her and say, "Hello, Big Gal, is the Chairman in?" C. J. Sandoe.

(Sound of the bell.)

(Applause.)

Mr. Gebhart: We have a new member of the Board, a chap who is able to get in anywhere. He came down to go to work in the coal mines of Southern Illinois and said he was an expert railroader and in talking to certain superintendents I was told that the first switch he laid, you could not fly a kite over. Ben H. Schull.

(Sound of the bell.)

(Applause.)

Mr. Gebhart: We have another Board Member; he bears a relation to C. J. Sandoe. I have the happy privilege of presenting my good friend T. J. Thomas—

(Sound of the bell.)

(Applause.)

Mr. Gebhart: Another good Board Member, I know something about this fellow; he is quite a hunter, and he went far into the northern woods to hunt deer, and on this trip he couldn't find anything. He bought goat meat and sent it to his friends and said it was deer. My good friend, Loren Wasson.

(Sound of the bell.)

(Applause.)

Mr. Gebhart: We have got another Board Member. I have got a lot on his card. This is pretty serious. I suppose he has been a Board Member for quite a while. I saw him play golf last summer and he is not a bad golfer. They tell me that one night he started to drive home and stopped for one glass of beer and had eight or ten scotch and soda and was really in good shape. This gentleman's friends lived close by to where he lived, and his wife saw the lights in other houses go on but no husband. She called the other houses and wanted to know where her husband was, and they started searching for him and finally found him in the coal shed back of the house where he went to relieve himself and went to sleep. They woke him up and he said, "Bring in a couple of empties, I have found a fresh fall." W. P. Young.

(Sound of the bell.)

(Applause.)

Mr. Gebhart: I think those are all of the Board Members present and in deference to those who are absent, I will read their names without comment. We have messages from all of them expressing their regrets: M. M. Leighton, State Geological Survey, Urbana; James McSherry, Department of Mines and Minerals, Springfield; F. S. Pfahler, Superior Coal Company, Chicago; Bud Smith, Chicago, Wilmington and Franklin Coal Company, Chicago; Louis Ware, United Electric Coal Company, Chicago.

Now we are getting down to something dreadfully serious and we will put the bell in front of our ex-president, Herb Taylor. I understand the speaker has promised to make it very short in view of the time the toastmaster has taken. I have a lot of stuff on him. There is one little story that goes with this fellow. He is a chap that I would expect always, under any circumstances, to do the right thing in the right place; and that drags up some ancient history and the story about Dr. Beable, a famous explorer. One time Dr. Beable was attending a fashionable party in New York and the hostess was worried about the actions of her gold fish and asked him to look at it. He looked at the gold fish and it was curled up and laying on top of the water and he knew it was dead but didn't want to tell her, so he said he would do his best and that he would take the gold fish. He carefully wrapped it up in his handkerchief and put it in his pocket and said to her that he would do the best he could. He thought he would buy a new gold fish. When he left the party it was snowing and he started home and suddenly sneezed and got out his handkerchief, and the gold fish fell in a pile of snow. He could not find it and got down on his hands and knees and started looking through the snow, looking for the gold fish, and as he was working there he realized that somebody was standing beside him. He was a distinguished looking fellow and had on full evening clothes, and as he knelt there on his hands and knees looking for the gold fish, he looked up and saw a New York cop. It didn't strike him as being particularly funny. The cop said, "What are you doing?" It struck him what an odd situation he was in, and he decided the best thing was to tell the truth and he said, "Officer, I am looking for a gold fish." The officer said, "That is all right my man, go ahead and look for the gold fish." Dr. Beable realized the ridiculous situation and finally the cop said, "All right, come on, come on, there is no gold fish there," but he went on looking and the cop said again, "Come on now, it is all right." But he would not budge, so the cop went to call the paddy wagon and the wagon came along and the policeman thought that he had a tough guy on his hands, here was a fine old gentleman looking for a gold fish in a snow bank; and he said, "I am sorry, you will have to come with me." Just then, as fate would have it, Dr. Beable found the fish and said, "Here is the gold fish," and the cop said, "*I* am dippy," and got in the wagon and let them drive him home.

Of course Ralph Sherman would do the right thing. He was born in Ohio, is married, has a daughter and is very proud of a cocker spaniel who is a great performer. There is a strange thing about Ralph Sherman: you would suppose he had been all over the country but up until last year he had never been west of the Mississippi River. He took a trip and came back convinced that the width and breadth of this country is a wonderful thing. Ralph is associated with the Battelle Memorial Institute; he is in charge of the technical and engineering work. We know that Ralph is doing a lot for the coal industry not only in Illinois but in all of the States.

I know that you are going to enjoy hearing from Ralph Sherman of the Battelle Memorial Institute, Columbus, Ohio.

THE FUTURE OF COAL

By RALPH A. SHERMAN
Supervisor, Fuels Division, Battelle Memorial Institute, Columbus, Ohio

Mr. Toastmaster, Mr. President, Gentlemen of the Illinois Mining Institute: The opportunity to participate in your forty-sixth annual meeting is greatly appreciated. This is the first opportunity that I have had to meet with you and, although I had known that your Institute had been organized for so many years, yet I was truly amazed at the attendance today and this evening and the figures that your Toastmaster has given on the number of members and the sound financial position of the organization. The strong co-operative spirit evidenced by these figures shows me that the remarks that I have prepared are about to fall on sympathetic ears.

The subject that I have chosen for my remarks is "The Future of Coal." What I shall have to say on this subject is intended to apply to the entire bituminous coal industry of the United States and not particularly to that important part in the State of Illinois. In fact, because I have not had the opportunity to become as familiar as I should like with the unique problems of your State, some of my statements may not apply to you.

In consideration of much that one reads and hears of the condition of the coal industry, your first thought may be that I am indeed an optimist to venture to predict that coal has a future. Such a hasty conclusion might, however, be unwarranted. Let me remind you that there are at least two kinds of futures, rosy or drab, bright or dull. For the benefit of those of you, who, tired by the technical session of the day and now comfortably warmed and filled by the excellent dinner that we have enjoyed, might wish to nap a bit, I will state in advance that I am an optimist and that I hope to prove that the bituminous coal industry, if it embraces the opportunities at its command, has before it a bright future.

A meeting of men connected with the bituminous coal industry is a place only for optimists. This statement may seem strange in view of the pessimistic talk both from within and without the industry in regard to the shrinkage of markets, the competition of other fuels, the problems of labor, the problems of government regulation, and the continued financial losses entailed by most of the producing companies. The record of the coal industry is not bright in regard to profits. An analysis of the incorporated companies engaged in the production of coal that was made by the National City Bank of New York showed that in only six of the sixteen years from 1916 to 1933 did the industry as a whole make a profit. In the period from 1924 to 1929, when all other business was practically rolling in prosperity, only 1926, the year of the strike in Great Britain which resulted in large exports of coal from this Country, showed a profit for bituminous coal.

In view of such a record, the leaders of the industry should have a right to be pessimistic. But, gentlemen, I submit that the fact that producers, in the face of such a record, continue to operate their properties, that they expand existing properties, and that they even open up new ones, demonstrates conclusively that the coal industry is headed by incurable optimists. Optimism is the only quality of mind that should be admitted to your company. I now wish to discuss why I, too, share this optimism.

You have all had painted for you the discouraging picture of the decrease in the percentage of the total energy demand of the United States furnished by coal. The curves presented by the Bureau of Mines show that whereas bituminous coal and anthracite produced 83 per cent of the total energy in 1915, they produced but 57 per cent in 1936, and but 54 per cent in 1937. But, gentlemen, in this period the total energy demand of the country has greatly increased; in 1929, the energy requirements of the nation were greater by 60 per cent than in 1914 and, though they decreased during the period of the depression, they were back in 1936 to 50 per cent above the 1914 figure.

Furthermore, much of this energy demand was of a newly created type that coal could not well serve. The figures presented by the Bureau of Mines include all of the natural gas that is used in operations in the field and for the production of carbon black. These two uses for natural gas account for two-thirds of the total industrial use and one-half of the grand total of industrial and domestic use of natural gas. The figures also include the petroleum that is used for lubricants and for gasoline. Although gasoline has displaced coal that was used on railroads through shifts of freight traffic to trucks and shifts of passenger traffic to the bus and private automobile, an immense tonnage of coal has been required for the production of the steel for the automobile and of the cement for the concrete highways. In the past few years, the precipitous decrease in the percentage of energy supplied by coal appears to be checked.

From time to time, you have heard that the oil and natural gas reserves of the Country would be exhausted within a few years. Some of the latest predictions have placed the limit for oil as 10 to 15 years. The prophets have been wrong before and they may be wrong again. The coal industry must not be lulled into any false sense of security from competition of these fuels at an early date. Whatever the future of petroleum, natural gas reserves appear to be enormous; a representative of the gas utility of a large midwestern city only last week told one of our staff that they had enough natural gas for their needs for the next 100 years. Coal must not relax its efforts to maintain and improve its position with respect to these competitive fuels.

The past twenty years have seen remarkable increases in the efficiency with which coal is utilized; the extent of these increases has been pointed out in the technical sessions today. This increase in efficiency is viewed with alarm by some producers of coal as they believe that it is largely responsible for the decrease in the demand for their coal. During this period of increase in the efficiency of coal utilization, we have had, as I have just pointed out, a great expansion in the energy demand. To cite one example, the electric power output by the utilities was approximately four times as great in 1935 as in 1917. If this electric power had been produced with coal at the same requirement as in 1917, 160 million tons would have been used by the electric utilities, but because the coal rate decreased and because of the increase in the use of competitive fuels and water power, the amount of coal used for this purpose was practically the same in 1935 as in 1917.

Do you ask me, "Where is there room for optimism in the face of these facts?" My answer is that if the number of pounds of coal required to produce a kilowatt hour had not decreased and thus made possible the decrease in the cost of electricity, the growth of the demand for electric energy would not have been possible. Nor would it have been possible to show so clearly that the cost of the generation of electricity through steam power is less than that through hydropower and the competitive position of coal would have been so much the poorer.

Let us now turn to the domestic market to see whether we can find any trends worthy of further optimism as to the future of coal. The domestic market is one of great interest and importance to every producer of coal. In anthracite, the domestic use constitutes almost 100 percent of the market and in bituminous coal it represents some 15 to 20 percent. Not only is it an important fraction of the tonnage but it has been the profitable fraction, consisting of the larger sizes and the premium grades of coal. Again to quote statistics, we find that of the one and two family homes of the cities of the United States nine percent have adopted oil and four percent use gas for heating. All of this, however, is not lost to coal as some of these homes are in the southwest and far west where coal is not competitive with oil and gas and some of the gas-heated homes use manufactured gas made from coal.

The loss has, however, been important and has rightly been of concern to the industry. The reason for optimism in view of the market that has been lost is that something has been done about it. You heard Tom Marsh present very clearly this afternoon the story of the advances made by the small stoker industry, and he gave you figures that showed that the small stoker was rapidly gaining on the oil burner. A few more figures than those that he gave you should hearten you even more. In 1937, for the first time in the history of the industry, the sale of oil burners decreased from that of the previous year while the sale of stokers continued to increase. In the first six months of this year, the sales of both oil burners and stokers were less than in 1937 but oil burners decreased 40 percent while stokers decreased 30 percent. In July, just past, 9,061 stokers were sold as compared to 10,689 oil burners. It appears that the time will shortly come when stokers will outsell oil burners.

Another encouraging feature of the domestic situation is that the coal industry has had an important part in the advancement of the small stoker. Through the efforts of Bituminous Coal Research, Inc. at Battelle Memorial Institute, many of the problems of the selection of the type and size of coal for these firing devices have been solved. Individual producers have attacked the problem of adapting their coals to stokers by research methods. The result has been increased acceptance of the stoker, retained and regained markets for coal and the adoption of high-grade coal on which the realization is often as great as on the egg and lump sizes rather than the use of cheap, low-grade coals which were advocated some years ago.

Stoves are still an important feature in domestic heating as 45 percent of our city homes are still so heated. I am glad to report that something is being done about these. We had an opportunity to test, some months ago, a newly designed space heater that uses free-burning bituminous coals. Although some further developments remain to be made, this stove showed promise for it was found possible to hold a fire over night or for longer periods and the stove had the outstanding feature that it was practically smokeless. Kitchen ranges are having their share of attention and manufacturers are developing ranges that will give automatic, trouble-free operation with coal.

The bituminous coal industry has been faced with many problems of competition, of labor, and of government regulation. Although these problems have seemed and do seem difficult, it is my opinion that they have benefited the industry for they have awakened it to its needs. Faced by low-cost competitive fuels and by increased labor costs, the industry has taken steps to decrease its costs of production through mechanization of underground mines and through production by stripping, while it has improved the quality of its product by cleaning. No state has been ahead of Illinois in these advances. For them, the industry has reason for optimism.

Another reason for optimism in the industry is your organization with headquarters in Washington, the National Coal Association. Although it is not unanimously supported by the industry, it maintains a constant vigilance on matters of legislation that are of importance to all. It keeps you continually informed on the activities of the Bituminous Coal Commission. With the Stoker Manufacturers Association, it has engaged in a program of advertising to acquaint the public with the merits of coal. In the past two years, it has had an engineering department under the able directorship of C. A. Reed; that department is doing a great service in these times when engineering is so important to your industry.

One condition about which it is difficult to be optimistic is the competitive situation within the industry itself. Always existent to some extent, the era of competition in which the sale of coal is based on price rather than on quality has seemed particularly serious in recent months. Faced by weak markets, producers try to sell coal wherever and for whatever price they can. While the salesman for Jones is trying to get a user away from Smith and Smith is trying to get one away from Jones, Brown's salesman is getting a customer away from each and he, too, is losing customers to other producers. All of this effort does not add one ton of coal to the total that is produced and sold; it merely obtains a trial of a few cars of a different coal that may or may not be suited to the needs of the user. As this goes on continually, users shift from one coal to another, the cost of selling coal continues to mount, and the returns to the producer continue to fall.

This sinister threat to the industry of selling on price should be halted by the full operation of the Bituminous Coal Act of 1937. I do not venture to make any predictions in regard to the success of this Act; you gentlemen know far more about it than I. But I do share the hope that I am sure that you all have that the Act will be successful in helping your industry.

Even if the Act should fail, the means for correcting the evil of price competition are available and always have been available within the industry itself. This means is the realization that sales at a loss can benefit no one and that co-operation among the producers is the solution of the problem. The same spirit of co-operation that you demonstrate in your membership in the Illinois Mining Institute, if applied whole-heartedly and sincerely in district marketing agencies of the type of which Appalachian Coals, Inc. was the forerunner would provide the means for the solution not only of this problem but of other problems as well.

The customer turnover of which I have spoken is due not only to price cutting but also to a lack of knowledge of the characteristics of coal and their relation to its utilization. The answers to many technological problems such as grindability, friability, ignitibility, caking and coking, clinkering, and the relation of the size and size distribution of coal to its combustion are not yet known. If these answers were all available, each producer should be able to place his coal in plants where he knew it would serve satisfactorily. Even if no more coal were mined and sold, customer turnover would decrease, sales costs would fall, and profits would rise.

A continual difficulty in the bituminous coal industry is the lack of balance between demand and production. As J. E. Tobey, manager, Fuel Engineering Division, Appalachian Coals, Inc., said in his address before the Michigan Retail Coal Merchants Association, with the striking and unusual title, "What's Right with Coal!" "The coal industry has 'indigestion.' We dig it faster than we burn it. We must either burn it faster or dig it slower." It is my opinion that even if the price-cutting were stopped, if coal were so intelligently sold that customer turnover was materially decreased, and if the industry were operating profitably even at reduced production, you men would not be content. You should not be for you should aim at greater and more profitable markets.

Two ways are open to greater markets for coal. They are (1) increased efficiency in the use of coal and (2) new uses for coal. Increased efficiency in the utilization of coal will not only regain markets lost to competitive fuels but also will so reduce the cost of the product made from coal that the demand for the product and thus the demand for coal will be increased. New uses for coal include those markets now supplied by oil and gas because proper equipment for the utilization of coal is not available or entirely new uses for heat or new products that can be made from coal.

You have undoubtedly expected that, as one engaged in research, I would say something about research this evening. I shall meet your expectations for I firmly believe that the answer to this problem of your industry is research. You are undoubtedly familiar with General Motors' Kettering's definition of research as "What one does to find out what he is going to do when he cannot keep on doing what he is doing now." Certainly, the coal industry cannot well keep on doing what it is doing now. Unfortunately, it did not adopt research early enough to have the answer to its next step ready at this time.

Time is not available this evening for me to outline a definite program of research that the coal industry should follow. Nor is there a need for that as the particular program is less important than the fact that research is undertaken and amply supported. I do not mean to infer that a program should not be carefully outlined and well directed but, as in swimming, the most carefully prepared instructions will not take the place of the actual plunge into the water and continued practice. In research, ideas are self-propagating. Any program designed to obtain more knowledge about the chemical and physical characteristics of coal and the phenomena occurring in its processing and utilization will bring worthwhile results.

Two specific examples of lines of research that can be profitably followed are worthy of mention. We all know that for many purposes gas is an ideal form of heat energy. That this is true is shown by the fact that many coal producers use gas to heat their homes. Natural gas, a competitor of coal, has reached many parts of the country but coal is still the source of gas for a large part of our people. It is in the interest of the coal industry that this production be expanded. Investigations have shown that relatively small decreases in the unit cost of production of manufactured gas will greatly widen this use. The manufactured gas industry is ready to co-operate with the bituminous coal industry in research to find new processes of manufacture to decrease these costs.

Another market for coal that may not have occurred to you is its use for hay drying. There are many reasons why hay dried by heat from fuel is better than that dried in the field by the sun. The yield is greater and it has greater nutritive value that results in greater production of milk or meat from the animals to which it is fed. The hay-drying industry is not old but it has attained considerable proportions. Because the coal industry has not devoted any particular attention to this use of fuel, most of the hay now dried by heat from fuel is dried with oil or natural gas but experience with the use of coal fired by stokers shows that coal is a desirable and economical fuel. From 400 to 800 pounds of coal are required per ton of dried hay depending upon the moisture content of the hay as placed in the drier. In 1934, 69,500,000 tons of hay were produced in the United States. Of this amount, 17 percent was produced in Iowa, Missouri, Illinois, and Wisconsin, states which Dr. Voskuil pointed out this afternoon as your logical markets for Illinois coal. Here is a potential market for 3½ million tons of your coal.

The bituminous coal industry needs a unified program of research supported by the producers in proportion to the production of each. This program would be properly divided into two phases. One phase would be devoted to fundamental and engineering research on problems of the characteristics of coal and on problems of its utilization that are of common concern to coal from all fields. The other phase would be devoted to those problems of unique interest to individual districts. Supervision of the entire program would be vested in a director aided by an Advisory Committee made up of executives and engineers from the several producing districts together with outstanding engineers and technologists of equipment manufacturers and users. Supervision of the program in each district would be entrusted to a similar director and advisory committee from the district. Co-ordination of the entire program would be obtained by regularly circulated progress reports and meetings of the advisory committees.

Physical facilities of existing institutions devoted to research are ample to care for such a program and little or no funds need be expended for this purpose from those appropriated for the program.

You are all familiar with the splendid results of the research done by the Illinois State Geological Survey and the University of Illinois on the problems of the production, preparation and utilization of Illinois coal. You should make even greater use of these facilities through appropriations for research made directly from the industry to the institutions rather than to rely solely on the support from the general taxation. I am sure that means are available so that you could take this direct approach to your problem.

Such a direct approach to some of the pressing problems of the entire industry has been made in the past three and a half years through Bituminous Coal Research, Inc. At Battelle Memorial Institute, where the major part of the program has been centered, we have investigated the relation of the characteristics of coals to their performance on small stokers, on the process of combustion of coal in small and larger stokers, on the selection and utilization of coal for larger underfeed stokers and for burning in pulverized form, on segregation of coal in bunkers, on the dustless treatment of coal with oil, on the gasification of coal, and on new uses for coal. At the Pennsylvania State College, a fundamental study of the hydrogenation of coal has been made. The results of all of these investigations have been made public as quickly as possible in reports, bulletins, and papers. We have had countless statements as to the immediate value of the research to the producer, distributor, equipment manufacturer and the user of coal. To cite but one example, the research on dustless treatment discovered the difficulties with certain Illinois and other midwestern coals and showed that heavier oils than those previously used would give permanently effective treatment of these coals and result in consumer satisfaction.

The expenditures on this program have not been great. They have averaged about $20,000.00 annually, —just about the cost of a good vice-president. In spite of the general agreement as to the value of the program, I regret to tell you tonight, gentlemen, that present indications are that funds will not be available for its continuation after January 1st. If the program had not been productive of good results, its discontinuance would not be surprising but because it did produce such results, the cessation is indeed disappointing. The support of research by the coal industry had attracted much favorable comment in the trade, technical and public press and, without doubt, the discontinuance will result in press comment that is unfavorable to the industry. Those concerned with the program will not admit defeat and it is to be hoped that their efforts to obtain funds to continue will meet with success.

Although few executives of the coal industry will not agree when asked that the industry needs its own program of research, no one has yet been able to arouse a real enthusiasm that will insure its success. An incident related to me a few days ago by Clyde E. Williams, director of Battelle Memorial Institute, will illustrate what is needed. Mr. Williams was told by the director of research of one of our large and successful corporations whose success has been founded on research that before Battelle was established a committee of our Board of Trustees called upon him to discuss their plans. The first question that they asked was in regard to the type of building that he would suggest. He replied, "If you want to discuss buildings and their physical construction, you may talk to my superintendent of construction. I can give you no advice on buildings, and in my opinion, the type of building is of little importance. If you want to make a success of the trust that has been placed in your hands, there is one thing that is essential. You must be filled with the spirit of the 'Holy Ghost.' "

The coal industry has not, obviously, been filled with the spirit of the Holy Ghost. It needs a Billy Sunday, a Dwight L. Moody, or perhaps an Aimee Semple McPherson to fire it with this spirit, the will and determination to do research.

Other branches of the coal industry have been so inspired. The anthracite industry, faced with not greatly different problems, has had for a number of years an Anthracite Institute that has carried on an eminently successful program of research and development and has supported a laboratory at Primos, Pa. For the past two and a half years, under an organization known as Anthracite Industries, Inc., this program has been greatly expanded. In developmental, promotional, and research activities, approximately a million dollars annually is being expended with valuable results. In Great Britain, the program of the Research Department of the Combustion Appliance Makers Association (Solid Fuel) was reorganized this year with the formation of the British Coal Utilization Research Association with an assured annual income for the next five years of \$125,000.00 to \$150,000.00. A part of this comes from a grant from the Department of Scientific and Industrial Research. The annual production of coal in Great Britain is but approximately 200,000,000 tons or one-half that of the United States. In the Union of South Africa, where the production of coal is only 16,000,000 tons per year, research is conducted that involves the expenditure of \$86,500.00 each year. About half of this comes from the Union government and half comes from the producers through a tonnage tax which amounts to about $2\frac{1}{2}$ mills per ton. Such a tax in this country would make available for research \$100,000.00 per year.

Gentlemen, I do not assert that research is the only essential cure for all of the evils that beset the bituminous coal industry. The competitive situation within the industry that leads to ruinous price cutting must also be cured but it does appear that the practice of price cutting and the failure to support research are not unrelated phenomena. The man who will cut the price of his coal ten, fifteen or twenty-five cents per ton to take business away from his fellow producer is quite likely to be one who will not agree to an assessment of one mill per ton of coal that he produces to be spent on research to decrease his costs or to increase his markets. When the industry has the will to do constructive merchandising based on the sale of coal on the basis of performance rather than on price, it will also have the will to support research as it should be supported.

The coal resources of this country are immense. Best estimates are that we have enough bituminous coal to last us 4,000 years at the present rate of consumption or for 2,000 years if all of our present energy demands were supplied by coal. Energy supplied by bituminous coal has been the very foundation of our industry and there is no question as to the future of coal as the basic source of energy for this country. The only question is whether industry is to be in the hands of unorganized, non-co-operating groups, operating only in self interest and at a loss, or in the hands of organized, co-operating groups, operating for the mutual benefit of the industry and at a profit.

* * *

Mr. Gebhart: Gentlemen, I know that you will agree with me when I say to Mr. Ralph Sherman that we are deeply grateful to him for this very splendid talk.

I think I owe Ralph an apology in hurrying his introduction as I did. A few things more should have been said.

I think it can be safely said that Ralph Sherman has the widest acquaintance among engineers in the United States of any man living.

One other word about Ralph and his conduct of the Battelle Memorial Institute. It has been suggested that some of you may not know what that Institute is—and Ralph, correct me if I am wrong in this,—it is a private Institute founded and supported by a man named Battelle who endowed it for the purpose of mineral research. Coal, being one of the principal products, has come in for a great deal of work at Battelle.

I think that we, as members of the Coal Industry, should consider ourselves fortunate in having the continued applied interest of a man like Ralph Sherman.

Just one more remark, certainly Ralph proved his engineer background, he said he would talk one-half an hour and he did talk just one-half an hour.

He talked about new products from coal. I heard one the other day that I would hardly believe, but it is true. All of us appreciate a pretty leg on a pretty girl and the hose she wears. I sat along with Tom Harris last week in Chicago and he told me that DuPont, next spring, would be ready to bring out a new type of stocking for women, just as sheer and beautiful, but it will be elastic and will encase the limbs of women just as lusciously. The yarn out of which these hose will be made will be from coal. I am assured that that is a fact, and it is a new product by DuPont. If every woman in the United States wears hose made from coal, we will get quite a boost.

There is one man at this table who has not been introduced to you this evening. I appreciate this man's serious frame of mind. I am indebted to him and his wife for the finest breakfast I ever ate.

In trying to figure out something funny about Paul, Herb Taylor and I thought of so many funny things. Herb told me something about the P and W, and he tells me that in 1917 Paul Weir was a Penn State Whippersnapper and in 1937 he was a Patient Waiter; that is Vice President. I now give you, your friend and my friend, Paul Weir, the President of your Organization for the year 1939.

(Applause.)

President Paul Weir: Mr. Toastmaster and Gentlemen: This is an occasion which I have awaited for a good many years. Tonight I am the fellow who will have the last word. The Toastmaster has given me his tools, the bell, and the hammer, and the mike, and I will not compromise with him, your Ex-President, or anyone else. You men have elected me President and I feel that I can say what I want to say without being interrupted.

I appreciate very much the honor conferred upon me. I have no doubts as to the duties of the President of your Institute and the responsibilities which go with that office. One of such responsibilities concerns the 10 or 12 thousand dollars in the Institute's treasury and the ever-increasing income of the Institute. This Institute, after all, has for its purpose the serving of the industry in the State of Illinois. Unlike so many Institutes, it has funds available for doing some work. I do think that each year's current net income should be spent instead of there being any further accumulation. Undoubtedly each and every one of you has some ideas as to how this Institute can better serve the industry. I will be very, very glad to have your suggestions for not only serving the industry but also for the intelligent utilization of its income.

We publish the Year Book containing the minutes of our meetings. This book, thanks to the Advertising Committee, is a very good source of income. This Advertising Committee, in case you don't know it, is composed of purchasing agents for the coal companies in the state. They are much concerned about the advertising revenue which accrues to the Institute through their efforts. Today I have told them that if we could not find a better way for spending the funds we would at least make a contribution to the Home for Old and Decrepit Purchasing Agents; therefore it is up to you to help me so that I will not have to make good on my promise to the Advertising Committee.

We have had a wonderful meeting today. We have enjoyed listening to our Toastmaster and to our speaker of the evening, Ralph Sherman, and I know that I express your feelings when I say to them that we deeply appreciate their services. At this time I inquire if there is any further business to come before this meeting of the Illinois Mining Institute? If none, the meeting stands adjourned.

The following advertisers in the 1937 Yearbook displayed merchandise of their manufacture in the Exhibit Hall at the Forty-sixth Annual Meeting. The exhibits were very well attended and created a great deal of interest.

LIST OF ADVERTISERS EXHIBITING AT FORTY-SIXTH ANNUAL MEETING

Name	*Address*
Ahlberg Bearing Company	Chicago, Ill.
American Brattice Cloth Corporation	Warsaw, Ind.
American Cable Company	Chicago, Ill.
American Crucible Products Co.	Lorain, Ohio
Asbestos Wood Manufacturing Co.	Chicago, Ill.
Atlas Powder Company	Joplin, Mo.
Berry Bearing Co.	Chicago, Ill.
Broderick & Bascom Rope Co.	St. Louis, Mo.
Bureau of Mines, Dept. of the Interior	Vincennes, Ind.
Cardox Corporation	Chicago, Ill.
Central Mine Equipment Co.	St. Louis, Mo.
Chicago Pneumatic Tool Co.	St. Louis, Mo.
Cincinnati Mine Machinery Co.	Cincinnati, Ohio
Dept. of Mines & Minerals, State of Illinois	Springfield, Ill.
E. I. du Pont de Nemours & Co.	Chicago, Ill.
Egyptian Sales Agency	Murphysboro, Ill.
Electric Storage Battery Co.	Philadelphia, Pa., Chicago, Ill.
Ensign Products Co.	Cleveland, Ohio, St. Louis, Mo.
Evansville Electric & Mfg. Co.	Evansville, Ind.
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Gould Storage Battery Corp.	Chicago, Ill., Depew, N. Y.
W. M. Hales Co.	Chicago, Ill., Danville, Ill.
Hazard Wire Rope Co.	Chicago, Ill., Wilkes-Barre, Pa.

Hercules Powder Co.....Chicago, Ill.
Hulburt Oil & Grease Co.....Philadelphia, Pa.
Indiana Bearings, Inc.....Indianapolis, Ind.
I-T-E Circuit Breaker Co.....Philadelphia, Pa.
A. Leschen & Sons Rope Co.....St. Louis, Mo.
Link-Belt Co.....Chicago, Ill.
Macwhyte Wire Rope Co.....Kenosha, Wis., Chicago, Ill.
Mine Safety Appliances Co.....Pittsburgh, Pa.
Ohio Brass Company.....Mansfield, Ohio
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Frank Prox Company, Inc.....Terre Haute, Ind.
John A. Roebling's Sons Co.....Trenton, N. J., Chicago, Ill.
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Socony-Vacuum Oil Co., Inc.....St. Louis, Mo.
Southwest Bolt & Nut Co.....St. Louis, Mo.
State Geological Survey.....Urbana, Ill.
Sterling Steel Casting Co.....East St. Louis, Ill.
Streeter-Amet Company.....Chicago, Ill.
Templeton-Kenly & Co.....Chicago, Ill.
Bertrand P. Tracy Co.....DuQuoin, Ill., Pittsburgh, Pa.
U. S. Sanitary Specialties Corp.....Chicago, Ill.
The Upson-Walton Company.....Chicago, Ill.
Utility Mine Equipment Co.....St. Louis, Mo.
The Watt Car & Wheel Co.....Barnesville, Ohio
Westinghouse Electric & Manufacturing Co.....Chicago, Ill.
The West Virginia Rail Co.....Huntington, W. Va.

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, to 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. Funds received from life members are to be invested and only the income from these funds may be used in the regular operation of the Institute.

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 President 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 sign all orders for payment of money by the treasurer, and with the executive board shall 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, countersign all orders for money which have been signed by the president, and shall purchase necessary supplies under the direction of the executive board.

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 the president, and countersigned 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.

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BROOKS, C. W., Contr. Engr................Room 601, 53 W. Jackson Blvd., Chicago, Ill.
BUCHANAN, D. W., Pres....................Old Ben Coal Corp., 230 S. Clark St., Chicago, Ill.
BUTCHER, FRED E..............................First National Bank Bldg., Danville, Ill.
COWIN, G. D., Pres..............................
Bell & Zoller Coal & Mining Co., 307 N. Michigan Ave., Chicago, Ill.
DUNCAN, W. M., Pres..............................Duncan Foundry & Machinery Co., Alton, Ill.
GARCIA, JOHN A....................Allen & Garcia Co., 332 S. Michigan Ave., Chicago, Ill.
GREEN, ARTHUR C....................Goodman Mfg. Co., 4834 S. Halsted St. Chicago, Ill.
HARRINGTON, GEO. B., Pres..............................
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HARRIS, ALLYN, Pres...........Safety Mining Co., 307 N. Michigan Ave., Chicago, Ill.
JENKINS, S. T..............................Goodman Mfg. Co., 322 Clark Ave., St. Louis, Mo.
JENKINS, W. J., Pres..............................
Consolidated Coal Co. of St. Louis, Railway Exchange Bldg., St. Louis, Mo.
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JOYCE, A. R..............................The Wood Preserving Corp., Marietta, Ohio
KEELER, E. R....................Franklin County Coal Co., 135 S. LaSalle St., Chicago, Ill.
KNOIZEN, A. S..............................Joy Mfg. Co., Franklin, Pa.
LEACH, B. K., Pres...Egyptian Tie & Timber Co., 1803 Ry. Exch. Bldg., St. Louis, Mo.
McFADDEN, GEO. C., A. V.-P.......Peabody Coal Co., 231 S. LaSalle St., Chicago, Ill.
PEABODY, STUYVESANT, Pres...Peabody Coal Co., 231 S. LaSalle St., Chicago, Ill.
PELTIER, M. F., V.-P....................Peabody Coal Co., 231 S. LaSalle St., Chicago, Ill.
PFAHLER, F. S. Pres..................Superior Coal Co., 400 W. Madison St., Chicago, Ill.
POWERS, F. A..............................Hulburt Oil & Grease Co., Box A-22, Peoria, Ill.
RYAN, JOHN T., V.-P. and G. M.............Mine Safety Appliances Co., Pittsburgh, Pa.
SANDOE, C. J., V.-P. and G. M..............................
W. Va. Coal Co. of Mo., Boatmen's Bank Bldg., St. Louis, Mo.
SCHONTHAL, B. E., Pres..............................
B. E. Schonthal & Co., Inc., 28 East Jackson Blvd., Chicago, Ill.
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TAYLOR, H. H., JR., V. P.........Franklin Co. Coal Co., 135 S. LaSalle St. Chicago, Ill.
THOMAS, T. J., Pres.....................Valier Coal Co., 547 W. Jackson Blvd., Chicago, Ill.
WANNER, E. W., V.-P..............................Hulburt Oil & Grease Co., Philadelphia, Penn.
WARE, LOUIS, Pres..............................
United Electric Coal Companies, 307 N. Michigan Ave., Chicago, Ill.
WEIR, PAUL, Consulting Engineer..............................307 N. Michigan Ave., Chicago, Ill.
ZELLER, HARRY, V.-P. and G. M.........West Virginia Rail Co., Huntington, W. Va.

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ACTIVE MEMBERS

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ABRELL, JOHN, Supt.....Peabody Coal Co., No. 7 Mine, Kincaid, Ill.
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Consolidated Coal Co. of St. Louis, 612 W. Main St., Staunton, Ill.
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ADAMS, W. G., Mgr.....Dooley Bros., 1201 S. Washington St., Peoria, Ill.
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ADAMSON, C. H.....Stephens-Adamson Mfg. Co., 20 N. Wacker Drive, Chicago, Ill.
AITKEN, W. L., Slsmn.....Dooley Bros., 1201 S. Washington St., Peoria, Ill.
ALFORD, NEWELL G.....
Eavenson, Alford & Auchmuty, 2050 Koppers Bldg., Pittsburgh, Pa.
ALLARD, A. F.....United States Fuel Co., Danville, Ill.
ALVERSON, RALPH, Gen. Supt.....Carney Coal Co., Harrisburg, Ill.
ANDERSON, G. G., Mine Mgr...Old Ben Coal Corp., 204 N. Maple St., Christopher, Ill.
ANDERSON, J. C.....1633 N. Vermilion St., Danville, Ill.
*ANDERSON, J. S.....Saxton Coal Mining Co., Terre Haute, Ind.
ANDERSON, LLOYD.....Peabody Coal Co. No. 43, Harrisburg, Ill.
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A. Leschen & Sons Rope Co., 810 W. Washington Blvd., Chicago, Ill.
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BARLOW, J. E.....Goodman Mfg. Co., 1122 S. 11th St., Springfield, Ill.
BARR, ROY E., Coal Traffic Mgr.....
Illinois Central Railroad, 135 E. 11th Place, Chicago, Ill.
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Peabody Coal Co. No. 59, 401 S. Lincoln Ave., Springfield, Ill.
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Utility Mine Equipment Co., 620 Tower Grove Ave., St. Louis, Mo.

BEDA, P. W., V. P..........Old Ben Coal Corp., 230 S. Clark St., Chicago, Ill.
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BEGGS, D. W., Pres..........Macon County Coal Co., Decatur, Ill.
BELL, J. H..........Cardox Corporation, 307 N. Michigan Ave., Chicago, Ill.
BELLAMY, C. C., Service Engr..........
Shell Petroleum Corp., 231 S. Sycamore St., Centralia, Ill.
BELTZ, JOHN S..........Jeffrey Mfg. Co., Columbus, Ohio
BENTLY, J. G.....The Johnson-March Corporation, P. O. Box 38, West Frankfort, Ill.
BESS, DUDLEY C.....Central Illinois Coal Mining Co., P. O. Box 396, Springfield, Ill.
BEVERS, P. T..........
The Electric Railway Improvement Co., 2070 E. Sixty-First St., Cleveland, Ohio
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BLAKE, ARTHUR..........Peabody Coal Co., Taylorville, Ill.
BLAKELY, W. V..........Western Powder Mfg. Co., East Alton, Ill.
BLANKINSHIP, G. F., Sales Engr..........Egyptian Sales Agency, Murphysboro, Ill.
BLOOMQUIST, C. A..........Link-Belt Co., St. Louis, Mo.
BLUTH, MARC G., Mgr. Chicago Office..........
National Coal Association, 307 N. Michigan Ave., Chicago, Ill.
BOEDEKER, S. A., Mgr. Ind. Sls.....Sligo Iron Store Co., 1301 N. Sixth, St. Louis, Mo.
BONTEMPS, CARL W., Engineer....Commonwealth Edison Co., Box 7, Taylorville, Ill.
BOTTOMLEY, J. A..........Sahara Coal Co., Harrisburg, Ill.
BRADBURY, WILLIAM..........Peru Deep Vein Coal Co., Peru, Ill.
BRANDENBURGER, E. W., Dist. Sls. Mgr..........
Southern Coal Co., Inc., 1242 Syndicate Trust Bldg., St. Louis, Mo.
BREWER, JACK H., Engr. Sales & Serv..........
Streeter-Amet Co., 4101 Ravenswood Ave., Chicago, Ill.
BREWSTER, BURT B., Editor-Publ..........
The Mining Review & Contracting, 506 Dooly Bldg., Salt Lake City, Utah
BRISTOW, JAMES W., Sec..........
Illinois Coal Strippers Assn., Rm. 2300, 230 N. Michigan Ave., Chicago, Ill.
BRITT, R. E..........Goodyear Tire & Rubber Co., 407 E. 25th St., Chicago, Ill.
BROADWAY, J. W..........Bell & Zoller Coal Co., 307 N. Michigan Ave., Chicago, Ill.
BROOKS, BIRCH..........Saxton Coal Mining Co., Terre Haute, Ind.
*BROOKS, C. W..........Room 601, 53 W. Jackson Blvd., Chicago, Ill.
BROWN, BYRON..........Franklin County Coal Co., Herrin, Ill.
BROWN, HAROLD C..........Binkley Mining Co. of Mo., Macon, Mo.
BROWN, WM. H., Chief Elect..........Crescent Mining Co., P. O. Box 267, Peoria, Ill.
BROWNE, HORACE D., Engr. of Tests, C. & N. W. R. R..........
4200 W. Kinzie St., Chicago, Ill.
*BUCHANAN, D. W., Pres..........Old Ben Coal Corp., 230 S. Clark St., Chicago, Ill.
BUCHANAN, J. H., Res. Mgr..........Atlas Powder Co., 135 S. La Salle St., Chicago, Ill.
BUCK, GEO. M., Auditor..........
Western Coal & Mng. Co., 1400 Missouri Pacific Bldg., St. Louis, Mo.
BURK, COLVIN..........Saxton Coal Mng. Co., Terre Haute, Ind.
BURKEY, W. H..........Gould Storage Battery Co., 400 W. Madison St., Chicago, Ill.
BURKHALTER, C. H.....Ohio Brass Co., Rm. 1580, 231 S. La Salle Street, Chicago, Ill.
BURNELL, E. J..........Link-Belt Co., 300 W. Pershing Road, Chicago, Ill.
BURNETT, FRED, Supt..........Peabody Mine No. 47, Harco, Ill.

BURNETT, WM. J., JR., Div. E. E...
Peabody Coal Co., 705 W. Boulevard, Marion, Ill.
BURRIS, W. S..Duquoin Iron & Supply Co., Duquoin, Ill.
BURTLE, W. R..Goodyear Tire & Rubber Co., Louisville, Ky.
BUSCH, A. D..............................The W. S. Tyler Co., 7540 Lovella Ave., St. Louis, Mo.
BUSWINK, WILLIAM...Illinois Zinc Co., Peru, Ill.
*BUTCHER, FRED E..First National Bank Bldg., Danville, Ill.
BUTLER, GILBERT W........................Link-Belt Co., 317 N. 11th St., St. Louis, Mo.
BUTLER, S. A.....................................Southern Coal, Coke & Mining Co., Belleville, Ill.
CADY, GILBERT H..State Geological Survey, Urbana, Ill.
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CAMPBELL, C. E..............................Shell Petroleum Corp., Shell Bldg., St. Louis, Mo.
CAMPBELL, GEO. F........................Old Ben Coal Corp., 230 S. Clark St., Chicago, Ill.
CAMPBELL, H. E., P. A.................Peabody Coal Co., 231 S. La Salle St., Chicago, Ill.
CAPE, SAM...Sahara Coal Co., Harrisburg, Ill.
CARLISLE, THOS. O., Engr...........Link-Belt Co., 300 W. Pershing Road, Chicago, Ill.
CARLSON, GEORGE......................Bucyrus-Erie Co., 105 W. Adams St., Chicago, Ill.
CARROLL, D. J., Pres...Continental Coal Co., Fairmont, W. Va.
CARSON, CHARLES, Mine Mgr..........Crescent Mining Co., P. O. Box 267, Peoria, Ill.
CARTER, DALE, Supt..Mine No. 2, Bell & Zoller, Zeigler, Ill.
CARTWRIGHT, HARVEY................Indiana Coal Operators Assn., Terre Haute, Ind.
CASASSA, JOSEPH B., State Mine Insp...........209 W. Dakota St., Spring Valley, Ill.
CASSADY, PETER A., Gen. Mgr...
Pac Lubricating & Service Co., 1500 S. Western Ave., Chicago, Ill.
CASSIDY, S. M., Mgr...Weirton Coal Co., Isabella, Pa.
CECIL, C. H..........................Bethlehem Steel Co., 400 N. Michigan Ave., Chicago, Ill.
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CHRISTENSEN, NICHOLAS, Sls. Mgr...
Cardox Corporation, 307 N. Michigan Ave., Chicago, Ill.
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CONWAY, C. C., Chief Elect..Consolidated Coal Co., Herrin, Ill.
CONWAY, LEE, M. E.........................Consolidated Coal Co. of St. Louis, Staunton, Ill.
COOK, WALTER, Secretary..........Central Mine Equipment Co., Webster Groves, Mo.
COPAS, H. W...................Union Wire Rope Corp., 431 W. Pershing Road, Chicago, Ill.
COPLEY, J. S., Sales Engr..7555 York Dr., St. Louis, Mo.
COREY, J. W...Reliance Electric & Engrng. Co., Cleveland, Ohio
*COWIN, G. D., Pres...
Bell & Zoller Coal & Mining Co., 307 N. Michigan Ave., Chicago, Ill.
COX, R. L., Sls. Mgr...Jeffrey Mfg. Co., Columbus, Ohio
CRAGGS, W. C..Peabody Mine No. 8, Taylorville, Ill.
CRAWFORD, J. G., Gen. Mgr.........Valier Coal Co., 547 W. Jackson Blvd., Chicago, Ill.
CROWDER, GORDON G., Asst. to V. P...
Peabody Coal Co., 231 S. La Salle St., Chicago, Ill.

CUNNINGHAM, M. F.........Goodman Mfg. Co., 149 Madison Blvd., Terre Haute, Ind.
DAKE, WALTER M., Research Mgr., Mining Publications..
McGraw-Hill Publishing Co., New York, N. Y.
DANKS, G. H.........E. I. du Pont de Nemours Co., 1814 McCormick Bldg., Chicago, Ill.
DAVIDSON, JAMES S...Jeffrey Mfg. Co., St. Louis, Mo.
DAVIS, JOHN H., Asst. Comm..
Illinois Coal Operators' Assn., 530 W. Williams St., Springfield, Ill.
DAVIS, WM. H............................Simplex Wire & Cable Co., P. O. Box 62, Decatur, Ill.
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DAWSON, HUGH........................Bethlehem Steel Co., 500 W. Monroe St., Herrin, Ill.
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DAYHOFF, LYLE H., Pres..
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DELAMATER, G. R., Asst. V. Pres...
The W. S. Tyler Co., 3615 Superior Ave., N. E., Cleveland, Ohio
DETWEILER, M. H., Mgr......................................Zeigler Coal & Coke Co., Zeigler, Ill.
DEVONALD, D. H., Asst. to V. P...
Peabody Coal Co., 231 S. La Salle St., Chicago, Ill.
DEWITT, C. S., P. A..................C-W-F Coal Co., 332 S. Michigan Ave., Chicago, Ill.
DICKINSON, A. W.......American Mining Congress, Munsey Bldg., Washington, D. C.
DICKSON, S. A...The Alton Railroad, Springfield, Ill.
DODD, A. F., Gen. Supt.......United States Fuel Co., 157 N. Vermilion St., Danville, Ill.
DOLD, R. N., Slsmn...
Chicago Pneumatic Tool Co., 837 Ravenswood Ave., Evansville, Ind.
DONIE, P. L...Little Betty Mining Corp., Linton, Ind.
DOZIER, JOS., Chief Elect..................................Peabody No. 58 Mine, Taylorville, Ill.
DRINKWATER, JAMES S...........Link-Belt Co., 300 W. Pershing Road, Chicago, Ill.
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DUNCAN, A. W..Duncan Fdry. & Machine Co., Alton, Ill.
DUNCAN, GEO. D..Duncan Fdry. & Machine Co., Alton, Ill.
DUNCAN, GEO. D., JR.......................................Duncan Fdry. & Machine Co., Alton, Ill.
*DUNCAN, W. M..Duncan Fdry. & Machine Co., Alton, Ill.
DUVAL, GASTON, Slsmn.................Atlas Powder Co., 116 N. 32nd St., Belleville, Ill.
EANDI, FRED...Peabody Coal Co., No. 59, Springfield, Ill.
EDGAR, R. L..Watt Car & Wheel Co., Barnesville, Ohio
EDMUNDSON, RAY, Pres...............................District 12, U. M. W. A., Springfield, Ill.
ELDER, E. H..Pyramid Coal Corp., Pinckneyville, Ill.
ELDERS, W. M., Supt...Peabody Mine 14, DuQuoin, Ill.
ELLIS, HOWARD R., Slsmn. & Engr.............Cardox Corp., Box 385, Mt. Vernon, Ill.
ELSHOFF, CARL H., Pres.............Mine B Coal Co., 1301 Bates Ave., Springfield Ill.
EMERICK, F. J...................Bethlehem Steel Co., 400 N. Michigan Ave., Chicago, Ill.
ENGLISH, THOMAS...2013 S. Fourth St., Springfield, Ill.
EQUITABLE POWDER MFG. CO..East Alton, Ill.
ESSINGTON, T. G., Chief Counsel..
Illinois Coal Operators Assn., 231 S. La Salle St., Chicago, Ill.
EUBANKS, FRANK.....................................Old Ben Coal Corp., West Frankfort, Ill.
EVANS, CADWALLADER, JR., Gen. Mgr...................Hudson Coal Co., Scranton, Pa.
EVANS, JOHN H., Supt..Wasson Coal Co., Harrisburg, Ill.
FALCETTI, OSCAR, Supt............................The Mine "B" Coal Co., Springfield, Ill.
FARNSWORTH, NAT...Gillespie Coal Co., Gillespie, Ill.

FELLINGER, A. C.........................Link-Belt Co., 300 W. Pershing Road, Chicago, Ill.
FERRELL, J. L...
Crescent Lubricating Co., 406 First National Bank Bldg., Huntington, W. Va.
FIELDS, RAY E...Evansville Electric & Mfg. Co., 600 W. Eichel Ave., Evansville, Ind.
FIRMIN, W. H...Wyoming Tie & Timber Co., Metropolis, Ill.
FIRTH, B. H., Supt...Lumaghi Coal Co., Collinsville, Ill.
FISHER, S. M...Superior Coal Co., Gillespie, Ill.
FLASKAMP, F. A.......Broderick & Bascom Rope Co., 4203 N. Union St., St. Louis, Mo.
FLEMING, J. B.......Mine Safety Appliances Co., 403 Pennsylvania Ave., Urbana, Ill.
FLEMING, J. E...
Electric Storage Battery Co., 1015 Architects & Bldrs. Bldg., Indianapolis, Ind.
FLEMING, JAMES R...
Mine Safety Appliances Co., 1012 W. Stoughton St., Urbana, Ill.
FLETCHER, J. H., Consulting Engr......................332 S. Michigan Ave., Chicago, Ill.
FORBES, C. R..Missouri School of Mines, Rolla, Mo.
FORD, CLEM C..........................Jeffrey Mfg. Co., 307 N. Michigan Ave., Chicago, Ill.
FOSTER, JOHN R., Supt...
Chicago, Wilmington & Franklin Coal Co., West Frankfort, Ill.
FRIES, J. J., Gen. Supt................................Indiana & Illinois Coal Corp., Nokomis, Ill.
FULKE, FRANK L...Frank Prox Co., Terre Haute, Ind.
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*GARCIA, JOHN A.....................Allen & Garcia Co., 332 S. Michigan Ave., Chicago, Ill.
GARCIA, JOHN A. JR..........Allen & Garcia Co., 332 S. Michigan Ave., Chicago, Ill.
GARWOOD, THOMAS L...
Chicago, Wilmington & Franklin Coal Co., West Frankfort, Ill.
GATELY, ALBERT..........Republic Coal Co., Fullerton & Southport Ave., Chicago, Ill.
GEBHART, B. R., V. P...
Chicago, Wilmington & Franklin Coal Co., 332 S. Michigan Ave., Chicago, Ill.
GILES, WM. S..Giles Armature & Electric Works, Marion, Ill.
GILGIS, W. L., Pur. Agent........Superior Coal Co., 1417 Daily News Bldg., Chicago, Ill.
GILLESPIE, EDWARD..Peabody Coal Co., Taylorville, Ill.
GIMBLETT, J. H., Mgr..
Hytest Division, International Shoe Co., 1507 Washington Ave., St. Louis, Mo.
GIVEN, IVAN A., Asst. Editor...
McGraw-Hill Publishing Co., 330 W. 42nd St., New York, N. Y.
GLENWRIGHT, J. W..Atlas Powder Co., Springfield, Ill.
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The American Brake Shoe & Foundry Co., P. O. Box 943, Huntington, W. Va.
GOODWIN, A. E..Ensign Products Co., Zeigler, Ill.
GORDON, G. B...Bell & Zoller Coal & Mng. Co., Zeigler, Ill.
GORDON, O. M., Treas...
Bell & Zoller Coal & Mining Co., 307 N. Michigan Ave., Chicago, Ill.
GORDON, RALPH E..Valier Coal Co., Valier, Ill.
GOURLEY, S. R., Sec.............................Mine "B" Coal Co., Box 311, Springfield, Ill.
*GREEN, ARTHUR C..................Goodman Mfg. Co., 4834 S. Halsted St., Chicago, Ill.
GREEN, E. E...Valier Coal Co., Valier, Ill.
GREEN, HOWARD, Engr.....North. Ill. Coal Corp., 310 S. Michigan Ave., Chicago, Ill.
GREEN, KENNETH.....................................1301 Saw Mill Run Blvd., Pittsburgh, Pa.
GREENE, D. W., Gen. Supt..................................West Virginia Coal Co., O'Fallon, Ill.

GRIFFEN, JOHN..................Koppers-Rheolaveur Co., Koppers Bldg., Pittsburgh, Pa.
GRIMM, A. O., Purch. Agt..
West Virginia Coal Co. of Mo., Boatmen's Bank Bldg., St. Louis, Mo.
GRIMMETT, O. C..C-W-F Coal Co., Benton, Ill.
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HALBERSLEBEN, PAUL, Gen. Supt........................Sahara Coal Co., Harrisburg, Ill.
HALE, SYDNEY A......................................Coal Age, 330 W. 42nd St., New York, N. Y.
HALES, W. M., Pres..............................W. M. Hales Co., 605 W. 116th St., Chicago, Ill.
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HALL, R. DAWSON.............................340 Burns St., Forest Hills, Long Island, N. Y.
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HANNAFORD, FOSTER, Coal Officer..
Commonwealth Edison Co., Rm. 1628, 72 W. Adams St., Chicago, Ill.
HANSON, JOHN..Peabody Coal Co., Taylorville, Ill.
HANTMAN, SAMUEL..80 E. Jackson Blvd., Chicago, Ill.
HARBULAK, H. J...............................American Car & Foundry Co., Terre Haute, Ind.
HARCARIK, JOHN, JR., Night Boss..
Peabody Mine No. 24, 748 E. North St., Danville, Ill.
HARDSOCG, LESTER C..Hardsocg Mfg. Co., Ottumwa, Iowa
HARDY, JOHN W., Supt.......Peabody Mine No. 9, 1220 W. Main St., Taylorville, Ill.
HARDY, WM...Peabody Coal Co., Mine No. 58, Taylorville, Ill.
HARRELL, C. L.......................................Sterling Steel Casting Co., East St. Louis, Ill.
HARRIMAN, G. W..Valier Coal Co., Valier, Ill.
*HARRINGTON, GEO. B., Pres..
Chicago, Wilmington, Franklin Coal Co., 332 S. Michigan Ave., Chicago, Ill.
*HARRIS, ALLYN, Pres..................Cardox Corp., 307 N. Michigan Ave., Chicago, Ill.
HARRIS, JOE...............................Joy Mfg. Co., 907 Highland Road, Charleston, W. Va.
HARVEY, HADLEY....................Ohio Brass Co., 1414 S. E. First St., Evansville, Ind.
HASKELL, J. B...West Virginia Rail Co., Huntington, W. Va.
HASKINS, LEE, Supt...Mine No. 1, Bell & Zoller, Zeigler, Ill.
HAWLEY, E. W.....................American Powder Co., 20 N. Wacker Drive, Chicago, Ill.
HAYDEN, CARL T., Gen. Mgr.......Sahara Coal Co., 59 E. Van Buren St., Chicago, Ill.
HAYNES, O. V., Face Boss.................Crescent Mining Co., P. O. Box 267, Peoria, Ill.
HAYWARD, T. Z.................Jos. T. Ryerson & Son, Inc., 2558 W. 16th St., Chicago, Ill.
HAZEN, LEE...Bell & Zoller Coal & Mng. Co., Zeigler, Ill.
HEBLEY, HENRY F..
Commercial Testing & Engineering Co., 307 N. Michigan Ave., Chicago, Ill.
HELBING, ERNST..103 Morgan St., Tonawanda, N. Y.
HELBURN, B. L...Southern Electric Co., DuQuoin, Ill.
HENDERSON, J. R., Exec. Sec., Bituminous Coal Producers Board for District No. 10,
Rm. 1307, 105 W. Monroe St., Chicago, Ill.
HENRY, J. E........................The Alton Railroad Co., 340 W. Harrison St., Chicago, Ill.

HERBERT, C. A., Superv. Engr....................................Bureau of Mines, Vincennes, Ind.
HERBERT, C. F.............Bituminous Casualty Co., Cleaveland Bldg., Rock Island, Ill.
HERBIG, R. O., Dist. Mgr...Reliance Elec. & Eng. Co., 431 S. Dearborn St., Chicago, Ill.
HERBSTER, BERT..Peabody Coal Co., Springfield, Ill.
HERRINGTON, M. K., Sec. to Dir.............Dept. of Mines & Minerals, Springfield, Ill.
HILL, L. A...C. W. & F. Coal Co., Herrin, Ill.
HIPPLER, F. R...........................Ohio Carbon Co., 12508 Berea Road, Cleveland, Ohio.
HITT, JOS. E.................................Walter Bledsoe & Co., Arcade Bldg., St. Louis, Mo.
HOLMES, JOHN K., Secy..
Robert Holmes & Bros., Inc., 520 Junction Ave., Danville, Ill.
HOOK, GEORGE H., Sls. Mgr.....Beck & Corbitt Co., 1230 N. Main St., St. Louis, Mo.
HOPE, JOHN...Peabody Coal Co., Mine No. 24, Danville, Ill.
HOWARD, HUBERT E., Pres...
Pyramid Coal Corp., 230 N. Michigan Ave., Chicago, Ill.
HUBBART, C. C..Superior Coal Co., Gillespie, Ill.
HUFF, FRED A..United Electric Coal Co., DuQuoin, Ill.
HUGHES, JOHN A.....The Electric Storage Battery Co., 1218 Olive St., St. Louis, Mo.
HUMMERT, AUGUST J..Industrial Commissioner, Breese, Ill.
HURST, W. C., Senior V. Pres...
Chicago & Illinois Midland Railway Co., 821 Public Service Building, Springfield, Ill.
HYSLOP, JAMES..Walter Bledsoe & Co., Terre Haute, Ind.
JAMES, D. G..407 S. Dearborn St., Rm. 1030, Chicago, Ill.
JARVIS, WILLIAM R., Sls. Mgr.............Sullivan Machinery Co., Michigan City, Ind.
JAXON, GEORGE S.........................Link-Belt Co., 300 W. Pershing Road, Chicago, Ill.
JEFFERIS, J. A.......Illinois Terminal R. R. System, 710 N. 12th Blvd., St. Louis, Mo.
JENKINS, G. S., M. E...
Consolidated Coal Co. of St. Louis, Railway Exchange Bldg., St. Louis, Mo.
*JENKINS, S. T.................................Goodman Mfg. Co., 322 Clark Ave., St. Louis, Mo.
*JENKINS, W. J., Pres...
Consolidated Coal Co. of St. Louis, Railway Exchange Bldg., St. Louis, Mo.
JENSEN, E. E., Div. Mgr...Swan-Finch Oil Corp., 3870-A Humphrey St., St. Louis, Mo.
JOHNSON, E. H...Jeffrey Mfg. Co., Columbus, Ohio
JOHNSON, H. F.......U. S. Rubber Products Co., 440 W. Washington St., Chicago, Ill.
JOHNSON, JOHN..Superior Coal Co., Gillespie, Ill.
JOHNSON, NEIL O...............................The Dorr Co., 221 N. La Salle St., Chicago, Ill.
JOHNSTON, I. W....................................The Dorr Co., 221 S. La Salle St., Chicago, Ill.
JOHNSTON, J. M., C. E...Bell & Zoller C. & M. Co., Zeigler, Ill.
JONES, ARCH M...........John A. Roebling's Sons Co., 2023 Locust St., St. Louis, Mo.
JONES, D. W..Princeton Mining Company, Princeton, Ind.
JONES, DAVID C., Vice Pres...
The Wood Preserving Corp., Ayer & Lord Division, 80 E. Jackson Blvd., Chicago, Ill.
*JONES, JOHN E...Old Ben Coal Corp., West Frankfort, Ill.
JONES, WALTER M..Joy Manufacturing Co., Centralia, Ill.
JORGENSEN, F. F., Gen. Mgr.......................Consolidation Coal Co., Fairmont, W. Va.
JOY, DEWEY E..Cutter Bit Service Co., Christopher, Ill.
JOY, JOSEPH F.................J. F. Joy & Associates, Union Trust Bldg., Pittsburgh, Pa.

*JOYCE, A. R.....The Wood Preserving Corporation, Marietta, Ohio
JOYCE, L. V.....American Car & Foundry Co., 30 Church St., New York, N. Y.
JOYCE, PETER.....722 N. Grand Ave., W., Springfield, Ill.
KAGA, R. L.....Box 147, Arcola, Ill.
*KEELER, E. R., Pres.....Franklin County Coal Co., 135 S. LaSalle St., Chicago, Ill.
KELCE, L. RUSSELL, Vice Pres.....
Delta Coal Mining Co., 1012 Baltimore Ave., Kansas City, Mo.
KELCE, MERL C., Gen. Supt.....
Delta Coal Mining Co., 1012 Baltimore Ave., Kansas City, Mo.
KELLY, R. H.....Ahlberg Bearing Co., 2831 Locust St., St. Louis, Mo.
KENNEDY, H. M., Pres.....
Kennedy-Webster Electric Co., 300 W. Adams St., Chicago, Ill.
KENTFIELD, R. H., Ch. Engr.....Superior Coal Co., Gillespie, Ill.
KIDD, WILLIAM E.....U. M. W. of A., 609 W. Armstrong Ave., Peoria, Ill.
KISS, LAWRENCE.....Superior Coal Co., Gillespie, Ill.
KLEIN, GEO.....Klein Armature Works, Centralia, Ill.
*KNOIZEN, A. S.....Joy Mfg. Co., Franklin, Pa.
KOEPPEL, R., Asst. Mine Mgr.....Crescent Mining Co., P. O. Box 267, Peoria, Ill.
KOHOUT, J. F.....Commercial Testing & Engr. Co., 307 N. Michigan Ave., Chicago, Ill.
KOLB, FRED, Dist. Mgr.....Jeffrey Mfg. Co., Terre Haute, Ind.
KOSTBADE, C. J., Pres.....Berry Bearing Co., 2715 S. Michigan Ave., Chicago, Ill.
KRAMER, R. E.....H. Channon Co., 149 N. Wacker Drive, Chicago, Ill.
LAMBERT, M. S.....Robins Conveying Belt Co., 37 W. Van Buren St., Chicago, Ill.
LANDRY, E. N., Dist. Sls. Mgr.....
Gilmore Wire Rope Div., Jones & Laughlin Steel Corp., 2250 W. 47th St., Chicago, Ill.
LANGTRY, W. D., Pres.....
Commercial Testing & Engr. Co., 307 N. Michigan Ave., Chicago, Ill.
LAURELL, ERIC.....United Electric Coal Co., Canton, Ill.
LAWRY, R. G.....Roberts & Schaefer Co., 400 N. Michigan Ave., Chicago, Ill.
*LEACH, B. K., Pres.....
Egyptian Tie & Timber Co., 1803 Railway Exchange Bldg., St. Louis, Mo.
LEDNUM, E. T., Mgr.....
E. I. du Pont de Nemours & Co., 332 S. Michigan Ave., Chicago, Ill.
LEE, CARL.....Peabody Coal Co., 231 S. La Salle St., Chicago, Ill.
LEIDENHEIMER, JOHN.....Central Ill. Pub. Serv. Co., Marion, Ill.
LEIGHTON, M. M.....State Geological Survey, Urbana, Ill.
LEMING, ED., Supt.....Union Colliery Co., Dowell, Ill.
LETE, ACHILLE.....Lete & Sons Coal Co., 129 S. Gilbert St., Danville, Ill.
LEVIN, M. D.....Jeffrey Mfg. Co., Columbus, Ohio
LEWIS, A. D.....
United Mine Workers of America, United Mine Workers Bldg., Washington, D. C.
LEWIS, HOWARD, Asst. Gen. Supt.....
Old Ben Coal Corporation, 509 W. Sixth St., Benton, Ill.
LEWIS, JAMES, Supt.....Mine No. 8, Peabody Coal Co., Tovey, Ill.
LEYHE, CAPT. W. H.....Eagle Packet Co., St. Louis, Mo.
LINDSAY, GEORGE, Supt.....Rex Coal Co., Eldorado, Ill.
LINDSAY, W. L.....Vacuum Oil Co., Benton, Ill.
LISSE, HERMAN, Sec.....Ill. Mining Investigating Comm., Kincaid, Ill.
LOEWENHERZ, E., Pres.....K-W Battery Co., 3705 N. Lincoln Ave., Chicago, Ill.
LOHR, CARL P., Repr.....I-T-E Circuit Breaker Co., 4903 Delmar, St. Louis, Mo.
LOTT, GEO. M.....332 S. Michigan Ave., Chicago, Ill.

LOWE, ROBT. W., Engr..
Panther Creek Mines, Inc., 225½ S. Sixth Ave., Springfield, Ill.
LUBIN, A.......................Barker-Goldman-Lubin, Inc., 300 N. Ninth St., Springfield, Ill.
LUCAS, ANTON, Welding Supr..
Metal & Thermit Corp., 7300 South Chicago Ave., Chicago, Ill.
LYMAN, G. E...7535 Luella Ave., Chicago, Ill.
LYONS, JACK...Bell & Zoller Coal & Mng. Co., Zeigler, Ill.
LYTLE, GEORGE F., Sales Representative....................636 E. Main St., DuQuoin, Ill.
MABRY, H. E..................Equitable Powder Mfg. Co., 1625 Washington Ave., Alton, Ill.
MACFADYEN, F. R.......Timken Roller Bearing Co., 3300 Lindell Blvd., St. Louis, Mo.
MACWHYTE CO..Kenosha, Wis.
MALKOVICH, M.....................Sullivan Machinery Co., 2639 Locust St., St. Louis, Mo.
MALSBERGER, A. H............Dupont Powder Co., 1837 S. College St., Springfield, Ill.
MANCHA, RAYMOND..............................Jeffrey Manufacturing Co., Columbus, Ohio
MARBLE, G. E.................................General Electric Co., 230 S. Clark St., Chicago, Ill.
MARDIS, EARLE J.........American Steel & Wire Co., 208 S. La Salle St., Chicago, Ill.
MARIE, JOHN E., Master Mech.........Crescent Mining Co., P. O. Box 267, Peoria, Ill.
MARSH, I. D., Supt...Alcoa Ore Co., Belleville, Ill.
MARTIN, ENOCH, Asst. Dir..........................Dept. Mines & Minerals, Springfield, Ill.
MASELTER, JOHN E., Shop Supt...
General Electric Co., 1110 Delmar Blvd., St. Louis, Mo.
MATTHEWS, M. A.................................Templeton-Matthews Corp., Terre Haute, Ind.
MAYOR, ELMER S...Binkley Mining Co., Macon, Mo.
McALPIN, M. L...McLaren Coal Co., Marion, Ill.
McARTOR, GEORGE, Asst. Comm.................Illinois Coal Operators Assn., Herrin, Ill.
McAULIFFE, EUGENE, Pres...Union Pacific Coal Co., 1416 Dodge St., Omaha, Nebr.
McBRIDE, W. P.............American Car & Fdry. Co., Ry. Exchange Bldg., Chicago, Ill.
McCABE, PROF. LOUIS C., Asst. Geol........................305 Ceramics Bldg., Urbana, Ill.
McCLOUD, DON B.....Liquid Oxygen Explos. Mfr., 119 N. Chestnut St., DuQuoin, Ill.
McCOLLUM, H. C.........................Allen & Garcia Co., 1932 Lowell Ave., Springfield, Ill.
McCULLOCH, WM. C...United Electric Coal Co., DuQuoin, Ill.
McCULLOUGH, E. W..........................American Car & Foundry Co., Terre Haute, Ind.
McELHANEY, L. O.............................Crescent Mining Co., P. O. Box 267, Peoria, Ill.
McELHATTAN, D. F., Saf. Engr.................................Peabody Coal Co., DuQuoin, Ill.
McEVOY, F. E., P. A..
Bell & Zoller Coal & Mng. Co., 307 N. Michigan Ave., Chicago, Ill.
*McFADDEN, GEO. C., A. V. P.......Peabody Coal Co., 231 S. La Salle St., Chicago, Ill.
McFADDEN, NAT, Div. Engr...............................Peabody Coal Co., Taylorville, Ill.
McGURK, SAM, Supt..................................Mt. Olive & Staunton Coal Co., Staunton, Ill
McKENNA, THOMAS...Dept. Mines & Minerals, Danville, Ill.
McLAREN, A. B...McLaren Coal Co., Gas Building, Marion, Ill.
McLAREN, W. S...McLaren Coal Co., Marion, Ill.
McPHAIL, ROBT., Supt...............................Peabody Mine No. 18, West Frankfort, Ill
McREAKEN, C. W..Marion, Ill.
McSHERRY, JAMES, Dir............................Dept. of Mines & Minerals, Springfield, Ill.
MEAGHER, GEORGE ....C. W. F. Coal Co., West Frankfort, Ill.
MEISSNER, JOHN F., Dist. Mgr...
Robins Conveying Belt Co., 37 W. Van Buren St., Chicago, Ill.

MELKUSH, ONEY.....Peabody Coal Co., R. R. No. 5, Springfield, Ill.
MEYER, BRUNO F.....Staunton, Ill.
MILLER, ALEX U., Assoc. Mng. Engr.....
U. S. Bureau of Mines, La Plante Bldg., Vincennes, Ind.
MILLER, FRED.....Franklin County Coal Co., Herrin, Ill.
MILLER, J. B.....Mines Equipment Co., 1909 S. Kingshighway, St. Louis, Mo.
MILLER, JAMES E.....Mines Equipment Co., 1909 S. Kingshighway, St. Louis, Mo.
MITCHELL, A. G.....Burton Explosives, Inc., Mt. Vernon, Ill.
MITCHELL, D. R.....Mineral Industries Bldg., State College, Pa.
MOFFATT, H. A., Sec.-Treas.....Dooley Bros., 1201 S. Washington St., Peoria, Ill.
MONTGOMERY, N. L.....Templeton, Kenly & Co., 1020 S. Central Ave., Chicago, Ill.
†MOORSHEAD, A. J.....Colonial Apartment Hotel, La Jolla, Calif.
MORROW, J. B., Vice Pres.....Pittsburgh Coal Co., Oliver Bldg., Pittsburgh, Pa.
MOSEBACH, K. J., Pres.....
Mosebach Elec. & Supply Co., 1115 Arlington Ave., Pittsburgh, Pa.
MOSER, M. M.....United Electric Coal Co., 307 N. Michigan Ave., Chicago, Ill.
MOSES, HARRY M., Pres.....
H. C. Frick Coal Co., 1322 Frick Bldg., Pittsburgh, Pa.
MOSES, THOMAS.....H. C. Frick Coal Co., 1322 Frick Bldg., Pittsburgh, Pa.
MOWRIS, D. L.....U. S. Sanitary Specialties Corp., 435 S. Western Ave., Chicago, Ill.
MULLEN, E. C., Pres.....E. C. Mullen Co., 2525 W. 21st St., Chicago, Ill.
MULLINS, T. C., Pres.....
Northern Illinois Coal Corp., 310 S. Michigan Ave., Chicago, Ill.
MUNRO, CHAS. W.....Box No. 152, Homewood, Ill.
†MURRAY, HUGH.....Equality, Ill.
MYERS, R. E.....R. E. Myers Co., 317 N. 11th St., St. Louis, Mo.
NASH, R. O.....Westinghouse Electric Co., 1605 Ambassador Bldg., St. Louis, Mo.
NELSON, I. C.....Beall Bros. Supply Co., Marion, Ill.
NICHOLSON, PROF. HUGH P.....
Univ. of Illinois, 211 Transportation Bldg., Urbana, Ill.
NIEDRINGHAUS, R. C.....A. Leschen & Sons Rope Co., 5909 Kennerly, St. Louis, Mo.
NUCKELS, C. E.....Post-Glover Electric Co., 221 W. Third St., Cincinnati, Ohio
O'BRIEN, FRANK.....American Cable Co., 114 S. McKinley St., Harrisburg, Ill.
OELBERG, EMIL, Engr.....Sahara Coal Co., Harrisburg, Ill.
OLDHAM, R. J., Gen. Mgr.....Centralia Coal Co., Centralia, Ill.
O'NEIL, CHAS.....DuPont Powder Co., McCormick Bldg., Chicago, Ill.
O'ROURKE, DAN.....Sanford-Day Iron Works, c/o Sonntag Hotel, Evansville, Ind.
O'ROURKE, JOHN.....303 W. Lindell St., West Frankfort, Ill.
O'ROURKE, PETE.....William Hales Co., West Frankfort, Ill.
OVERSTREET, J. W.....National Electric Coil Co., Columbus, Ohio
PAUL, R. J.....Allis-Chalmers Mfg. Co., Railway Exchange Bldg., St. Louis, Mo.
*PEABODY, STUYVESANT, Pres.....Peabody Coal Co., 231 S. La Salle St., Chicago, Ill.
*PELTIER, M. F., V. P.....Peabody Coal Co., 231 S. La Salle St., Chicago, Ill.
PENWELL, WARREN, Pres.....Penwell Coal Mining Co., Pana, Ill.

PERRY, R. G. .... Sahara Coal Co., Harrisburg, Ill.
*PFAHLER, F. S., Pres. .... Superior Coal Co., 400 W. Madison St., Chicago, Ill.
PHILLIPS, ARTHUR, Supt. ....
Peabody Coal Co., Mine No. 59, 2710 S. Douglas Ave., Springfield, Ill.
PHILLIPS, EDGAR R. ....
Joy Manufacturing Co., 631 McCully St., Pittsburgh, Pa.
PICKARD, A. E. .... Mt. Vernon Car Co., Mt. Vernon, Ill.
PLASKON, JOHN, Welding Engr. ....
Metal & Thermit Corp., 7300 South Chicago Ave., Chicago, Ill.
POLING, GILBERT..Evansville Elec. & Mfg. Co., 600 W. Eichel Ave., Evansville, Ind.
POLING, J. W. .... Evansville Elec. & Mfg. Co., 600 W. Eichel Ave., Evansville, Ind.
POPE, RAYMOND W. .... Peabody Coal Co., Marion, Ill.
PORTER, R. T. .... Union Carbide Co., Springfield, Ill.
POWELL, JAS., Supt. .... Superior Coal Co., Gillespie, Ill.
*POWERS, F. A. .... Hulburt Oil & Grease Co., Box 21, Peoria, Ill.
PRICE, W. H., Supt. .... Delta Coal Mining Co., Marion, Ill.
PRINS, KLAAS .... The Morrow Mfg. Co., Wellston, Ohio
PRITCHARD, W. .... Goodman Mfg. Co., St. Louis, Mo.
PROCTOR, PETER .... Mine Rescue Station, 245 Buck St., La Salle, Ill.
PROFFITT, R. P. .... Timken Roller Bearing Co., 2534 S. Michigan Ave., Chicago, Ill.
PRUDENT, ED .... Bell & Zoller C. & M. Co., Zeigler, Ill.
PRUDENT, NORMAN .... Crescent Mining Co., P. O. Box 267, Peoria, Ill.
PURDON, H. L., Engr. .... Link-Belt Co., 300 W. Pershing Road, Chicago, Ill.
PURSGLOVE, JOS., JR., Asst. Gen. Mgr. ....
Pursglove Coal Mining Co., Pursglove, W. Va.

QUEBBEMAN, EDWARD ....
Universal Atlas Cement Co., 4303 Grand Ave., Western Springs, Ill.

RASOR, L. W., Rep...Goodyear Tire & Rubber Co., Inc., 614 Jefferson St., Paducah, Ky.
RASSIEUR, B. F., Treas. .... Central Mine Equipment Co., Webster Groves, Mo.
REED, FRANK H. .... State Geological Survey, Urbana, Ill.
REED, PAUL .... State Mine Examiner, 1701 S. Spring St., Springfield, Ill.
REES, O. W., Assoc. Chem. .... Ill. State Geol. Survey, Ceramics Bldg., Urbana, Ill.
REGAN, J. E. .... Goodyear Tire & Rubber Co., St. Louis, Mo.
REICHLING, R. L., Sales Engr. .... The Tool Steel Gear & Pinion Co., Cincinnati, Ohio
REID, H. A. .... United Electric Coal Co., 307 N. Michigan Ave., Chicago, Ill.
REILLY, JOHN E. .... Ensign Products Co., 3304 Shenandoah Ave., St. Louis, Mo.
REITHER, E. C. .... Timken Roller Bearing Co., 416 Craig St., Pittsburgh, Pa.
REUTER, W. P., Div. Mech. .... Peabody Coal Co., Marion, Ill.
RHEIN, HERBERT E., Salesman ....
American Brattice Cloth Corp., 2934 Broadway, Indianapolis, Ind.
RHINE, F. E. .... c/o Joy Manufacturing Co., Franklin, Pa.
RHOADS, M. J. .... Spring Valley Coal Co., Spring Valley, Ill.
RICHARDS, L. O. .... Robert Holmes & Bros., Danville, Ill.
RICHARDSON, DORWIN .... Coal Producers Assn., Pana, Ill.

RICHART, F. W........General Electric Co., Carterville, Ill.

RICHMOND, H., Face Boss........Crescent Mining Co., P. O. Box 267, Peoria, Ill.

ROBERTS, HARRY, State Mine Inspector........Box 15, Edinburg, Ill.

ROBERTSON, C. E........Westinghouse Elec. Co., 20 N. Wacker Drive, Chicago, Ill.

RODENBUSH, JAKE, Asst. Mine Mgr........Peabody No. 24 Mine, Georgetown, Ill.

RODENBUSH, JOHN, Supt........
Chicago, Wilmington & Franklin Coal Co., West Frankfort, Ill.

ROLLO, JAMES........Egyptian Powder Co., Herrin, Ill.

ROMAN, F. W........332 S. Michigan Ave., Hercules Powder Co., Chicago, Ill.

ROSENQUIST, G. C........Wood Preserving Corp., 80 E. Jackson Blvd., Chicago, Ill.

ROSING, BORGE, Gen. Sls. Mgr........West Virginia Rail Co., Huntington, W. Va.

ROZANSKI, M., Mine Mgr........Peabody Mine No. 8, 524 S. Cherokee, Taylorville, Ill.

RUSSELL, FRANK........Russell & Son, 100 W. St. Louis St., West Frankfort, Ill.

RUSSELL, W. H., E. E........Consolidated Coal Co., 608 Eddy Bldg., Saginaw, Mich.

RUTLEDGE, J. J........22 Light St., Bureau of Mines, Baltimore, Md.

*RYAN, J. T., V. P........Mine Safety Appliances Co., Pittsburgh, Pa.

RYAN, W. D., Arbitrator........
Illinois Coal Operators' Assn., 1501 S. Fifth St., Springfield, Ill.

RYAN, W. M........Central Illinois Coal Mining Co., Springfield, Ill.

SACKBAUER, L. A., Coal Traf. Mgr........Mo. Pac. R. R. Co., St. Louis, Mo.

ST. CLAIR, GUY N........Cardox Corp., Benton, Ill.

*SANDOE, C. J., V. P.....West Virginia Coal Co., Boatmen's Bank Bldg., St. Louis, Mo.

SANDOE, RICHARD D., Chief Engr........
West Virginia Coal Co. of Mo., Boatmen's Bank Bldg., St. Louis, Mo.

SAURS, FRED, Face Boss........Crescent Mining Co., P. O. Box 267, Peoria, Ill.

SAYLOR, H. N., JR., Pres........
Saylor Tie & Timber Co., 2121 Railway Exchange Bldg., St. Louis, Mo.

SCARLETT, FRED......Benefit Assn. of Ry. Employees, 901 Montrose St., Chicago, Ill.

SCHLEGEL, WM. P., Gen. Mgr., West. Div........
Truax-Traer Coal Co., 1161, 314 N. Broadway, St. Louis, Mo.

SCHLITT, FRANKLIN C........Schlitt Hardware Co., Springfield, Ill.

SCHMIDT, E. A.......I. T. E. Circuit Breaker Co., 810 Ambassador Bldg., St. Louis, Mo.

SCHOEN, W. H. JR., Pres........
Pittsburgh Knife & Forge Co., 718 Park Bldg., Pittsburgh, Pa.

*SCHONTHAL, B. E., Pres.......B. E. Schonthal & Co., 28 E. Jackson Blvd., Chicago, Ill.

*SCHONTHAL, D. C., Pres........West Virginia Rail Co., Huntington, W. Va.

SCHONTHAL, JOSEPH, Sec...B. E. Schonthal & Co., 28 E. Jackson Blvd., Chicago, Ill.

SCHRAUB, L. G., Gen. Sales Mgr........
Union Wire Rope Corp., 21st & Manchester Ave., Kansas City, Mo.

SCHULL, B. H., Supt........Binkley Mining Co., Terre Haute, Ind.

SCHULL, F. M., Vice Pres.......Binkley Mining Co., 925 S. Fifth St., Terre Haute, Ind.

SCHWARTZ, H. L........W. M. Hales Co., Hillsboro, Ill.

SCOTT, G. W........Timken Roller Bearing Co., Huntington, W. Va.

SCULLY, T. ALVIN, State Mine Inspector........Troy, Ill.

SEEKAMP, HERMAN L....Superior Coal Co., Gillespie, Ill.

SEVER, L. G., Exec. Vice Pres....Mt. Vernon Car Mfg. Co., Mt. Vernon, Ill.

SHAFER, GLENN A., Pres....Pana Coal Co., Pana, Ill.

SHAFFER, ARTHUR G., C. E....
C. W. & F. Coal Co., 702 W. St. Louis St., West Frankfort, Ill.

SHAMBLIN, JOHN, Mine Mgr....Consolidated Coal Co., Staunton, Ill.

SHARAV, W. B., Welding Supr....
Metal & Thermit Corp., 7300 South Chicago Ave., Chicago, Ill.

SHERMAN, H. S....General Electric Co., Pierce Bldg., St. Louis, Mo.

SHULTZ, T. M....Central Ill. Pub. Service Co., Beardstown, Ill.

SIMPSON, J. H....Mines Equipment Co., 1909 S. Kingshighway, St. Louis, Mo.

SMILEY, E. B....Illinois Gear & Machine Co., 2108 N. Natchez Ave., Chicago, Ill.

SMITH, C. M., Editor Mechanization....Munsey Building, Washington, D. C.

SMITH, GEO. M., Mine Supt....
Peabody Mine No. 57, 1800 Whittier Ave., Springfield, Ill.

SMITH, L. D., V. P....
Chicago, Wilmington & Franklin Coal Co., 332 S. Michigan Ave., Chicago, Ill.

SNARR, GEORGE W....Geo. W. Snarr & Co., 110 S. Ninth St., St. Louis, Mo.

SNARR, F. E....Chicago, Wilmington & Franklin Coal Co., Benton, Ill.

SNEDDON, JAMES, Asst. Mine Mgr....Franklin County Coal Co., Valier, Ill.

SOLOMON, E. C., Vice Pres....
Panther Creek Mines, Inc., 225½ S. Sixth St., Springfield, Ill.

SOLOMON, G. W., Vice Pres....
Panther Creek Mines, Inc., 225½ S. Sixth St., Springfield, Ill.

SOLOMON, H. A., Pres....
Panther Creek Mines, Inc., 225½ S. Sixth St., Springfield, Ill.

SOLOMON, R. D....Panther Creek Mines, Inc., 225½ S. Sixth St., Springfield, Ill.

SOMERS, BYRON, Supt....Truax-Traer Coal Co., St. David, Ill.

SONDAG, RAY J....Industrial Supplies, Inc., Belleville, Ill.

SONTAG, ROBT. E., Sales Rep....The Okonite Co., 411 N. Seventh St., St. Louis, Mo.

SOPER, ROY....Goodman Mfg. Co., 322 Clark St., St. Louis, Mo.

SOULE, M. M., Vice Pres....Coal Sales Co., 307 N. Michigan Ave., Chicago, Ill.

SOUTHWARD, G. B., Mng. Engr....
American Mining Congress, 439 Munsey Bldg., Washington, D. C.

SPAHT, A. W....Old Ben Coal Co., West Frankfort, Ill.

STADELL, CHARLES W....
Ill. Coal Traffic Bureau, 307 N. Michigan Ave., Chicago, Ill.

STAREK, R. B....Old Ben Coal Corp., 230 S. Clark St., Chicago, Ill.

STARKS, J. W., Div. Supt....Peabody Coal Co., Marion, Ill.

STEDELIN, JOHN W., Pres....Marion County Coal Co., 725 S. Elm, Centralia, Ill.

STEFFENS, A. B., Pres....
Indiana & Illinois Coal Corp., Rm. 1215, 37 W. Van Buren St., Chicago, Ill.

STEIGER, A. E....Binkley Coal Co., Terre Haute, Ind.

STELLING, H. C....Union Carbide Co., 30 E. 42nd St., New York, N. Y.

STEVENS, E. F....Union Colliery Co., Union Electric Bldg., St. Louis, Mo.

STINTON, WM. S., Asst. Sls. Mgr.........
Socony-Vacuum Oil Co., 4140 Lindell Blvd., St. Louis, Mo.

†STOCKETT, THOMAS R.........Alta Club, Salt Lake City, Utah

STOREY, JOHN.........Peabody Coal Co. No. 59, Springfield, Ill.

STOTLAR, J. C., Rep.........Mechanization, Inc., Benton, Ill.

STOUGHTON, F. A.........Jeffrey Mfg. Co., Columbus, Ohio

SUTHERLAND, HARRY T.........Standard Oil Co., Marion, Ill.

SUTOR, DON M.........Mines Equipment Co., 1909 S. Kingshighway, St. Louis, Mo.

SYERS, JACOB.........Western Powder Co., 825 Jefferson Bldg., Peoria, Ill.

TARLTON, G. L.........Gundlach Coal Co., 808 Continental Life Bldg., St. Louis, Mo.

TAYLOR, EARLE.........Illinois State Geological Survey, Urbana, Ill.

*TAYLOR, H. H., JR., V. P...Franklin County Coal Co., 135 S. La Salle St., Chicago, Ill.

TEMPLETON, ROBERT A.........Templeton Coal Co., 311 N. State St., Sullivan, Ind.

THIES, HENRY.........Joy Manufacturing Co., Franklin, Pa.

THIES, JOHN.........Portable Lamp & Equipt. Co., 420 N. Fourth St., Vincennes, Ind.

THOMAS, G. W.........Valier Coal Co., Valier, Ill.

THOMAS, R. H.........U. S. Fuel Co., Danville, Ill.

*THOMAS, T. J., Pres.........Valier Coal Co., 547 W. Jackson Blvd., Chicago, Ill.

THOMPSON, JOHN, Mine Mgr.........Bellwood Coal Co., Bellwood, W. Va.

THOMPSON, R. A.........Hercules Powder Co., Collinsville, Ill.

†TIRRE, FRANK F.........3659 Dover Place, St. Louis, Mo.

TOVEY, STEVE, Asst. Mine Mgr.........Peabody Mine No. 24, Westville, Ill.

TREADWELL, H. A., Gen. Supt.........
Chicago, Wilmington & Franklin Coal Co., Benton, Ill.

TREGONING, C. M.........Peabody Coal Co., Mine No. 59, Springfield, Ill.

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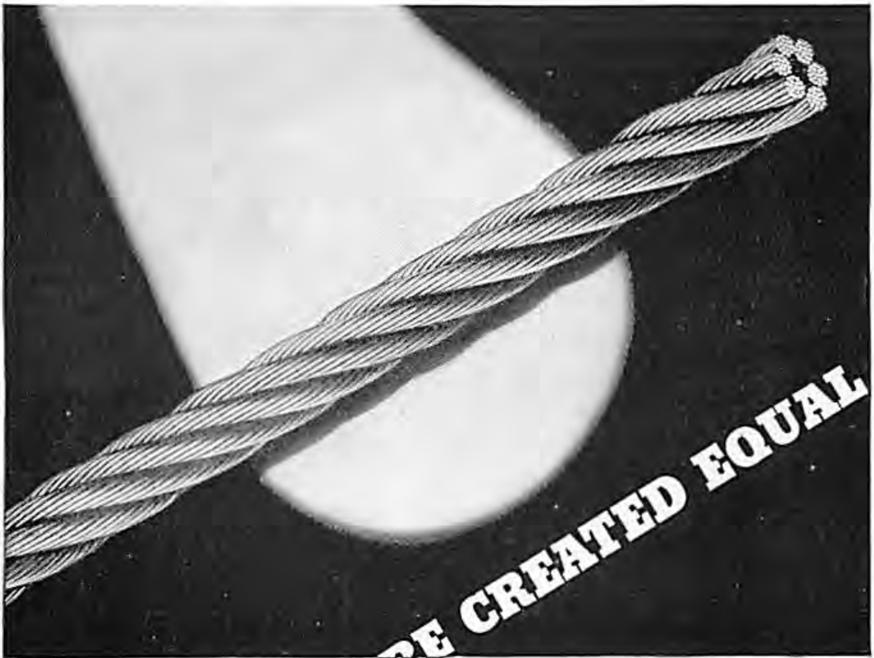

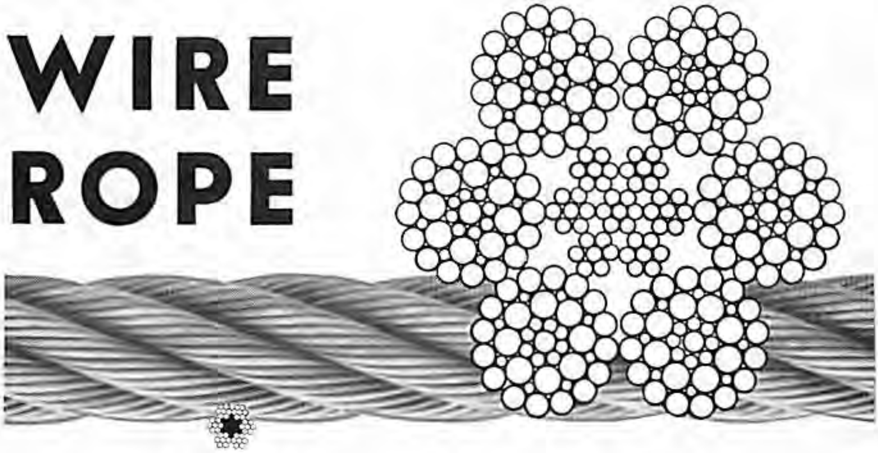

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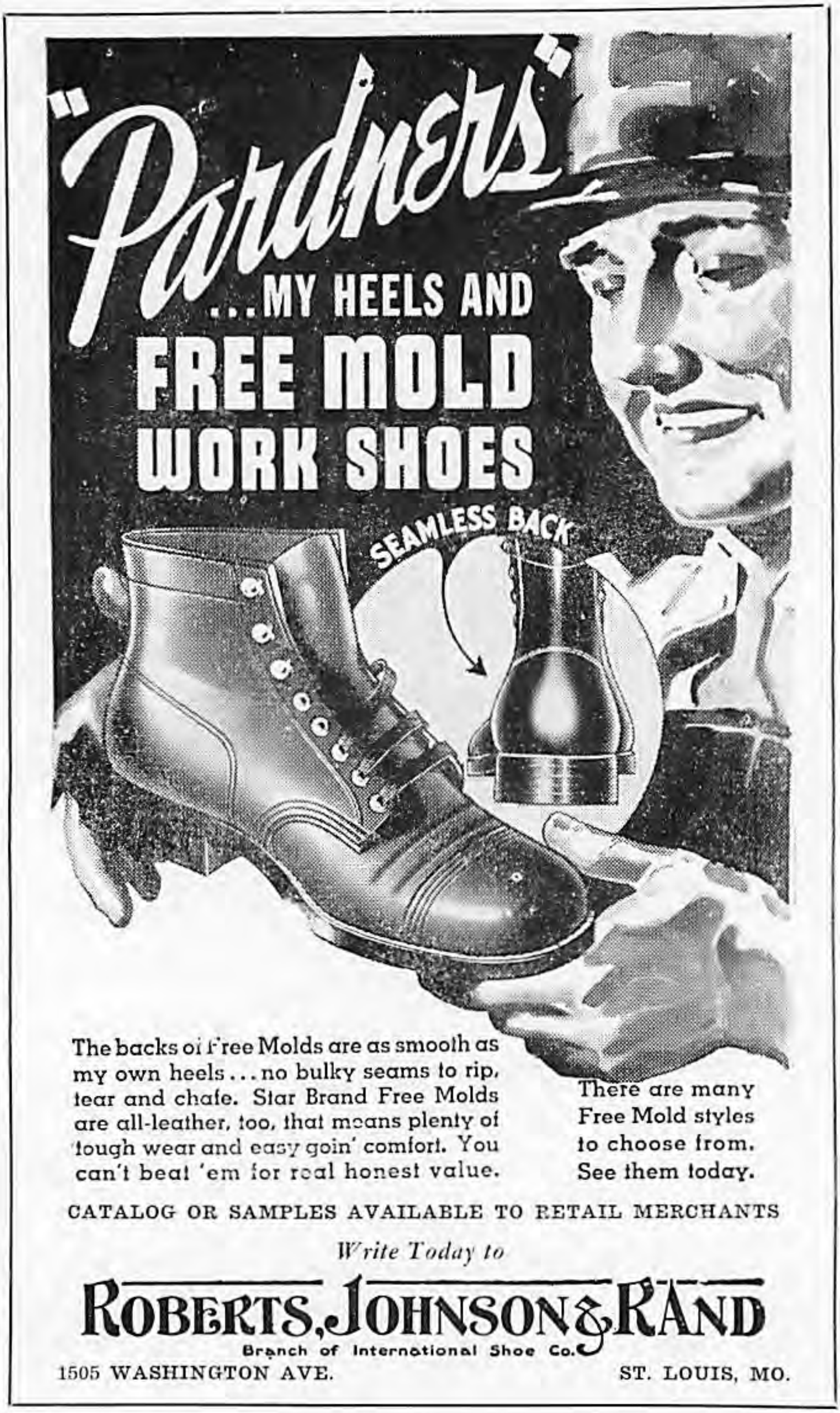
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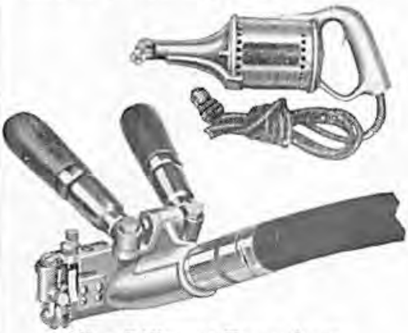

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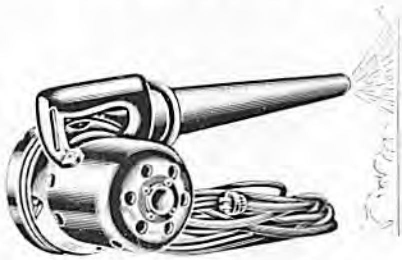

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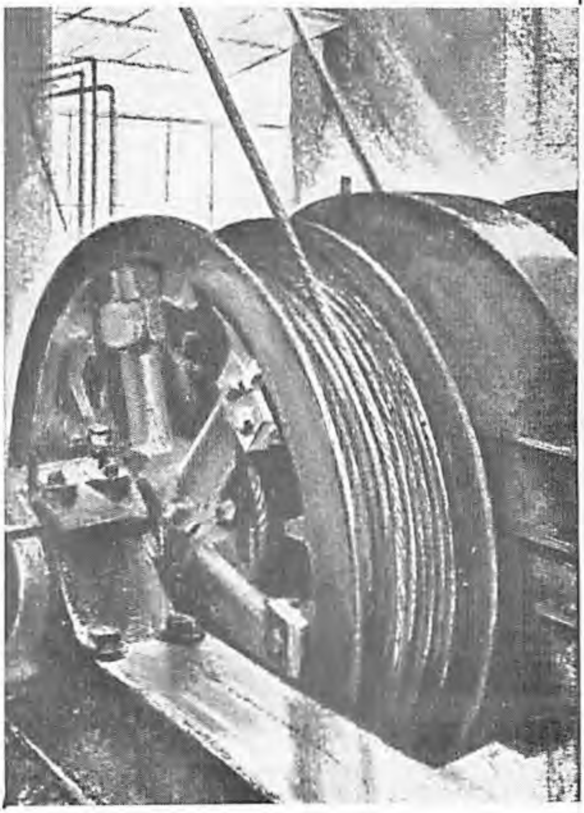

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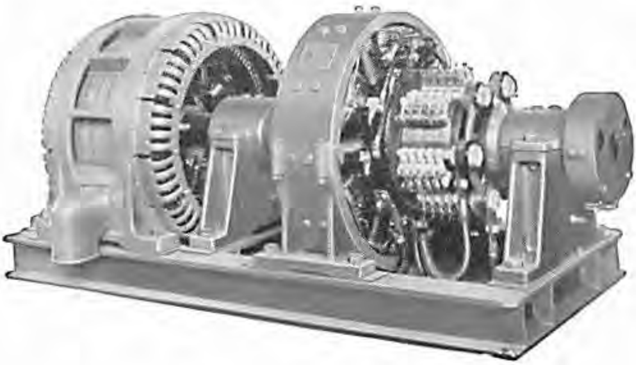

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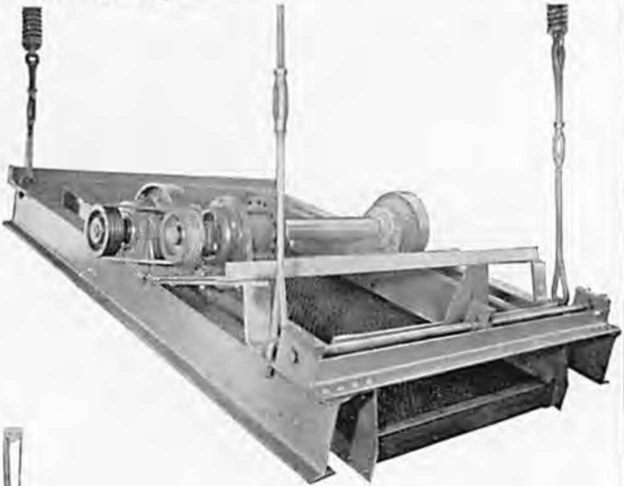

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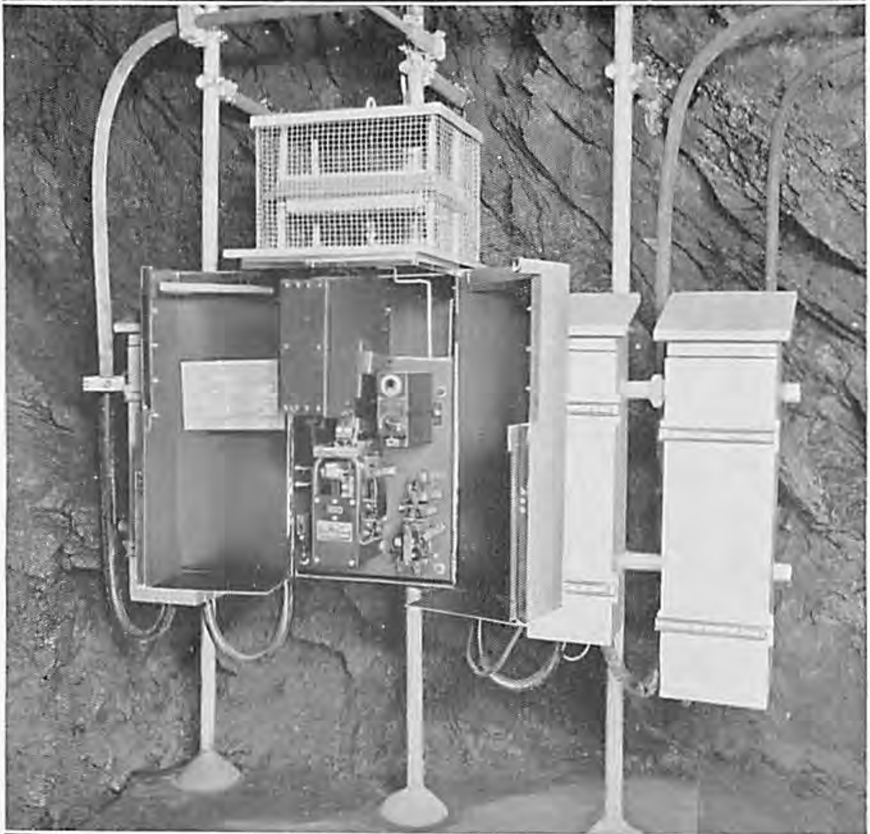

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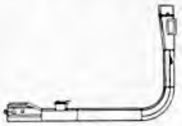

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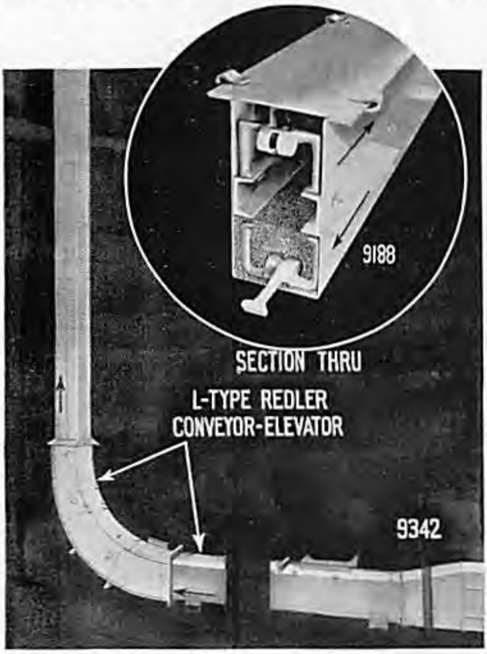

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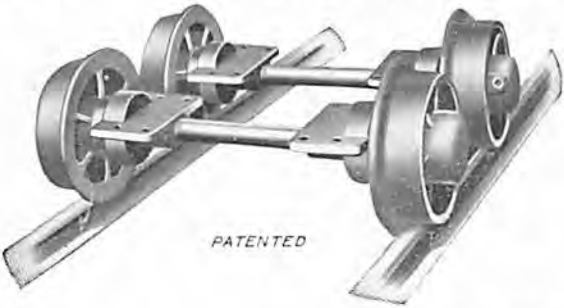

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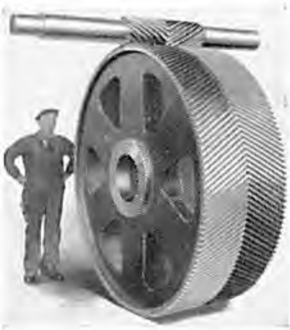

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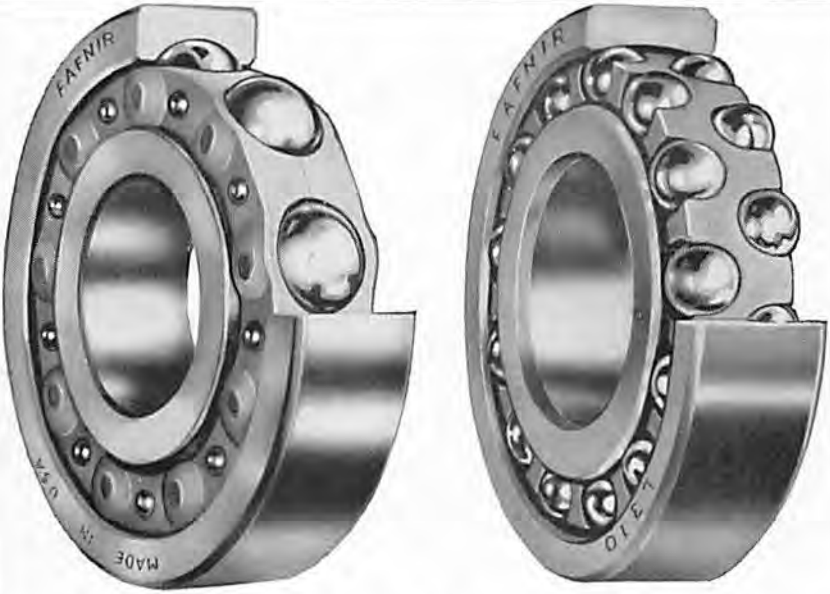

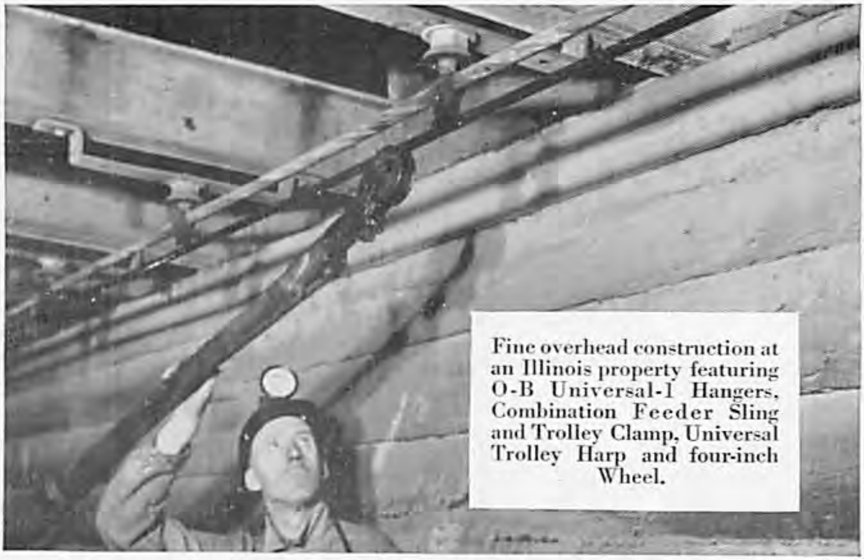

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for their untiring efforts in connection with this Yearbook.


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June 9-10-11, 1939

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