PROCEEDINGS OF THE ILLINOIS MINING INSTITUTE

FOUNDED FEBRUARY 1892

1935

HOMER LANDAU & CO.
Chicago, Illinois

PROCEEDINGS

of the

ILLINOIS MINING INSTITUTE

FOUNDED FEBRUARY, 1892

1935

Summer Meeting
on Board S. S. Golden Eagle
June 7-8-9

and

Annual Meeting
SPRINGFIELD, ILLINOIS
November 8

C. J. Sandoe

President, 1935

OFFICERS 1935

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St. Louis, Mo.

VICE-PRESIDENT

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Chicago, Ill.

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H. H. Taylor, Jr.
Paul Weir

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.

A WORD TO THE MEMBERS FROM THE SECRETARY

I doubt whether our members realize the tremendous amount of work connected with getting together the year-book 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 year-book. This is our seventh issue. Many of the advertisers have contributed to each issue, and we feel that the users of equipment would assist the Institute very materially if they would give due consideration to the suppliers whose advertisements appear in the advertising section in the back of this book, whenever in need of equipment and supplies.

It will be of great assistance for future issues if you will patronize our supporters—the advertisers—whenever possible. The success or failure of this publication and the issuance of future editions will depend greatly on this assistance.

OUR MEETINGS.

Two red letter days have been added to my calendar hung on the wall,
One day pops up in the Summer, the other pops up in the Fall.
These days I anxiously wait for and never allow to pass by,
For I then meet the boys, from good old Illinois, my friends of the I. M. I.

Some folks attend all the meetings, in order to learn what they can
Regarding new methods in mining, or any new "Safety First" plan;
Others may go for the parties, held after the night meeting ends,
But I only go, as others I know, simply to meet my old friends.

We go to the various meetings and hear many good papers read,
And hear the arguments, pro and con, and everything else that is said;
We stay for the evening dinners, in fact, see the whole thing through,
But my one big treat is the friends I meet, of everything I do.

It makes no difference when you go, in the Summer or in the Fall;
Or why you go, or what you do, you're fully repaid for all.
Some like November meetings best, held in some good hotel;
Some like the meetings held in June and think the boat trip's swell.

I can't afford to miss a one, where I know my friends will be,
For Time is getting pretty short, in this Old World, for me.
So let's not argue when to go, or even argue—why,
Just hear the call and attend them all, and boost the I. M. I.

J. A. ("JEFF.") JEFFERIS.

CONTENTS

ILLINOIS MINING INSTITUTE BOAT TRIP

June 7-9, 1935.

Annual Summer Meeting and Boat Trip of the Illinois Mining Institute held on S. S. Golden Eagle, leaving St. Louis Friday, June 7, 1935, at 11 p. m., and returning to St. Louis Sunday, June 9, 1935, at 10 a. m.

MORNING SESSION

Meeting called to order 9:45 A. M. by C. J. Sandoe, President.

Mr. Sandoe: Gentlemen, please come to order. There will be no service at the bar nor any other service during these meetings. I would like for everyone to attend these meetings and unless it is absolutely necessary do not leave while the papers are being presented.

I am very glad to see so many here, and I am sure we are going to have a delightful trip. It was quite a decision we had to make about taking this boat. As you know, the Cape Girardeau was sold and it was necessary at the last moment to take this boat. I want you to know we have done everything possible to make this trip a pleasant one.

I will now ask our Secretary to call the roll.

ATTENDANCE

ILLINOIS MINING INSTITUTE SEVENTEENTH ANNUAL BOAT TRIP

St. Louis, Down the Mississippi River, and Return

June 7-8-9, 1935

ADAMS, W. C.	Koppers-Rheolaveur Co., Pittsburgh, Pa.
AITKEN, W. I.	Dooley Bros., Peoria, Ill.
ALLEN, THOS.	Chief Insp. Bureau of Mines, Denver, Colo.
ARMSTRONG, E. R.	Equitable Powder Co., Alton, Ill.
BARTLETT, A. G.	Austin Powder Co., W. Frankfort, Ill.
BASKIN, E. D.	Upson-Walton Co., Chicago, Ill.
BEAN, F. M.	Egyptian Iron Works, Murphysboro, Ill.
BEDDOE, A. H.	Illinois-Pocahontas Coal Co., St. Louis, Mo.
BIGGER, I. S.	Socony-Vacuum Oil Co., Benton, Ill.
BLAKE, ARTHUR	Peabody Coal Co., Marion, Ill.
BOWIE, ROBERT	Consolidated Coal Co., Herrin, Ill.
BRANDENBURGER, E. W.	Southern Coal Co., St. Louis, Mo.
CAPE, SAM	Sahara Coal Co., Harrisburg, Ill.
CHRISTIANSON, C.	Sullivan Machinery Co., Springfield, Ill.
COOK, WALTER	Central Mine Equipt. Co., St. Louis, Mo.
CRAWFORD, J. G.	Valier Coal Co., Chicago, Ill.
DAWSON, HUGH	Bethlehem Steel Co., Herrin, Ill.
FERRELL, J. L.	Hulburt Oil & Grease Co., St. Louis, Mo.

FIRTH, JOS., JR.............Dept. Mines & Minerals, Benld, Ill.
FISHER, S. M.............Superior Coal Co., Gillespie, Ill.
FLEMING, J. B.............Mine Safety Appliances Co., Urbana, Ill.
FLETCHER, JAMES.............Allen & Garcia Co., Chicago, Ill.
GIVEN, IVAN A.............''Coal Age,'' New York, N. Y.
GREENE, D. W.............West Virginia Coal Co., O'Fallon, Ill.
GRIFFEN, J.............Koppers-Rheolaveur Co., Pittsburgh, Pa.
GRISSOM, J. F.............Aluminum Ore Co., Belleville, Ill.
HALL, L. W.............Goodman Mfg. Co., Benton, Ill.
HAMILTON, CHAS. F.............Binkley Coal Co., Chicago, Ill.
HARVEY, HADLEY.............Ohio Brass Co., Evansville, Ind.
HENDERSON, ROBERT.............Pyramid Coal Co., Pinckneyville, Ill.
HERRINGTON, M. K.............Dept. Mines & Minerals, Springfield, Ill.
HILL, LAWRENCE.............C. W. & F. Coal Co., W. Frankfort, Ill.
HUGHES, JOHN J.............Elect. Storage Battery Co., St. Louis, Mo.
JEFFERIS, J. A.............Illinois Terminal R. R., St. Louis, Mo.
JOHNSON, EDWIN H.............Sullivan Machinery Co., Michigan City, Ind.
JONES, ARCH M.............John A. Roebling's Sons Co., St. Louis, Mo.
JONES, D. W.............Valier Coal Co., Valier, Ill.
JONES, JOHN E.............Old Ben Coal Corp., W. Frankfort, Ill.
KELLY, R. H.............Ahlberg Bearing Co., St. Louis, Mo.
KLEIN, GEO.............Klein Armature Works, Centralia, Ill.
KNOIZEN, A. S.............Joy Manufacturing Co., Franklin, Pa.
LAWRY, R. G.............Roberts & Schaefer Co., Chicago, Ill.
LINDSAY, GEORGE.............Rex Coal Co., Chicago, Ill.
LINDSAY, WILLIAM.............Socony-Vacuum Oil Co., Benton, Ill.
LYONS, JOHN.............Bell & Zoller Coal & Mng. Co., Zeigler, Ill.
MacVEAN, GORDON.............Mine Safety Appliances Co., Pittsburgh, Pa.
MALSBERGER, A. H.............DuPont Powder Co., Springfield, Ill.
MARDIS, EARLE J.............American Steel & Wire Co., Chicago, Ill.
MARSH, I. D.............Aluminum Ore Co., Belleville, Ill.
McELHATTAN, D. F.............Peabody Coal Co., DuQuoin, Ill.
McFADDEN, GEO.............Peabody Coal Co., Chicago, Ill.
McFADDEN, NAT.............Peabody Coal Co., Taylorville, Ill.
MEAGHER, GEORGE.............C. W. & F. Coal Co., W. Frankfort, Ill.
MEYER, BRUNO F.............Consolidated Coal Co., Staunton, Ill.
MILLER, ALEX U.............Bureau of Mines, Vincennes, Ind.
MILLER, FRED A.............Franklin County Coal Co., Herrin, Ill.
MILLER, J. B.............Mines Equipment Co., St. Louis, Mo.
MITCHELL, A. G.............Burton Explosives, Mt. Vernon, Ill.
MOFFATT, H. A.............Dooley Bros., Peoria, Ill.
MONROE, JAMES O.............State Senator, Collinsville, Ill.
NELSON, I. C.............Beall Bros. Supply Co., Marion, Ill.
NIEDRINGHAUS, R. C.............A. Leschen & Sons Rope Co., St. Louis, Mo.
O'BRIEN, FRANK.............American Cable Co., Harrisburg, Ill.
OLDHAM, R. J.............Bell & Zoller Coal & Mng. Co., Centralia, Ill.
ORR, JAMES F.............Cent. Ill. Pub. Service Co., Springfield, Ill.
PFAHLER, FRED S.............Superior Coal Co., Chicago, Ill.
PICKARD, ALFRED E.............Mt. Vernon Car. Mfg. Co., Mt. Vernon, Ill.
POWERS, F. A.............Hercules Powder Co., Chicago, Ill.
RAWLINS, H. E.............Sahara Coal Co., Harrisburg, Ill.

REED, FRANK........State Geological Survey, Urbana, Ill.
RHINE, FRANK........Duncan Fdry. & Machine Co., Alton, Ill.
RICHART, FRED W........General Electric Co., Carterville, Ill.
RODENBUSH, JACK........C. W. & F. Coal Co., W. Frankfort, Ill.
SANDOE, C. J........West Virginia Coal Co., St. Louis, Mo.
SCHONTHAL, B. E........B. E. Schonthal & Co., Chicago, Ill.
SCHULL, F. M........Binkley Mining Co., Clinton, Ind.
SCOTT, G. W........Timken Roller Bearing Co., St. Louis, Mo.
SIMPSON, J. H........Mines Equipment Co., St. Louis, Mo.
SMITH, C. M........University of Illinois, Urbana, Ill.
STEDELIN, JOHN........Marion County Coal Co., Centralia, Ill.
SUTHERLAND, HARRY T........Standard Oil Co., Marion, Ill.
SUTOR, DON M........Sullivan Machinery Co., St. Louis, Mo.
THIES, JOHN........Portable Lamp & Equipt. Co., Pittsburgh, Pa.
THOMPSON, ROBERT A........Hercules Powder Co., Collinsville, Ill.
TIRRE, FRANK F........St. Louis, Mo.
TREADWELL, H. A........C. W. & F. Coal Co., W. Frankfort, Ill.
VLASAK, JOSEPH........St. Louis & O'Fallon Coal Co., Caseyville, Ill.
VOLTZ, GEO. P........Peabody Coal Co., Springfield, Ill.
WALSH, H. T........Sullivan Machinery Co., Chicago, Ill.
WEIMER, EARL........Snow Hill Coal Corp., Terre Haute, Ind.
WEISSENBORN, F. E........Illinois Coal Oper. Assn., St. Louis, Mo.

(Photograph reprinted through courtesy of "Coal Age.")

Among those present on the Boat Trip. Reading from left to right: B. E. Schonthal, W. H. Leyhe, C. J. Sandoe, Geo. C. McFadden, D. W. Jones, John E. Jones, Frank Schull, Thomas Allen.

WHITE, JOHN	Franklin County Coal Co., Royalton, Ill.
WIEDERANDERS, E. O.	Jeffrey Mfg. Co., Springfield, Ill.
WILKEY, FRED S.	Illinois Coal Oper. Assn., Chicago, Ill.
WILLS, S. T.	Peabody Coal Co., Springfield, Ill.
WILSON, J. C.	Ohio Brass Co., Mansfield, Ohio
WILSON, J. W.	McNally-Pittsburg Mfg. Corp., Chicago, Ill.
WOOSLEY, C. W.	Pyramid Coal Co., Pinckneyville, Ill.
WRIGHT, D. D.	Cent. Ill. Pub. Service Co., Marion, Ill.
YOUNG, W. P.	Crescent Mining Co., Peoria, Ill.

Mr. Sandoe: Our Secretary has some telegrams and other communications which I will ask him to read.

(Communications read by Mr. Schonthal.)

Mr. Sandoe: You have heard a reading of the communications. I guess there are no remarks further, other than regarding the Fall Meeting. If it is your wish to leave the selection of the place of the Fall Meeting up to the Executive Board, I will entertain a motion to that effect.

Mr. Stedelin: I make the motion that the matter of selecting the place for the Fall Meeting be left in the hands of the Executive Board.

(Motion seconded and carried unanimously.)

(Proposed amendment to the By-Laws of the Institute read by Mr. Hamilton.

Amendment to Section 5 of Article IV, Constitution and By-Laws of the Illinois Mining 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.

Proposed amendment passed first reading unanimously.)

Mr. Sandoe: Now that we are starting on our program, I would like to introduce Mr. Thos. Allen, Chief Inspector, Bureau of Mines of Colorado. Will you please stand, Mr. Allen?

I will not make a speech to introduce our Chairman of the Morning Session. He is one of our loyal members who has devoted a great deal of time and effort in building up the membership of our Institute. I will now introduce our good friend Mr. Fred Pfahler.

Mr. Pfahler: I am glad he said good. . . .

I would like to request that there be no private or secret conversations carried on while the papers are being read. The first paper is by Mr. James McSherry, but as Mr. McSherry was unable to be here his paper will be presented by Mr. M. K. Herrington.

A REVIEW OF THE ILLINOIS COAL INDUSTRY'S ACCIDENT RECORD DURING THE CALENDAR YEAR 1934

By JAMES McSHERRY

Director, Department of Mines and Minerals, State of Illinois, Springfield, Illinois

Considered from every angle Illinois' accident record in coal mines during 1934 was neither the best nor yet the worst that has been written into the annals of the industry in the State. Consequently a review of the accident experience during 1934 should resolve itself into the discussion of a somewhat ordinary, average accident record for coal mines. Looking back over the previous five years in some respects 1934's accident figures bear a favorable comparison; in other respects it does not look so good. 1934 saw altered conditions in the industry. In some respects it was an unusual year. The number of mines operated in the State, tonnage produced, number of men employed, average days worked—all showed increases (in some cases were sharply up) in 1934 as compared with 1933. Tonnage mined per fatal accident dropped from 539,720 in 1933 to 485,164 in 1934 to keep pace with what in reality is the highest fatality record in the industry in four previous years, 1932 excepted. But whether the comparison is favorable or unfavorable, whether 1934's record is good, bad or indifferent—there is something for us all to think about in the fact that eighty-six men lost their lives in Illinois coal mines last year, that 3,133 compensable non-fatal accidents were reported and that a high percentage of both fatals and non-fatals was absolutely preventable. The record is written. Obviously no amount of discussion could change it in any particular. The figures and any analysis of them that can be made are now of value only in the light of the experience that can be gained to better the records of future years.

It is usually an easy matter to start a discussion among mining men about safety and accident prevention and therefor when the Program Committee requested me to prepare a paper on this subject for today's meeting I was glad to have the opportunity to say a few words on a topic that should be of paramount interest to men in the coal mining industry. I believe that most of the progress that has been made in accident prevention and safety work has started with the thought, study and discussion of some of the excellent papers that have been written on this subject. 1934's record will be printed in detail in the Annual Coal Report of the Department and as this publication will soon be available for all of you gentlemen who desire a copy of it I shall not burden you in this discussion by setting forth the tables that will appear in the printed report.

As we look at the records of past years and try to "pierce the veil of the future" of the industry in Illinois it is gratifying to the Department to note a growing interest on the part of coal operators and miners in first aid training. During 1934 a total of 5,930 persons were trained in first aid at our eight mine rescue stations throughout the State. Most of these were coal miners and some of the largest operators in the State of Illinois either began or completed One Hundred Percent first aid training compaigns. It is significant that some of the best safety records established in the industry in the State were made by these organizations who were One Hundred Percent first aid trained. Illinois was honored this year by three safety awards of merit from the Joseph A. Holmes Safety Association. One to the Valier Coal Company at Valier, one to Bell & Zoller Coal and Mining Company, Mine No. 1, at Zeigler, and an individual award to Thomas Howard, face boss, at No. 2 mine of the Bell & Zoller Coal and Mining Company at Zeigler. Without reciting in detail the records of these organizations or comparing them with mines of the same class, similar working conditions, etc., I can say without fear of contradiction that if the accident experience of organizations like Bell and Zoller and Valier had been duplicated by all of the large producers in Illinois we would have had a much better safety record, something in fact to boast of. I don't mean to say that the organizations just mentioned are the only operators in the State who had safety records above the average; in fact, it would hardly be possible to give individual mention here to all of the operators whose accident experience figured either on the tonnage, or a man-hours-of exposure, or frequency basis, was not above average. Nor were good safety records confined altogether to the big operators. And I am glad to say, too, that some of the operators who have been going along for years and years and years without a fatality are still maintaining their records. Accident records like these don't "just happen;" they represent a lot of hard work, attention and supervision. But I know that we can rely on an increasing number of organizations in the State of Illinois to endeavor to maintain good safety records. For the Department I want to say that we are sincere in our desire to cooperate in every way possible to cut down accidents in our mines. If this interest in first aid training continues it cannot fail to have good results in our future accident experience.

I believe a great many of you gentlemen are familiar with the monthly accident reports of the State of West Virginia and those of you who have seen and studied them, I am sure will agree with me that the preparation of accident statistics as it is done in that State is very helpful to men who make a study of safety and are interested in reducing accident rates.

Mr. Enoch Martin, Assistant Director of the Department of Mines and Minerals, represented Illinois at the meeting of the Mine Inspectors' Institute of American recently held at Beckley, West Virginia. I had the opportunity of reading and studying a paper entitled, "The Use of Current Detailed Accident Statistics," prepared by Dr. Rhinehart, Chief of the West Virginia Department of Mines and was asked to comment upon it. Unfortunately we do not have the facilities in our Illinois Department for compiling and publishing accident information to the extent that it is done in West Virginia. But in one respect Illinois has begun to follow the lead of some of the other coal producing States in publishing accident figures. The main thought in Dr. Rhinehart's report can be summed up in a statement I quote from his paper, as follows:

"The publication of annual reports is valuable as the history of past performance but to serve a useful purpose the facts must be fresh so that preventive measures can be instituted immediately."

In outlining at the Inspectors' meeting at Beckley what Illinois is doing to get accident information to coal operators while it is "hot" I told them about the report that we began last April to publish and mail out of the Department with our monthly report of production. I am going to quote that portion of my comment on Dr. Rhinehart's paper because while most of you men who are active in the industry in Illinois are now familiar with our "Casualty and Recommendations Report," I want to be sure that everyone who is interested in safety promotion knows about it and I would be glad to have any comment or suggestions any of you may have to offer. My comment was as follows:

"By the end of March in 1934 our fatality rate in coal mines had begun to show an increase and we decided in the Department that the time was right for Illinois to fall in line with some of the other states and publish monthly detailed reports of fatalities, to enable all concerned to keep a better check on the trend of our accident rate. True, both production and employment were up; both fatal and non-fatal accidents however appeared to be more than keeping pace with increased tonnage figures. Then, too, in March '34 the industry was faced with the prospect of the seven-hour working day which in fact shortly thereafter became effective in Illinois coal mines. We wondered whether, in view of these changing conditions, there might be the need for more careful study of statistics to determine the cause of the increase—to see, for instance whether there might be found some other explanation than the old one of invariably coupling increased activity in the industry with any increase in accidents which shows up during the same period. In talking it over we saw the advantage of having such a report as the West Virginia Department of Mines publishes monthly and we discussed the feasibility of publishing similar statistics. But in Illinois our operators do not make monthly reports to the Department of man-days lost, classification, etc., of non-fatal accidents and usually do not report them to State Inspectors at once, unless they are of a very serious nature. We have no specially constituted Safety Department in our Department of Mines and Minerals and therefore must rely entirely on our Mine Inspectors for the investigation and report of accidents. We decided however that if anything to better Illinois coal mine accident record could be accomplished by more prompt compilation and dissemination of detailed statistics, we would have enough to do for awhile if we concentrated our attention and efforts on fatalities alone, which our State laws require the operator to report to us at once. We went on the theory that to successfully bring about a reduction in fatal accidents would automatically reduce non-fatal accidents. We had the publications of some of the other states to study and what we came out with in April of 1934, called our 'Casualty and Recommendations Report,' was made up along much the same lines as the monthly report published by Dr. Daniel's Department of Mines of Kentucky and the fatality reports of Indiana, Maryland, Alabama, Pennsylvania and some of the other coal producing states. Our appropriations for printing and postage were none too ample and we have had to be content thus far with having the report mimeographed, for mailing with our monthly production report.

"Assistant Director Martin, who is directly in charge of our State mine inspection force, supervises the compilation and publication of our monthly accident reports and to him much praise is due for the success our efforts have met with thus far. The main object of the report is to provide word pictures of fatal accidents, as nearly as possible in the language of witnesses, mine managers, etc., describing what happened to cause the fatality in question. Usually the verdict of the coroner's jury is incorporated in our report and always the detailed report of the State Mine Inspector's investigation of the accident, together with his recommendations, are given.

"In getting up these reports a more or less set form is followed and, as stated above, while the original data submitted to the office is seldom changed in making up the report we do, for reasons that will perhaps be obvious to all of you gentlemen, sometimes omit minor details. For instance, we confine ourselves to a mention of the County only in which the accident occurred, giving the name of the deceased, his nationality, his age, experience in mining, and his marital status. The name of the company by which deceased was employed is not shown. And where a man is killed on or about machinery we are careful to make no mention in the report of the name of the manufacturer of the machine, describing it, for instance, merely as a 'loading machine,' 'conveyor,' 'haulage motor,' 'mining machine,' etc.

"From a rather modest beginning along these lines—our distribution of the first 'Casualty and Recommendations' report was only seven hundred copies—the circulation of this report grew to more than double the original number within six months time. And what to us was very gratifying was the spirit with which the report was received by coal operators and mining men generally in the State. It seemed to fill just the need we had planned it for. One thing in particular we wanted the report to do was to encourage men responsible for safety in and around coal mines to hold round-table studies and discussions of these reports and recommendations and we made it possible for coal operators to have as many copies as they might need in order to place one in the hands of every official interested in safety, every face boss, etc., in and around the mines. Soon we were receiving requests for as many as fifty and sixty copies of this publication from coal mine officials and good reports are coming to us frequently of the use to which it is being put. And so much for our 'Casualty and Recommendations Report.' We want to carry the idea further and eventually get out non-fatal accident statistics via the same medium—a monthly report. We will keep working toward that end for we believe such statistics would be of great value to the industry in Illinois."

I want to take this opportunity to express the appreciation of the Department for the splendid cooperation we have had from the United States Bureau of Mines in carrying out the first aid training campaigns in Illinois. Without the assistance of Mr. Herbert and his staff our task would have been a much more difficult one. The cooperative method of training was carried on in connection with the assistance of the Bureau men in all our large campaigns and without their help we might not have been able to accomplish the task. The records indicate that the number of persons trained in first aid in Illinois last year was the largest since 1930. I believe everyone who works in or around a coal mine, regardless of his occupation, should have first aid training and I know you gentlemen will agree with me that it is a helpful factor in reducing accidents. I hope the record for 1935 will show even a larger number of candidates trained and of One Hundred Per Cent first aid training campaigns begun or completed.

A word of praise and appreciation should also be said here for the operators and the miners themselves who have cooperated in making these training campaigns successful. Coal mine officials always went wholeheartedly into these campaigns and gave our Mine Rescue Superintendents every assistance possible.

We have had to work along on very drastically curtailed appropriations in the Department of Mines and Minerals and often times large classes taxed our facilities to the utmost. Operators were always very considerate of this and Mr. Herbert and his expert staff helped us along in fine shape.

Men who have followed safety promotion work for any length of time know that in many instances results are all too slow in first becoming apparent; but they know, too, that if they keep trying their accident records will improve and that better accident records will invariably write themselves in terms of profit on the cost sheet.

* * *

Mr. Pfahler: You have heard Mr. McSherry's paper presented by Mr. Herrington. Does any one want to ask Mr. Herrington any questions?

Mr. G. C. McFadden: I just wonder if Mr. Herrington has the fatality rate for small local mines and the large shipping mines for 1934. How many fatal accidents did we have in 86 in the large mines?

Mr. Herrington: There were 17 fatal accidents in the small local mines, and the tonnage was about 3,250,000 tons. As I remember, the fatality rate was about 2½ times greater than in the large shipping mines.

Mr. Allen: I don't know whether I can give you any information. I came East on this trip to meet as many of you gentlemen as possible to see what new ideas I could acquire, and to make a comparison as to what you have done in the past, with what we have done.

I suppose Colorado is in the same condition as the rest of the states. During the years 1931, 1932 and 1933 we supplied all reports. We used to have six field men to do this work, went down to two, but we now have four. This has been a big handicap to our department.

But I am going to tell you some of the things we are trying to do.

We have in our law that the operators must prepare a monthly report on all accidents. Fatal accidents must be reported immediately. Our system calls for insurance in any industry where four or more men are employed. The State has a compensation department, and all companies are required to carry compensation insurance. Some of the larger companies that can, carry their own insurance. All accidents have to be reported to the State Industrial Commission. There has been some slackness in some of these reports in the past, but we are trying to get better cooperation from the operators. We have a lot of trouble trying to get the information from the small fellows, and we have a lot of coal mined by the small fellows in our state, which increases our work. These are just some of the things we have to contend with and with only four field men to do it. Our fatal accident rate is much higher in the small mines than it is in the large mines.

Now as to our accident prevention training. In 1927, 1928 and 1929 we instituted a campaign for safety education, and in three years time put it in 126 of our small mines. During those three years we did not have a fatal accident at those mines.

We can not make a comparison on the non-fatal accident rate at the small mines with the large mines, as we have no reliable records as so many of them do not turn in a report on the non-fatal accidents. In the past it has been impossible for us to get this information, but we now think we have a measure to control these small mines. Now all coal mines must have a license stating thereon the producer's name and the tons produced. We have had some trouble in the past finding the ownership of certain mines, but we won't in the future if we have authority to close any mine without a license. This license costs $10.00 for mines producing up to 500 tons per day, $25.00 for mines producing 500 to 1,000 tons, and $50.00 for mines producing 1,000 tons or more.

You must understand, gentlemen, that we are not situated as you are here. We have more than 100 producing mines that are 50 miles or more from a railroad. You can ride 50 to 75 miles without seeing a fence. We have a large state to cover and it makes it pretty difficult on the small funds we have.

I do not think Illinois accidents are any worse than ours for last year. You had 86 men killed in the year, and we had 24 killed for 9,500,000 tons. I am like the gentleman who prepared the paper, in that I believe that first aid training should be continued by all means.

I think I can do better explaining our conditions in Colorado if you would ask me questions. If you have any questions I will be only too glad to give you what information I can on all the Rocky Mountain Area.

Mr. Pfahler: Thank you very much, Mr. Allen. If there is no more discussion we will proceed with the next paper.

THE APPLICATION OF PRACTICAL DEVELOPMENTS MADE BY THE OPERATORS TO STANDARD DESIGNS OF COAL MINING MACHINERY AND EQUIPMENT

By DAVID W. JONES
Superintendent, Valier Coal Company, Valier, Illinois

The operators of mines do not manufacture the major units of machinery and equipment they use and must depend upon established manufacturers to provide them with these vital elements which determine largely whether their operations will be successful or a failure. Everything else being equal, the manufacturers who serve the operators best will profit the most.

In the first place, a machine is built to do work of some particular kind, to replace the effort of either man or animal. Unless a machine built to do the work better or more efficiently than it can be done with physical energy, there will be no demand for it and it will not be used. We cannot build a machine to create another machine, because that involves two forms of energy, mental and physical. Mental energy is a priceless gift and cannot be mechanized or measured in units such as horsepower or kilowatts. Where work requires a combination of mental and physical energy, manual labor has an undisputed field of usefulness. To illustrate: twenty tons of coal can be loaded mechanically in a mine by a machine, but a human being is required to direct it and make its working place safe. No machine can determine where props or cross-bars are required to protect a working place. A man can load the twenty tons of coal referred to with an actual energy expenditure of about one-tenth of a kilowatt hour over normal human requirements, and this effort figured in purchased power, would have a maximum cost of perhaps one cent. The price of fuel enters into the value of work done, and as man derives his energy from food, one cent will not buy very much human work. Exceptions may be taken to this form of comparison but I wish to bring out the fact that there is a field of usefulness for manual labor when it is directed by a brain, and it is futile for man to compete with a machine built to perform purely mechanical acts. When a man or animal attempts to do mechanical work where fatigue is a factor, the results will be unsatisfactory and inefficient. We would not expect a thoroughbred race horse to compete with a plow horse in work on a farm, although both animals are capable of exerting horsepower. Let man be used to do the more pleasant tasks, and let's build more and better machines to do the tiresome mechanical work.

The first man who builds a machine, to use a slang expression, "Does not have a chance." The designer of a machine has a definite operation in view for his machine to do. After it is built, some one else will operate it, and although it performs the work expected, something additional is desired from it. A criticism is made. The criticism finally reaches the proper place and the additional duty is incorporated into the design of the machine. The machine is then rebuilt as an improved design. It is more useful than before, but some one else thinks about it along a new line and discovers another function which it should do. Thus, the criticism goes on in an endless circle. and ultimately the original machine appears to be very crude and poor in design. It is difficult for the men who operate machines to understand why the manufacturer did not think of everything in the first place, and build perfection into his first machine. Of course, such reasoning is not logical. Thomas Edison started out to use electricity as a means of creating light. Today light is but one of the many uses we make of electricity. Direct current was suitable for the purpose then, but alternating current is used now except where the direct current is close to the source of generation. Telsa developed the theory of the transformer and made it possible to transform alternating current to different voltages. When it became possible to transform electricity into high voltages its use became universal, and today alternating current is the standard. Our critics might ask, "Why did not Edison consider the question of distribution in the first place? Why did he not design the highly efficient Mazda lamp instead of the crude carbon lamp he used with direct current?" The answer is, Edison did not have the benefit of constructive criticism from a previous user of the thing called electricity. He was the first one to put his ideas into material form, and so his chances of building to perfection were slight.

In the field of machine design, when the first machines were built, why were not the journals equipped with efficient antifriction types of bearings instead of plain brass sleeves? Necessity is the Mother of Invention but she must have the proper materials and tools with which to work. Evolution follows invention, and it determines the survival of the fittest. We cannot perfect machinery until we perfect the component parts which make up the machine. Only time can tell which of the many theories and ideas of design will survive. As machines approach perfection, their duties become more intense. Therefore, the manufacturers must continually build better machines to withstand the extra requirements of the operators. The march of progress is similar to a battle between the manufacturer and the operator for supremacy. The operator will always try to get more out of a machine than was built into it by the designer.

In viewing the trends at present, indications point toward permissible equipment. Not entirely due to the fact that such equipment is explosion-proof, but because it is better built in every way. Permissible equipment is built to withstand some of the emergencies which may never arise, whereas ordinary equipment is built only to overcome ordinary deficiencies which always exist. In short, permissible equipment is the answer to the accident which does not happen. The application of permissible designs to mining equipment will be gradual. Means must be found to compensate the increased cost of its construction. The first factor to justify better equipment will be safety of operation. Second, decreased maintenance cost. Third, reliability. In explanation of these in order, it must be admitted that we are all becoming more safety conscious. Definite progress has been made in the last ten years, and we have now what might be considered a substantial credit balance on the side of safety in operation. To substantiate the second factor, it can be pointed out that the better construction built into permissible equipment has resulted in its being kept in practically continuous service wherever used, which performance is synonymous with low maintenance cost. Equipment cannot be in practically continuous service and be undergoing frequent repairs at the same time. The third factor, reliability, is evidenced by the fact that less idle equipment is required for reliable operation. When dependability is built into machines very little spare equipment is required.

Statistics support the statement that we are having fewer accidents in coal mines. The frequency of major catastrophies today is but one-tenth the rate we had ten years ago. What has made this remarkable record possible? Cooperation is the answer. Cooperation in two ways, between the manufacturer and operator in building machinery which can be used safely, and cooperation between the operator and employes, in observing safety rules. Today, we are standing on the same spot with regard to perfection in machinery, where Edison stood when he had visions of electric light. Perfection in equipment is somewhere in the future but we cannot even with our wonderful imagination, see its possibilities. Improvements must be applied gradually from year to year. Changes suggested by the operators from time to time will make machines better and the cost of such betterments will be absorbed by additional performance with less maintenance cost. Operating conditions at present are not such that we are prepared to accept radical changes immediately. The cost would be prohibitive. However, as we progress, the savings made from the use of better equipment must to some extent be applied to pay the way for new developments and still better machines. The so-called expensive equipment of today will be the necessity of tomorrow.

Improvements must be expected to pay their way, and will if they are worth while. Totally enclosed motors exclude dust and dirt, which are both destructive to machinery. Better lubrication will result from total enclosures, which will give longer life for the machines to do useful work. Thus, each improvement has a particular saving to offset its additional cost. Enclosure is synonymous with safety. Exposed moving parts are always a potential source of personal injury. Safety of operation is synonymous with Efficiency. There is less expenditure for time lost. Efficiency is synonymous with Profit. There is more output for a given input. If all of these points could be assembled into an equation, we would have the following result: Better Equipment equals Better Operation. Machines in the future will become obsolete in the ratio of their disregard for safety features required to prevent personal injuries.

Looking specifically into the construction trend of some of the major units of mining operations, the locomotives will undergo many improvements. Contactors will replace knife switches and the larger sizes of drum controllers. Alloy steel wire resistance will take the place of cast material of the grid construction. Wires and cables will have greater current carrying capacity than we consider ample for today. Defective wiring will be overcome by more carefully enclosing and protecting the wires in conduit. The slow speed locomotive will have a broader field for use in connection with mechanical mining. Mechanical loading of coal has developed three distinct types of locomotives, namely, high speed main line haulage locomotives, medium speed relay locomotives and slow speed gathering locomotives to serve the loaders.

It is quite likely that refinement in locomotive construction will be along the following lines:

(1) Application of antifriction bearings to axle journals, and practically all other moving parts.

(2) Improved suspension and equalization of weight, which will result in less vibration and wear. Sudden jars and vibration are the causes of much excessive cost of locomotive maintenance.

(3) Better accommodations for housing the motorman and trip rider. A motorman's cab should be made a place of safety instead of hazard so that he will prefer to stay with the locomotive in emergencies instead of jumping.

(4) The trip rider should have a seat on the locomotive instead of being required to crawl over the locomotive and expose his person to hazards along the roadway.

(5) Braking mechanism on the locomotive should be an integral part of the frame instead of accessories attached to it. Sanding apparatus should be built to more effectively and efficiently sand the rails.

(6) Spring bumpers on each end of the locomotive should be built to withstand severe jolts without transmitting the shocks to the frame and axles. Hard bumping and collisions will occur at times and the frames and axles should not be expected to serve as shock absorbers. Bent frames and axles are the causes of more unsatisfactory locomotive performance than any other causes. Modern principles for springing weight and absorbing shocks applied to automobile engineering would be an asset to locomotive construction and undoubtedly reduce maintenance costs.

In the field of cutting machines, we will expect to see the entrance of caterpillar mounted equipment. Track loading machines have their track cutting machines, and it is logical that the caterpillar loading machine should be served equally as well by caterpillar mounted cutting machine. Each one of these two types of loading machines has its field of usefulness and will continue in use. Auxiliary equipment should be designed to serve its loading unit in the most efficient way.

In the field of coal drills we have both track mounted and portable equipment. The track mounted drills have proven most useful in connection with track loaders and track cutting machines. Considerable improvement can be made in the so-called one man drills. The post must be made of lighter weight metal to replace the heavy and cumbersome steel and iron setup so that one man can really carry the portable drilling equipment. All portable tools must be made of light weight metal so that man power can be conserved for useful work instead of being used to carry around a lot of dead weight from place to place. In both the track mounted and portable drills there has been a marked disregard for safety in operation along one particular line, and that is the unguarded forward moving thread bar and auger. This disregard for safety by the manufacturers has exacted a heavy toll of compensation from the operators. Many workmen have been wound up with their clothing around these revolving parts, which have comparatively high speed and much power. A simple telescoping guard would eliminate the hazard. A stationary guard covers the rear end of the thread bar but that end is only one-half of the hazard. We will soon be out of the age of building the easiest way. The future will build safely and well or not at all.

It has been true in the past and it will continue to be so in the future, that industry is like the motion of the earth itself. It cannot stand still. It must move forward and progress or disintegrate. I wish to illustrate how the manufacturing of mining machinery has progressed by quoting from the "Story of Coal," issued by the Museum of Science and Industry. A copy of this pamphlet was presented to each member of the Illinois Mining Institute in recognition of the assistance rendered in building the Museum's Coal Mine at Chicago:

"Between the 13th and 17th centuries the use of coal by smiths and other industries in England gradually increased, but no marked advance was made in methods of mining it. The horse was used to operate pumps and to hoist material and many of the methods of the metal miners were applied to coal mining. When the outcroppings had been worked to the bone and the sea coal became less plentiful, the demand for coal in other countries increased and two inventions served to drive men to devising more elaborate methods of mining. These two inventions were the manufacture of cast iron and the steam pumps of Savery and Newcomen. Up to this period the coal mines were, mostly open pits which were frequently inundated with water and were then abandoned. The forests of England had been denuded to manufacture charcoal, and if sufficient coal was to be supplied for overseas demand and for making cast iron, the horse pump had to be replaced with a more efficient device. The steam pump was the answer. The open pit mine was replaced by a shaft. Simultaneously with the steam pump there began an era that came to be known as the industrial revolution. The individualistic artisan and craftsman began to disappear and manufacturing, which had been carried on by them at open shop windows, now moved behind the walls of the factory. Mass production was born. England turned in a few years from an agricultural to an industrial nation. Coal became king and engineers bent their best efforts toward devising better methods of mining, transporting, and preparing coal. Trevithick, in 1803, built the first locomotive with no other thought in mind but to haul coal cars."

That was the picture about five hundred years ago. The progress which will be made during the next five hundred years will depend mostly upon the personnel of three groups: (1) The progressiveness of the manufacturer in building mining machinery and equipment better from year to year to meet the ever increasing and more vigorous service. (2) The ability of operators of mines to work in harmony with the manufacturers and make it possible for the best ideas to be preserved and the impractical ones to be discarded without unnecessary experimenting. (3) A new manufacturing organization must be established to build new equipment for utilizing some of the potential values of coal now dormant. Here are some of the things we know about Coal: It is second only to the soil as a National resource—transports—drys—cures—refrigerates—and preserves our crops; mills our grain—cooks our food—weaves our textiles—gives us light—and keeps us warm. Coal also provides gas—coke—tar—chemicals—fertilizers—explosives—preservatives—drugs—dyes—perfumes—and plastics.

These are the possibilities. We should strive to expand the markets for coal. Development leads the way for Demand. Demand paves the way for Production. Production is the keystone of the whole industry. The future for coal will not be along a smooth and easy path. Opposition will be keen competition from oil and gas. The pioneers started the coal industry about five hundred years ago from nothing and it has grown to the maturity of today. It must not be allowed to stand still and disintegrate. Progress must continue.

* * *

Mr. Pfahler: Does anybody want to ask Mr. Jones any questions?

Mr. Allen: With the institution of so many machines, conditions have changed. I do not know exactly what your conditions are in Illinois, but the time has come when you can't take a man and place him anywhere. I do not believe the manufacturers of the new machines are playing their bets well. I have yet to see a man selling powder who has demonstrated the safe use of his products. I would like to ask the manufacturers if they expect all the expense to be borne by the operator. It seems to me that they could explain their products better and give the coal operator a lot more help than I have observed. I don't like to see the operator get it in the neck all the time. I believe it is time some of the manufacturers tell some of the men what these new machines are for.

Mr. Pfahler: I believe I will have to come to the defense of the manufacturers, for only recently we have had some splendid service, and in fact we have always had 100% co-operation from them.

Mr. Johnson: I think there is one thing Mr. Jones mentioned that is over-emphasized. I believe a person apart from the actual production of coal can build a machine that will be a success. This may be untrue in some instances, but the actual information needed is available. I do not believe it is possible for any manufacturer or group of manufacturers to build a new machine that will not have to have some altering to meet actual working conditions. They must get their equipment in service to make it work successfully.

Mr. Allen: My idea is to get more men in the field and talk to the coal diggers. You know some of these men can't read, and your only way of teaching them is by talking to them. The manufacturers should have their men get close to the men who use their equipment and teach them to know its condition at all times.

Mr. Lyons: I would like to ask Mr. Jones if he has any figures on his accidents for last year?

Mr. D. W. Jones: I don't have the exact figures, but for about five months last year out of the twelve, we worked 550 men without a lost time accident. In the other seven months our frequency rate was low, but our severity rate was high.

Mr. Lyons: To what do you attribute that record?

Mr. D. W. Jones: The secret of the whole thing is to keep a man safety conscious. You can not buy safety for him, but if you will give him some token that shows your appreciation of his safety record, he will appreciate it.

Mr. Crawford: As Mr. Allen has stated, the mines in Colorado are small, and many of them very small, compared with our Southern Illinois mines. The manufacturers' expense of selling to and serving such properties is, therefore, very high, and in most cases they must of necessity depend upon a middleman.

Getting back to the subject of accidents, you first have to sell the management in accident prevention, and your hardest job is to sell the mine manager and his immediate subordinates. Many are inclined to take the view that as long as there are coal mines, there will be accidents. Until this resistance is overcome, accident prevention will not get very far.

Mr. Allen: In regard to the company store business that has been spoken of here, I do not think our conditions are any different in Colorado than they generally are throughout the East. We are not any worse nor any better in Colorado than any of you. We may know a little less about coal mining, but a lot of our men came from the Eastern States.

My idea is that we should find some method of approach to acquaint our men with the proper use of the machines used. Also that we should try to get them to understand the provisions of their mining laws, and that observance of these laws means safer working conditions for them.

We have every kind of condition in Colorado that you have here. We have seams that range from 20 inches to 90 feet in thickness. We have gassy seams and seams with no gas. Our mine labor is just about the average of any other coal mining state. I do know that it is a proposition to teach a lot of these men, but I would like to see some of these fellows trained to where they won't think KVA is another radio station.

Mr. Malsberger: I was very much surprised at Mr. Allen's statement about the powder companies, and inasmuch as he mentioned the Du Pont Company, I guess the thing for me to do is ask for a transfer to Colorado.

But as far as education of the men is concerned, DuPont has motion pictures of all kinds, and I am surprised they have not utilized them in Colorado, as our Company is glad to give this service.

Mr. Pfahler: What is true of DuPont is also true of the other powder companies.

As it is getting late, if there is no further discussion we will stand adjourned until this afternoon.

AFTERNOON SESSION

Mr. Sandoe: For the afternoon session our chairman will be Mr. J. E. Jones. I will now turn the afternoon meeting over to Mr. Jones.

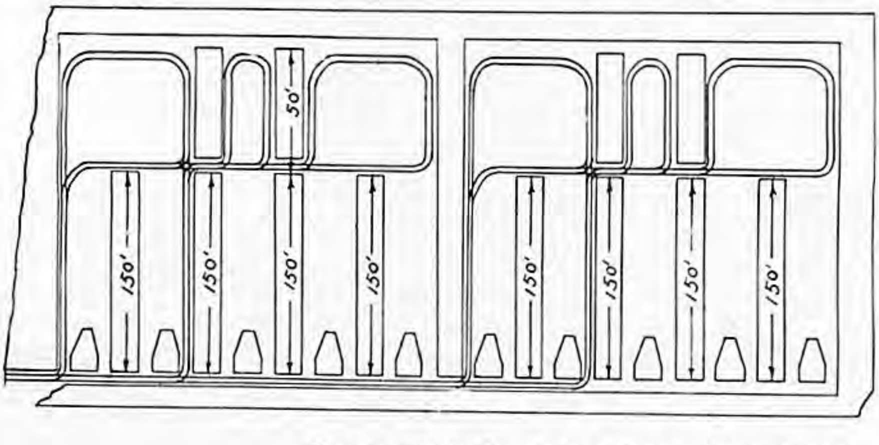
Mr. J. E. Jones: I am sure you will continue to give the good attention we had in the morning meeting, which was in charge of Fred, and which these papers deserve. The first paper on this afternoon's program will be read by Mr. Frank Schull.

THE USE OF CIRCULAR TRACK FOR MECHANICAL LOADING

By F. M. SCHULL
Superintendent, Binkley Mining Co., Clinton, Ind.

When we opened up our No. 10 mine, in August 1933, it was changed over from a hand loading, solid shooting mine to a 100% mechanical mine by the installation of Goodman short-wall cutting machines and 7-BU Joy loading machines. Due to the size of the pit cars, they hold only one and one-half tons mechanically loaded, it was decided to use a circular track in rooms so that we would be able to make a quick car change. In line with this decision our mine development was laid out and pushed forward.

All of our entries, both rooming and main, are driven three abreast with cut-offs or cross-cuts every third break-through. (See sketch.) The middle entry, on main entries, is the haulage road. This gives us one entry for intake air course and two for the return. The middle entry, in the rooming entries, is used mostly for car storage. You will note on sketch that rooming entries are opposite one another and the distance between rooming entries, along the main entry, is 525 feet. This gives us a room depth of 250 feet with a twenty-five foot fire wall along the face of the rooms, when completed; also, that one large double parting serves four sets of rooming entries. As you can see by the sketch, there are two cross-cuts leading into the middle entry of the rooming entry, one pointing into the parting and one to the outside which enables us to turn our cars around without any delay to speak of. As a general rule we pull up and back the empties into the entry and pull the loads out to the parting. In other words, these two switches act as a "Y" and it is necessary to turn our cars around once before they are delivered to the loading machines on the circular track. Then, when the cars go around the circle, and are loaded,



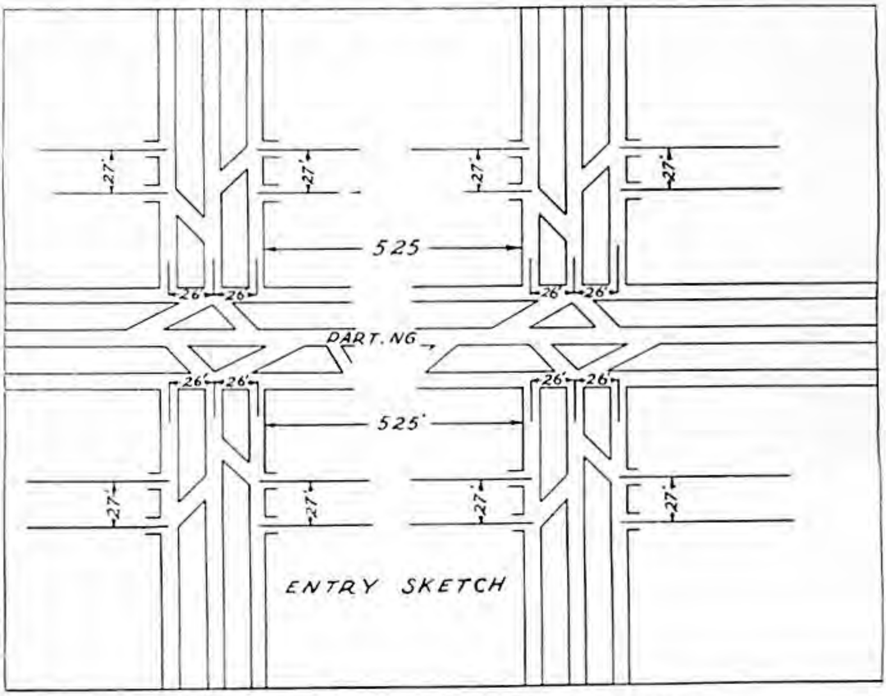
ROOMING ENTRY SKETCH

they are turned right for the bottom.

All of our rooming entries are driven deep enough to give us twenty rooms, on twenty-seven foot centers; (see sketch of rooming entries.) Ten of these rooms are worked abreast which constitutes a territory for one loading machine. Rooms 1 and 2, 3 and 4, 5 and 6, 7 and 8 and 9 and 10 are held together in pairs at a distance of thirty feet; 1 and 2 making one room forty feet wide, empties going in No. 1 and coming out No. 2 loaded and by carrying the sights six and one-half feet off of opposite ribs, it gives us a fourteen foot pillar between rooms. When rooms reach a depth of 200 feet, the pillar between 4 and 5 and 6 and 7 is cut out, giving a total face of 250 feet for the last fifty feet of the rooms. I might add, at this point, that we have loaded as high as 250 pit cars in seven hours, working on one of these long faces, with a 7-BU Joy loader.

Switches are laid in every room and when rooms reach a depth of 150 feet all of the switches, with the exception of 1 and 4, are abandoned on the entry and the road material is recovered out of all rooms, except 1 and 4, for the 150 feet. The other rooms are cut off, thus saving any long moves with the loading machine. The radius of the curve, in each corner of the rooms, is approximately 15 feet.

By this fall we hope to have a circular main line haulage laid out so that loaded cars will come in on the north side of the bottom and the empty cars will be taken inside from the south side of the bottom which will eliminate the use of "Ys" and the extra switching of turning our cars on "Ys" as we take them inside. It will also eliminate the meeting of main line motors on passing



tracks since all motors on main lines will be following each other, with both loads and empties. The circular track, main line haulage system will automatically turn our cars around when they leave the bottom; then, when they are put around the circular track at the face, and loaded, they will be in proper position for landing on the north side of the shaft for hoisting.

* * *

Mr. J. E. Jones: You have heard Frank's paper, and it is now open for discussion.

There is no question but what the success of Frank's system depends upon the strata that lies above the coal.

The next subject on the program is on the cleaning of coal. We have four papers on this subject, and all four papers will be presented before opening discussion on them. But first I am going to introduce to you Mr. Gordon MacVean of the Mines Safety Appliance Company, who has prepared a paper which I know will be of much interest to all of you.

THE MODERN ELECTRIC CAP LAMP AS AN AID IN CLEANING COAL

By GORDON MacVEAN
Mine Safety Appliances Company, Pittsburgh, Pa.

One of the features of the design of a modern tipple to which much attention has been given in recent years is the proper and effective illumination of the tables over which the coal flows and upon which hand picking is practiced. Upon numerous occasions have technical articles been written and published demonstrating the value of good lighting in the facilities of an up-to-date preparation plant at a bituminous coal mine.

Why, then, should not even greater attention be given to the problem of effective illumination at the working face where the coal receives its first attention and initial exposure to the possibility of beneficiation by man. Any removal of free impurities at the time of loading into the mine car obviously means not only a reduction in the work required of the preparation plant but also the elimination of haulage of valueless material. Examples are known where, at a 3,000-ton mine, the delivery of refuse to the tipple has been reduced by an average over a period of months of 20 tons daily after an increase in effective illumination at the working face. Sizeable reductions in men employed on picking tables have been accomplished in this manner also.

Most of you, in general, are familiar with electric cap lamps, over 325,000 of which are now in daily use on this continent. Many, however, do not appreciate what tremendous advances have been made in the last five or six years in the amount of illumination available from these lamps. It was realized some years ago by the manufacturers of electric cap lamps that, in order to widen the scope of their market, it would be necessary to develop equipment which would actually be preferred by the miner as a working lamp over open flame lamps. As a by-product of the efforts to accomplish this, the electric cap lamps available today are so far superior to the open flame lamps in illuminating qualities that their installation, in many cases has been motivated in recent years solely by the desire of the mine management to improve the coal preparation at the working face.

As an example of this, your attention is directed to information recently presented by Mr. Carel Robinson, Manager of Mines, Kellys Creek Colliery Company, of Ward, W. Virginia, at the session of the American Mining Congress devoted to Coal Preparation.

About two years ago this Company introduced the latest type of Edison electric cap lamp. Tonnage had previously been falling off due to orders lost on complaints of dirty coal. Since then, very marked improvements in the quality of the coal have been attained with resultant retention of market previously lost as well as a sizeable addition to tonnage formerly mined. Complaints were reduced almost to the vanishing point. It might be here said that the splint coal seams at Ward are free from explosive gas; the mines are drift mines, hence the basic reason for the change was to improve face illumination.

After the electric cap lamps had been in continual service at these mines for over a year and a half, the management determined they would investigate whether their step in changing to electric cap lamps was fundamentally sound and basically responsible for the improvement in the quality of the coal. The following method of investigation was used, this being an excerpt from Mr. Robinson's paper under the title of "Illumination in Relation to Preparation at the Face", presented at the American Mining Congress under date of May 14, 1935:

"A number of miners in different sections of the mine were furnished carbide lights and electric cap lamps. Each of the loaders was requested to alternate the use of each of the two types in loading alternate cars. He was also requested to try to use an equal effort to clean coal with each type of light. Careful time studies showed that the miner consumed 32% more time in cleaning and loading the cars with the carbide light than was required with light from the electric cap lamp. Each of the cars loaded as part of the test was marked foe examination at the tipple. The impurities were removed and weighed, and it was found that the coal loaded when wearing electric cap lamps contained on an average 25% less free impurities than when loaded with illumination from the carbide light.

"This measure of impurities was by the regular inspector on the 'jury table.' The 'jury' system at Ward is as follows: Provision is made on the tipple so that any car of coal can be passed from the regular flow to a special bin. From this bin it is fed to a short picking table and on this it can be minutely cleaned without interfering with production. All impurities are thrown into a box and weighed and the clean coal carried forward on the picking table and mixed with the other coal. If excess impurity is found then the tipple boss and checkweighman are called down to inspect the impurities and a dock, or suspension, or discharge is imposed.

"To supplement the above practical test, I requested the Mine Engineering Department and the Electrical Engineering Department at the West Virginia University to make a series of comparisons to check up on the difference in illumination. These tests were made in the laboratory at Morgantown and in two mines in the Pittsburgh seam near Morgantown. These tests showed that when the carbide lamps were first filled and lighted that the illumination was very nearly equal to the illumination from two of the most important types of electric cap lamps. In a few minutes, however, the carbide lights began to flicker and the illumination was gradually reduced. On the other hand the illumination from the electric cap lamps was almost constant through a period of five hours. To illustrate this, I will quote from one of the records which may be considered as typical:

"Carbide light taken from active use. Reflector had been blackened. The measurements with the foot candle power meter were made fifteen inches straight in front of the lamp. Lamp was freshly charged and reservoir filled with water and water feed adjusted. Measurements were taken at intervals of five minutes and lamp was in motion between these:

9:45 P. M.	—7	FCP
9:50 "	—8	"
10:00 "	—6.6	"
10:05 "	—4	"
10:10 "	—3.5	"
10:15 "	—3.7	"
10:20 "	—3.4	"
10:25 "	—2.7	"
10:30 "	—1.5	"
10:35 "	—1.6	"

At this time the water feed was opened wide and the lamp vigorously shaken and then the water turned off to secure maximum pressure and illumination. By this means the candle power was increased to 2.1. Thus in a period of forty-five minutes there was a drop in illumination amounting to 74%."

While well over half of the bituminous coal today produced in the U.S. is mined with electric cap lamps, only about one-quarter of the tonnage of Illinois is so mined. All of the tonnage of Illinois mined with electric cap lamps originates in mines classified as gaseous and their introduction was actuated by reason of this.

A miner's lamp is the most important tool he carries. Without it he can do no work; with a good lamp he can be a very efficient miner. The modern electric cap lamp is rapidly replacing the open flame lamp in both coal and metal mines because it is a better tool. The purpose of this paper is merely to draw your attention to the fact that the use of the modern electric cap lamp can play a very able part in any campaign for the preparation of a cleaner coal from any coal mine in which part or all of the coal is being hand loaded.

* * *

Mr. J. E. Jones: As stated by Mr. MacVean the lamps installed and introduced in the State of Illinois were introduced from a safety standpoint, although this is hard to believe. Mr. MacVean brings forth the use of these lamps in producing clean coal, which I am sure you all found to be a very interesting point.

The first paper on coal cleaning has been prepared by Mr. J. Griffen of the Koppers-Rheolaveur Company.

THE CLEANING OF ILLINOIS COAL

By JOHN GRIFFEN
Koppers-Rheolaveur Company, Pittsburgh, Pa.

Mr. Chairman—Gentlemen:

The Cleaning of Illinois Coals is an extremely interesting subject as it is profoundly influencing the economic status of coal and is upsetting existing competitive conditions. You gentlemen, who have access to the data showing the movement of Illinois coal into various market territories undoubtedly find that fields where mechanically cleaned coal has been produced in substantial quantities during the past months have materially increased their shipments to more distant markets where higher freight rates were formerly prohibitive. I am informed that competitive boiler tests in industrial plants with mechanically cleaned coal have quite generally shown lower fuel costs per 1,000 lb. of steam sufficient to pay the premium for cleaned coal and still leave a margin. Thus the cleaned coal enjoys a more favorable competitive position than the raw coal.

Mechanical cleaning may also be considered a mining tool. In shaft mining it allows changes in mining practice such as mechanical loading which may appreciably reduce mining costs and at the same time maintain or improve the quality of shipments. In many strip pits the overall recovery may be increased or maintained with a better shipped product of more uniform quality.

However, mechanical cleaning is but one element in the complete preparation of coal to suit it for the manifold requirements of its users and must be effectively combined with the tipple operations. Each property usually presents some new elements calling for experience and judgment in selecting a combination of preparation facilities which will add the greatest marketability and therefore the greatest increase in revenue with the least expenditure for plant and operation. We are interested in the profit motive only.

Perhaps the most important stage in the planning of a cleaning plant is a study of the markets for which that coal can be best fitted and into which it can go with the greatest competitive advantage. The complaint files on shipments from an operating property are very suggestive and will invariably show that uniformity in the quality of the coal shipped is vitally important. An Illinois operator, who is operating a strip pit without mechanical cleaning and who analyses every car of screenings shipped, had told me that his study of some 10,000 cars showed that 80% of the complaints as to impurities came from that 10% of the cars which his records showed were of the poorest quality. This demand for uniformity applies as much to sizing, moisture and freedom from degradation, as it does to impurity contents or analyses. Such market study must forecast not only the competitive situation of today, but, if possible, that which may be encountered during the succeeding years.

A study of the raw coal produced by a mine is of equal importance. It is not necessary to go into the details of test procedure, except to say that the samples taken should be large enough to be fully representative and should, of course, include complete screen and float and sink tests with analyses. Very important is a record of the appearance of the gravity fractions in the domestic sizes as these are sold on appearance rather than analyses. It should be emphasized that too often plants are built on too meager data on the variations that will occur in the raw material. It is safe to say that, if you have data which you think is quite complete and accurate, it is wise to check that data by a duplicate set of samples and tests.

When the cost of the complete preparation plant is analyzed it will be found that the cost of the equipment to remove refuse material, the actual cleaning machine, is a surprisingly small proportion of the total. It thus seems wise to build with some leeway for the future when competitive conditions may be more severe as more mechanical preparation plants are built. The efficiency of the cleaning equipment likewise may be a vital factor in the competitive race. It may seem easy to conclude that we will accept greater coal losses if we are forced to produce cleaner coal but it may happen that this increased loss will change the cost statement from black to red.

With wet cleaning equipment the treatment of the coarser sizes of coal is comparatively simple although uniformity in the quality of the product and recovery may vary considerably with the different processes. The No. 6 coal presents a special situation as the coarser sizes carry considerable medium gravity, high ash coal due to thin bands of impurities. This material must be removed from the cleaned coal but contains too much fuel value to be discarded. The Rheolaveur coarse coal unit conveniently separates this material as a middling product which is crushed to screenings size and returned to the same unit for cleaning. This feature and the regulating facilities of the Rheolaveur process enable the production of washed coal of unusual cleanliness and uniformity with a maximum recovery.

With Illinois coals the method of treatment of the fine coal, namely minus 5/16″, is quite important for this size usually contains the greatest amount of refuse materials. Also, efficient washing of the fine coal generally produces coal of materially lower ash content than in the coarser sizes. This is particularly true of the No. 6 coal. It is obvious that efficient cleaning of fine coal and slurry enables a higher tonnage of coal of a given analysis to be shipped. For, if the fine coal is thoroughly cleaned with a minimum loss of coal values, the coarser coal which is usually more bony can be washed at a higher gravity and thus a higher recovery for the same analysis on the shipped coal. The proper cleaning of the fine slack therefore has a very important effect on the quality of the screenings and the overall recovery.

With a washing plant which will effectively clean fine slack and slurry plus 48 mesh in size, it is essential that effective dewatering provisions be included. Dewatering screens equipped with 1 m.m. or even ½ mm. screens will not recover coal as fine as 48 mesh. 1/4 or even 1/5 mm. screens are necessary for such recovery. A product of this fineness should not be shipped without additional dewatering or drying. The Carpenter centrifugal dryer is a very effective machine for this purpose and will produce 5/16″ or 1/4″ x 48 mesh washed coal with approximately 8% surface moisture. This coal is still damp but is a light fluffy granular product from which no further moisture can be drained. Our experience in southern Illinois is that such a product will give little or no trouble from freezing during winter weather. Ordinarily direct operating costs are about 2c per ton of this size, which mean less than ½c per ton of total output of all sizes.

The first Rheolaveur installation in Illinois was a Slurry unit which was added to a jig washery. This unit is saving 80 to 90 tons per day of coal which otherwise was wasted as too dirty to include with the screenings. This additional recovery is fully 5% of the output.

The first complete Rheolaveur Washery was installed at the Fidelity Tipple of the United Electric Coal Companies and is treating No. 6 strip coal mined west of the Du Quoin anticline. This plant was fully described in the May issue of Coal Age and I simply wish to refer to the performance of this plant as it throws light on the generalized statements above.

The washing plant was designed to handle 600 tons per hour feed and has shown monthly averages of 595 tons per hour with the average for a day as high as 675 tons per hour which means that for one hour it has treated as high as 750 tons. Delays originating in the washery during March and April, 1935, were less than 1.4% of total operating time.

The washed coal is produced with an ash content equal to the ash of the float 1.50 Sp. Gr. in the feed.

The plant is designed to waste the slurry minus 48 mesh, or 0.01″ aperture, as this material in the feed analyzes over 30% ash due to its high clay content. The total losses in the slurry are less than the tonnage of minus 48 mesh in the feed and the 28x48 mesh size in the clean coal is the lowest ash coal produced.

The total clean coal produced averages 99.5% or more of the plus 48 mesh coal floating at 1.50 Sp. Gr. in the feed. The overall recovery from tipple and washery combined of over 90% of run-of-mine input is greater than was predicted.

The performance of the washery regarding dewatering and sizing has been very gratifying. The market sizes larger than 5/16″ are dewatered on the main classification screens and the minus 5/16″ coal is dewatered by boot and elevator followed by vibrating screens and Carpenter centrifugal dryers. With the low slurry losses stated the moisture of the screenings sizes is but a few per cent above the average of the corresponding sizes of raw coal and on an average lower than raw screenings loaded during wet weather.

Thus, without any heat drying, washed coal was shipped throughout last winter even into Wisconsin with no serious trouble from freezing and I have been advised by officials of the United Electric Coal Companies that they had fewer complaints on freezing from shipments from Fidelity than from their other properties shipping raw coal.

We are now designing a coal washing plant for the Northern Illinois Coal Corporation in connection with their property near Wilmington, Illinois, which follows substantially the plant layout and flow sheet which has proven so satisfactory at Fidelity. One new feature which may be of interest is the provision of one main launder in the Rheo coarse coal unit 56″ wide which will handle 435 tons per hour of feed. This, we believe, is the largest capacity single coal washing unit in the world.

As we view it, coal preparation is a manufacturing process. It takes your coal as a raw material and gives it the qualities your trade requires. The fact that most Illinois mines have a long life with an assured tonnage makes it possible to view mining and preparation as a manufacturing enterprise which warrants an investment in preparation plant that will assure efficient, dependable operation with low costs and low coal losses.

In closing you may be interested in some comments on the development of mechanical cleaning of bituminous coal throughout the country as a whole.

The statistics on the mechanical cleaning of bituminous coal recently issued by the United States Bureau of Mines contains some very significant data. The percentage of the bituminous coal output of the United States mechanically cleaned has increased each year from 1927 to 1934 and in 1934 the percentage was more than double that of 1927. Equally significant to the Illinois operator is the fact that this increase is consumed in the domestic and industrial markets rather than in the making of coke—the tonnage used for this purpose having decreased during the period, while that used for other purposes has increased 72%.

It is of particular interest to Illinois operators to realize that states such as Pennsylvania, Virginia and West Virginia, which have a reputation for producing raw coal of the highest quality, have shown in recent years unusually rapid advances in mechanical cleaning. Their statistics also show that the big advance in mechanical cleaning started in 1929 and has continued rapidly in the succeeding depression years as witnessed by the following figures showing percentage of each group's output that was mechanically cleaned.

Year	*Pennsylvania*	*Virginia and West Virginia*	*Illinois and Indiana*
1928	5.3=1.00	3.4=1.00	0.76=1.00
1929	7.7=1.45	5.5=1.62	1.33=1.75
1934	17.5=3.30	10.2=3.00	4.20=5.50

These statistics show that the mechanical cleaning of coal must be an effective means in the present keen competition for coal markets.

* * *

Mr. J. E. Jones: As explained to you a few minutes ago, the discussion on these papers will all come together.

The importance of this subject to the coal fields of the Mississippi Valley can not be overlooked. Since coal has been produced in Illinois, it has been the best prepared that has been mined, and in our drive for business we must continue to give the best, and build for the future. For if we were to mine 100,000,000 tons of coal a year, there would still be coal for over 1,000 years.

The second paper on coal cleaning has been prepared by Mr. R. G. Lawry of Roberts & Schaefer Company.

THE PLACE OF AIR CLEANING IN COAL PREPARATION

By R. G. LAWRY

Contracting Engineer, Roberts & Schaefer Co., Chicago, Illinois

About 12 or 14 years ago air cleaning of coal was introduced on a commercial scale and aroused very general interest. At the same time there was revival of washing. There then followed much controversy regarding the relative merits of the two systems.

This argumentative period is about over, as it seems reasonable that each process has its merits, and its special field.

The purpose of this paper is to discuss the place of air cleaning in a general beneficiation progam. Consideration is given principally to Illinois coals, but the statements apply to the treatment of any coals from any districts where the conditions are similar to those here.

The main points in this discussion will apply to any system of wet washing and to any system of air cleaning, but I will speak principally of the Air Flow machine as I am more familiar with it.

From a practical standpoint one of the most serious problems in washing is to dewater the fine coal and to recover it.

In air cleaning the recovery of fine coal is easily accomplished in a dust collector. There is an upper size limitation in air cleaning. This is because the horse power in air increases rapidly as the pieces of material increase in size.

The process to adopt then should:

1. Clean the product acceptably, and

2. Do the job at a reasonable cost.

Our recommendation is to wash all sizes down from the point where hand picking is inadequate, to the size where air cleaning is more advantageous, and from there to zero to clean with air.

It is not necessary to determine these size divisions theoretically. They should correspond to shipping sizes, as the Illinois standard sizes are of supreme importance in marketing.

The upper washing size can without argument be set at 6″ or 3″ to suit various conditions.

The upper size for air cleaning should be 1½″, ¾″ or 5/16″ depending on:

1. The relative amount of each size,

2. The tonnage of the entire plant, and

3. The moisture limit desirable for the smaller sizes of coal.

Returning now to the question of what system to use, wet or dry. If the surface moisture of the small coal is not consistently over 4 or 5% and if actual machine tests show good results can be obtained, air cleaning should be used. Sometimes washability curves are sufficient to make this determination.

It might be true that the presence of soft clay in the fine coal would make the recovery of this coal so difficult, combined with the clarification of the wash water, that it would be more economical to apply heat drying to the fine coal and then clean it by the air process. Heat drying is too expensive to use if it can be avoided, however if it should be necessary to heat dry the small coal after washing, it might be better to dry the raw coal first and then air clean it.

If it has been decided to use air cleaning in a washing plant setup the question of what sizes to treat can be determined by considering the points mentioned above; the amounts of the various sizes and the question of dewatering. It happens that 1½"x¾", ¾"x5/16" and 5/16"x0" are good size ranges to treat on the Air Flow cleaner as well as commercial sizes. If a washing system is used in which a small size range and definite tonnage is used for each washing unit it might be desirable to wash down to either 1½" or ¾" or perhaps to only 2". In this last case it is alright to air clean the size 2"x¾" in one Air Flow machine.

In most of the larger washing plants it will be found most desirable to limit the upper air cleaned size to ¾" or 5/16".

The question of dewatering may affect the decision of what sizes to air clean. A washing plant can be much simpler if the dewatering is confined to screens so that heat drying, or centrifugal drying will be unnecessary.

The smaller a piece of coal the greater its surface compared to its volume, and the more surface moisture it will hold. For example egg coal can be dewatered on a screen to about 2½%, pea coal to perhaps 4 or 5% surface moisture while minus ¼" coal will hold easily 10% of water.

The question of dewatering brings to the fore why air cleaning should be used for fine coal. Washing and air cleaning supplement each other. Where the difficulties of washing appear in treating fine coal, the advantages of air cleaning are the most apparent.

When for example 5/16"x0" coal is washed a certain part, say the minus 1/16" or minus 1/32" is not really cleaned, just made wet. When this size is air cleaned the same minus 1/32" may not be improved but the minus 48 mesh or greater is drawn off by the exhaust fan and can be disposed of in its natural state.

Air cleaning is facilitated by the extraction of the minus 48 mesh dust.

In a combination plant the moisture of the dewatered coal is decreased by the mixing of the wet and dry coal. Thus 1½" screenings composed of 1½"x5/16" washed, and 5/16"x0" air cleaned will not freeze and will be little different from untreated coal. If all of the minus ¾" coal is air cleaned any resulting mixtures will show but little moisture effect from washing.

The disposal of the collected dust from air cleaning will depend on its ash content and whether or not a dedusted product is desired. It can be mixed with the clean coal, the refuse, or sold as a special product if possible.

To summarize the advantages of a combination wet and dry plant:

1. The large sizes can be treated in large capacity units so that only one or two such units need be used.
2. Washing need only extend down to such a size that the dewatered coal will have a low moisture per cent.
3. Clarification of wash water will be easy as the quantity of solids will be small.
4. The air cleaned sizes will be shipping sizes.

5. Soft shale that dissolves in water will be removed as refuse or drawn off as dust, in air cleaning.
6. The amount of fines exhausted can be regulated in the Air Flow to suit the requirements of dedusting.
7. Mixing of wet and dry sizes reduces the final moisture.

In this discussion the statements are intended to be general and to apply to commercial plants. More exact statements about cleaning sizes, and moisture percentages can be made when applied to a specific problem.

We believe the coal industry is inclined to consider the merits of all systems of coal cleaning and that little prejudice exists against any process.

* * *

Mr. J. E. Jones: The third paper will be presented by Mr. J. W. Wilson of McNally-Pittsburg Mfg. Corporation.

COAL WASHING IN BAUM TYPE WASHERS WITH SELECTIVE ASH CONTROL

By J. W. WILSON
Engineer, McNally-Pittsburg Mfg. Corp., Chicago, Illinois

In some earlier types of coal washing equipment attempts were made to secure a densimetric classification in a single operation. The raw coal feed would be delivered into an upward flowing current or hydraulic water or an artificial solution in such a manner that the coal "floats" across the discharge outlet while the impurities sink through to some lower outlet. Obviously, in the presence of the continuous upward current or solution, a true densimetric separation is not made but rather a classification of so-called like-falling particles. Such classification depends on the sizes and shapes of the particles to as great an extent as upon their densities, so that true separation, on a specific gravity basis, is effected only within closely restricted size ranges.

Moreover, any desired change of the approximate separating gravity, involves readjustment of the upward current. Conversely, any variation in the rate of flow, due to blockage, changed resistance, pump wear, etc., necessarily results in a changed basis of classification.

The Baum Type washers do not attempt to accomplish the final separation directly, but function in two separate and distinct phases. The material is first stratified densimetrically and the stratified bed is then "sliced" through at any densimetric plane to accomplish the final separation. The lower, denser strata, or concentrates, are rejected from the bottom ends of the washing compartments, the remaining upper strata necessarily overflowing with the water.

These washers are equipped for rejecting concentrates from both ends of the bed. That at the intake or primary end consists of the highest density material and usually constitutes the pure refuse or primary rejects. The intermediate gravity materials or middlings, discharged at the secondary or outlet end, may vary widely with different coals. It may consist of an homogeneous natural middling, or bone, or high gravity, high ash coal, which may be utilized as a fuel, or marketed as a secondary, lower grade product. Again it may consist largely of laminations of good coal with impurities. In this case it is usually crushed to separate the laminae and then rewashed to recover the liberated values.

When the values are insufficient to justify recovery on either of these bases, the middlings are considered merely as secondary rejects and discarded with the primary. In still other instances, when there is sufficient freed pyritic material present in the seam to justify the recovery of the sulphur, separation at high gravity is established at the primary end, to reject all the pyrites there. The secondary discharge will then include all the carboniferous and non-pyritic impurities and constitutes the only direct rejection.

Assuming that we have established the densimetric stratification of the raw feed in this type washer, let us look at the second function of it, that is, the separate rejection of certain predetermined strata. In an automatically operated washer like this one the discharge rates must obviously be controllable to conform to variations in the rate and quality of the raw feed.

In this washer the heavier strata is rejected at the primary end and the middlings at the secondary end and rejected through adjustable orifices, placed in the vertical end walls. They are located at the bottoms of the washing compartments, extending across their total widths, and the discharge rates are governed by means of mechanically operated rejection devices. Whatever is not rejected here must obviously overflow with the lighter strata. In order therefore that only and all the proper strata be discharged it is essential that the stratum plane which represents the desired separating gravity be maintained at a sufficient height above the orifice to prevent the loss of float material with the concentrates or rejects *but* must not approach the orifice weir so closely as to permit sink material to go out with the lighter strata. In other words the concentrate bed must be controlled both as to depth and consistency, which is virtually impossible under manual operation.

The automatic rejection control mechanism now used on various types of Baum washers accomplishes these two purposes simultaneously. The somewhat misnamed "Float" (density finder) is of course the index and the exponent of its operation. Streamlined, to minimize frictional resistance, and maintained truly vertical, its bottom acts as merely another particle in the stratified bed and assumes its proper densimetric stratum.

For the purpose of illustrating more clearly the float controls as used in the Baum type washers, the particular arrangement used in the McNally-Norton application is described in the following:

To one end of the keyed pivot shaft is affixed a graduated dial and a short pendulum arm, adjustably mounted on the dial, contacts and operates the small piston valve which controls the position of the undercut reject gate. A screw controlled adjustment permits accurate and direct setting of the arm on the dial, to maintain any desired depth of concentrate bed. The scale reading, represents this depth in inches. For convenience, a second dial and pointer is mounted on the opposite end of the pivot shaft to facilitate observation of the operation from the front of the washer.

With any increase of the feed or of the proportion of the sink material in the feed, the concentrate bed will naturally tend to thicken unless the rejection rate is increased. The float however rises with the bed, rotating the pivot shaft through a small angle and increasing the port opening in the piston valve. This admits more air from the air receiver to the operating cylinder, further depressing the gate and expediting the rejection. Conversely as the bed falls, the float sinks with it, reducing the valve port opening and retarding discharge, interrupting it completely if the bed sinks appreciably below the predetermined elevation.

Pneumatic operation at very low pressure provides sensitive control, with a veritable infinity of operating positions between wide open and totally closed. A counterweight is provided on the gate operating lever arm and the position of this weight determines in a large degree the speed of opening and closing the gate. It is also used to compensate for variations in weight of the gates for different sizes of washers as well as for the different receiver pressures required for treating the different types of feed.

Changes in the feed to the washer, especially in the maximum size to be treated, frequently require changing the height of the reject orifices. This is readily accomplished without interrupting operation but entails also a change in the depth of the concentrate bed if the same "seal" of sink material is to be maintained above the orifice. This too may be instantly effected, merely by resetting the arm on the control dial but the resultant change in the submergence of the float will patently disturb its gravimetric balance.

To compensate for this, one of the float counterweights is of such net weight that one inch of movement along its beam produces the same moment change as does one inch vertical change in the float displacement. The beam is graduated to correspond to inches of actual submersion of the float, as read directly from a scale attached to the side of the float. Thus, the weight may be simply and accurately set to neutralize the change in float displacement for any desired bed depth or any required water level.

With stratification properly established; rejection orifices and concentrate bed depths adjusted to the size of feed and weights set at the float submergence readings; the separating gravities and hence the quality of the final products depends solely and directly upon the settings of the two weights. Thus is established accurate and immediate selectivity of final products on a densimetric basis.

This feature of the McNally Norton selective gravity control makes it possible for the tipple operator to instantly change the gravimetric separating point of his coal and reject, thereby changing the ash content of his washed coal. This is accomplished by an adjustable counterpoise mounted on a graduated beam supported on the extended arms of the "Float" linkage. To get this ash change the operator has only to move a sliding weight on a graduated balance beam to a predetermined setting and immediately the slice in the stratified bed at the discharge end will be cut at either a higher or lower level, as desired.

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Mr. J. E. Jones: Colonel O'Toole who was to present the fourth paper was unable to attend. However, he has supplied our Secretary with a copy of the paper and it will be read by Mr. Art Knoizen.

CLEANING OR BETTERMENT* OF ILLINOIS COAL BY THE DRY METHOD

By COLONEL EDWARD O'TOOLE
American Coal Cleaning Corporation, Welch, West Virginia

Betterment of Illinois Coals presents similar problems to that of other coals. The problem of betterment varies with the different mining conditions and the characteristics of coal found at each operation. The coal produced by shaft mines differs to that coming from the strip mines. This is true to a greater extent during the wet seasons.

This paper deals exclusively with the preparation of coal by the use of air as a flotation medium, or the pneumatic method. however, there are some interesting comparisons between the dry and the wet process. The wet process may be used to clean the coarser sizes (plus 1″) to their betterment, while the fine sizes (minus 1″) if cleaned wet, will be injured instead of bettered, as the liquid inerts (water) retained by the coal will be greater than the solid inerts removed.

All sizes of coal may be treated to their betterment by the dry process. This is being practically demonstrated every day at a number of plants, treating coal from 3″ to 0″. The sizes above 3″, including the egg and lump, can be more economically bettered by hand-picking than by any other means, as hand-picking subjects it to a minimum of degradation.

Recently the desirability of dedusting coal has been forced to the front. Dedusting can only be accomplished when the coal is dry, as it is impossible to satisfactorily dedust wet or partially wet coal. In a number of instances, specially designed and expensive dedusting equipment has been installed for this purpose, but simple effective means of collecting the dust has not been provided. In the dry cleaning of coal, the air used as the flotation medium, may also be utilized as the dedusting medium. Both functions are performed as one single operation, with but little additional expense for either power or equipment. The air as it rises from the surface of the pervious deck of the separator and the coal bed being cleaned on the deck, removes with it

* Betterment is the proper term, as coal may be cleaned and its condition not improved.

the dust particles contained in the coal, the size of the particles it carries depends upon the velocity of the air. The velocity of the air is maintained and carries the dust particles retained in suspension into the dust collecting chamber of the dust collector.

Illinois coal contains moisture in two forms, generally known as Inherent Moisture and Surface Moisture, Inherent Moisture being water of crystallization and hygroscopic, while the Surface Moisture is the water adhering to the surface of the coal particles. The Inherent Moisture varies with the composition, age, previous and present condition of the coal. The amount of surface moisture varies directly as the surface of the particles. The smaller the particle, the greater the surface, and it follows, the finer the particles, the greater the amount of water it will contain. The greater betterment of Illinois coal will result from the removal of all the surface moisture and as much as is desirable of the inherent moisture.

The passing of air heated above ordinary atmospheric temperatures through the agglomerated particles of the coal mass during the process of betterment is a new development. The prime purpose for using heated air is to reduce the amount of surface moisture contained in the coal. In the case of dedusting, the drying of the coal on the deck is incidental to the cleaning of the coal, and is accomplished at a very little additional expense. The heating of the air is accomplished by the use of a simply constructed furnace located near the cleaning plant with its flue connected to the intake orifice of the blower, which supplies the air to the air chamber of the cleaning separator. The temperature of air is governed by means of dampers, and the temperature of the air required will depend upon the size of the coal particles, the length of time the particles are in the dehydrating atmosphere, and the gross amount of water to be removed. An increase of from 100° to 300° F. above the prevailing atmospheric temperature if maintained will remove surface moisture. The removal of water will also increase the efficiency of cleaning.

In strip mining operations, the use of heated air in connection with the pneumatic separators is especially applicable. At certain seasons of the year, the moisture content of the coal is high due to the exposure of the coal in the pit to rain and snow. For this reason, washing the coal and then drying it in a separate operation is the accepted method. It was seemingly logical to presume that the water added by the washer was of no consequence.

This line of thought might be reasonable in cases where domestic sizes, such as Lump and Egg, are concerned. On the other hand, however, the moisture problem in the smaller sizes increases as the coal particles diminish in size. It follows, therefore, that the finer the coal, the more water it will retain, due to the fact that when a solid block of coal is broken into particles of various sizes, many voids are created in the coal mass. The number of the voids will vary with the size of the coal, thus, for instance, a cubic foot of 1/16″ to 0″ coal will have more voids or spaces filled with air than a 3″ to 0″ coal. Consequently, this void space occupied by the air of the atmosphere, can be, and is, replaced by water.

In order to determine the quantity of water retained by coal of a certain size, the following experiments were performed:

Coal passing ½″ square openings was screened into the following sizes: ½″ to ¼″; ¼″ to ⅛″; ⅛″ to 1/16″; 1/16″ to 1/32″ and 1/32″ to 0″. All sizes were first dried to expel all the free and hygroscopic moisture. A weighed amount of dry coal was placed into a 30 mesh sieve 10″ in diameter, and the coal was bedded evenly to form a bed of 2″ in depth. In order to avoid the loss of fine particles of coal that might be present among the larger coal, a loose filter paper previously wetted was placed on the bottom of the mesh of the sieve. The sieve with its contents was immersed into water in order to allow the coal to become thoroughly saturated. From time to time, the sieve was agitated under water by a slight up and down movement in order to expel trapped air. After thirty minutes of immersion, the sieve with the coal was carefully raised above the water and allowed to drain. The draining was considered complete when no more water droplets were found on the bottom of the sieve.

On the fines, 1/16″ to 1/32″ and 1/32″ to 0″, the drainage was performed by means of 6″ filter paper and funnel.

The drainage completed (12 hours for sizes ½″ to 1/16″ and 18 hours for 1/16″ to 0″) after proper correction being made for moisture retained by filter paper, the increase in weight due to water, was noted and the percentages were computed. The data observed are noted in the table below:

Size	*Weight of Raw Coal Per Cubic Foot—Dry*	*% of Water Retained after 12 hours*	*% of Water Retained after 36 hours*	*Differential % loss in 24 hours*
½″-¼″	34.05 lbs.	21.35	15.46	5.89
¼″-⅛″	34.40 lbs.	32.03	27.82	4.21
⅛″-1/16″	34.64 lbs.	37.49	34.04	3.45
1/16″-1/32″	33.25 lbs.	90.05 16 hrs.	87.03	3.02
1/32″-0″	32.98 lbs.	94.50 16 hrs.	92.00	2.50

The loss of moisture in the interval as shown in the differential column is of course, due to evaporation of moisture at the surface and the rate of evaporation under normal conditions will diminish the lower strata, due to the fact that the upper strata serves as a protecting layer.

There is being placed on the market at the present time a new combined pneumatic cleaning and drying unit to replace the wet washing and drying equipment, and at a much lower cost. This new unit uses heated air as a cleaning medium, which dries the coal before it reaches the cleaning deck, as well as when on the deck. It has the advantage during the dry seasons of treating the coal as it is mined in its dry state without the use of heat. At such times, the heated air is replaced by air at atmospheric temperature and the expense of heating eliminated.

* * *

Mr. J. E. Jones: You have heard these four papers. I know you will all be glad to go over this detail you have heard from the printed proceedings. There is such a mass that it needs to be studied at great detail.

Mr. Sandoe: I believe we are on the right track to compete with other fuels. I would like to hear some discussion as to whether water is the better method or air cleaning.

Mr. H. A. Treadwell: I was very much interested in listening to these papers. There has been much progress made in this field.

There was one statement made that they were discarding the 48 minus. I wonder how much of the oversize is discarded in discarding this coal. Our raw 5/16″ contains about 13% of 48 minus and the finished product carries about 3½ to 5% of —48 mesh. We have an arrangement for reclaiming the oversize in our 48 minus and I would say our final loss does not represent over 1% of the 5/16 x 48 mesh.

Mr. E. Weimer: Mr. Chairman, I would like to ask a question in regard to the dedusting of coal. What percentage of moisture can be in the coal and still get what we call satisfactory results on dedusting?

Mr. Lawry: I don't know whether I can answer that or not, but I would say you could draw the fine coal out of a moisture of 6 or 7%. But I do not believe you would get a satisfactory job of dedusting with coal of any higher moisture content.

Mr. G. C. McFadden: You have asked me to tell you all about the cleaning of coal. I do not pretend to be an authority on this subject, but we do have a combination plant that is equipped with an air cleaning table and Norton wash box. But before we get 100% from this plant we are going to have to obtain a heat unit to dry out the fines, for when the plant was built we decided to clean strip coal, and there is too much moisture in the 5/16″ size from the strip for the air cleaning table to do a good job. But when we were only running the shaft coal we could do a good job. So for the present we are running all the coal through the washer and we are doing a good job of cleaning the raw screenings.

Mr. Weimer asked about the moisture content of coal that could be satisfactorily dedusted. It seems to me that the number of dry places in a mine would regulate that.

Mr. Treadwell: Further in regard to dedusting wet coal. We have an ordinary mine in Southern Illinois that has about the usual number of wet and dry places, and we can dedust this coal and get satisfactory results.

I brought up the question of the amount of loss in the minus 48 because there is a certain per cent of the feed to the cleaning plant that is 48 mesh. And I have examined a number of wet washing plants in Illinois and there is very little coal in their finished product below 10 mesh and hardly any below 20 mesh, and in dedusting your waste production of —48 mesh is going to be about 15 or 20% of the 5/16″ raw. I wonder how close you can cut it to a predetermined size.

Mr. G. C. McFadden: Harry, you mentioned the percentage of waste on your 48 mesh. I don't know whether these figures are accurate or not, but it seems ours runs about 8%.

We have another small plant that has just been completed and was designed as an experimental plant and is recovering coal from picking table refuse. In years gone by we run about 200,000 tons of bands a year on a rock dump. Our recovery from this refuse is running about 46%. We dump the refuse into a track hopper and it is conveyed to a breaker that breaks it down to 1½″ size for washing.

Now getting back to the different methods of cleaning coal. There is no question but what there is a place for both wet and dry cleaning, and some satisfactory plan could be worked out for the different coals. You have to work out the best plan to adopt. In certain coal it calls for the dry cleaning of the 5/16 x 0 size, and wet washing of the larger sizes. Of course if you are loading 1½" screenings you have the proposition of mixture of the washed size with the 5/16 x 48 air cleaned.

John Griffen: Mr. Treadwell asked about the amount of plus 48 mesh coal lost at Fidelity resulting from the removal of minus 48 mesh. The following is a screen test on the fines removed by the fine screen:

	% Weight
Plus 14 Mesh	0.5
Minus 14 Plus 28 Mesh	1.0
Minus 28 Plus 48 Mesh	8.0
Minus 48 Plus 100 Mesh	32.5
Minus 100 Plus 200 Mesh	26.5
Minus 200 Mesh	31.5
	100.0

The minus 48 mesh in the minus 5/16" raw coal amounts to 13 to 15 per cent by weight and the minus 48 mesh in the finished minus 5/16" screenings is about 4 to 5 per cent. The minus 48 mesh removed thus amounts to 9 or 10 per cent of the raw minus 5/16" screens and the small amount of plus 48 mesh lost amounts to 1 to 1.5 per cent of the minus 5/16" screenings or a total loss of 10 or 11 per cent.

This is in distinct contrast to the wet washing plants in Illinois where Mr. Treadwell reports finding "very litle coal in their finished product below 10 mesh and hardly any below 20 mesh." At Fidelity the washed minus 5/16" screenings carries substantially the normal quantity of coal passing 10 mesh and retained on 48 mesh.

The above data covers operations at Fidelity during the early months of 1935.

This performance at Fidelity shows conclusively what I stated in my paper, namely that it is not necessary to have excessive losses of coal from 48 mesh to as coarse as 10 mesh in order to produce a coal dry enough for shipment.

Referring to the question of the effect of moisture on dedusting, we have had some experience with the Birtley Deduster on American coals and have a very considerable amount of data covering the dedusting of English and Continental coals. Our experience indicates that a damp coal requires more air than a dry coal for a given removal of dust. This means that more oversize is removed with the dust. Put in another way, damp coal can be dedusted but at a sacrifice of efficiency in the removal of the dust of the desired fineness and with a greater loss of coarser coal which should be retained in the finished product.

As Mr. Treadwell pointed out, the dedusters at Orient are making a very efficient removal of minus 48 mesh dust from the minus 5/16" coal produced at a shaft mine having the usual number of wet and dry places. We ascribe this successful operation to the use of a high velocity blast of primary air to distribute the feed to the dedusting column. This feature was developed by Mr. Garwood at Orient. The Koppers-Rheolaveur Company now controls the Garwood improvements and the Orient installation is a Birtley Deduster with these improvements. We are now installing a similar dedusting plant for the Pittsburgh Coal Company at their Champion No. 1 Washery. This installation is unique as it will treat washed coal that has been heat dried and will produce a dust of particular value in their low temperature carbonization plant.

Mr. Sandoe: I do not know of any other business at this time. But I do want to call to your attention the Fall Meeting. The place for this meeting will be selected by the Executive Board who will notify you.

We now stand adjourned.

The following papers by Edward Leming, E. F. Stevens, David R. Mitchell, Merl C. Kelce, L. Russell Kelce, C. W. Woosley and Dr. L. E. Young—all members of our Institute—were presented at the 1935 meeting of the American Mining Congress at Cincinnati and were published in "Coal Mine Mechanization," yearbook for 1935. We are grateful to the American Mining Congress for their full permission to give these papers to you herewith.

PROMOTION OF SAFETY IN MECHANIZED MINING IN ILLINOIS

By EDWARD LEMING and E. F. STEVENS
Union Colliery Co.

The property at which this plan has been in use is one of the first of Illinois properties to adopt mechanical loading. Before, during and after the gradual adoption of 100 per cent mechanical loading, the accident history of the property was not satisfactory. With the adoption of new methods of operation and the increased necessity for interlocking operations underground arising from mechanical loading, no improvement in the accident record was attained.

Foremen's meetings on safety have been held for years at this property. Bulletin services have been used and on two occasions in the last few years, 100 per cent of the employes have been put through rescue work courses of the Bureau of Mines with the assistance of the Bureau as a further means of attempting to promote safe operation. In spite of all of these measures used, the accident records continued to be unsatisfactory from the standpoint of fatalities suffered and the number of major injuries, both of which undermine the safety morale of the organization, and gradually lead to a feeling of uneasy and constant anticipation of further fatalities or major injuries.

Because of this history this property undertook to evolve some new and supplementary idea of promoting the cause of safety, not with the thought of supplanting regular recognized means of safety work, but rather with the thought of supplementing these established means, which are still in use at this and other properties.

This plan is based on the extremely simple thought of offering to share any improvement over long established average accident costs with the employes responsible for the improvement. It accomplishes this simply by paying in money to employes and foremen who work safely, their half of the savings.

Size and Type of Property

The property consists of a shaft mine of about 5,000 tons per day production, employes underground and on top approximating a total of 500 men.

Coal is loaded exclusively by mobile types of loading machines, haulage by electric motor, and preparation is accomplished in a shaker screen boom equipped modern tipple permitting sizing and loading of the various ordinary commercial sizes.

Coal is mined from the No. 6 seam of Illinois and the underground conditions are neither the best nor the worst in the state, though they are perhaps slightly worse than the average.

General Features of Plan in Use

Originally it was intended to organize the entire force into teams and pay periodically to winning teams a fixed prize in money. This quickly proved to be impractical for numerous reasons and was replaced by present plan now in use.

History of the property over several years indicated a fluctuating cost of accidents ranging to as much as 10 cents per ton produced, with an average figure approximating 5 cents for a number of years. This cost included actual compensation paid, medical and hospital expense of accidents, maintenance of first aid room at which a doctor is in daily attendance at quitting time of the day shift for dressing any slight injuries which might otherwise lead to infective lost time cases, as well as for attention to convalescents of a more serious nature. Also is charged against the 5-cent average cost all expense of examinations, legal and medical expense in connection with compensation hearings.

Under the plan in operation the entire working force is organized into teams headed by foremen, the actual total cost of accidents is figured as before, and any savings on total accident costs determined during a contest period is divided 50 per cent to the winning team or teams and 50 per cent to the company. Of the money which goes to the winning teams 15 per cent is paid to the winning foremen, share and share alike, and 85 per cent to the men on the same basis.

This distribution between foremen and men is on the simple arbitrary assumption on our part that the men are 85 per cent responsible for the decrease in accidents, and are therefore entitled to 85 per cent of the share of all employes. We do not maintain that this percentage can be established with any accuracy. We do believe on the contrary that no plan which rewards only the foremen can hope to attain the attention or success of a plan which recognizes the individual contribution of the individual employe.

Duration of the Contests and Payment of Prizes

A great deal of thought and study was put in on this question. The object of the contests being to *maintain* interest in safe work it was obvious that too long a contest would defeat the very purpose of the contest if one or two teams out of the 17 in the contest suffered a serious accident early in any period and hopelessly lost any chance of winning. In such an event the total record might prove to be a poor one due to loss of interest of a few men out of many, if the contest period be unduly prolonged. On the other hand too short a contest does not permit the accumulation of sufficient prize money to make winning something to definitely strive for, and the object of this plan was definitely to make the prizes financially worth winning.

The decision was reached to use a three months' period for each contest so that every one starts with a clean slate and a new chance each three months. This decision has been found to be a wise one. Payment is made by check by the 20th of the month following close of contest.

Organization of Teams

Under this property's operation the division of the force into teams is as follows:

11 teams—of loading machine crews determined according to the foremen to which the men report.
1 team —Main line transportation men.
1 team —Night material men.
1 team —Mechanics.
1 team —Wiremen and extra gang.
1 team —Topmen, including yard and shop but excluding tipple.
1 team —Tipple crew.

17 teams—Total.

	Man-Hours Lost
Goodman 1 and 2	1
Goodman 3 and 4	1
Goodman 5 and 6	1
Joy 1 and 2	1
Joy 4 and 9	1
Joy 3 and 10	1
Joy 3-A and 10-A	1
Joy 5-A and 6-A	1
Joy 7	2
Joy 8	2
Main Line men	¾
Night material men	¾
Mechanics	1½
Wiremen and extra gang	1
Top yard and shop men	2½
Tipple men	2½

Practical Rules of Application

Obviously, in the necessary shifting of individuals in such a mine, and by the size and complexity of the work engaged in, it has been found necessary to develop certain practical rules for the equitable administration of these contests.

Certain of the rules developed by our experience follow, other rules and other team division or organization may of course be necessary for different types of mine operation.

1. Teams and foremen are charged with man-hours lost due to accidents or for injuries which are compensible (according to the compensation awarded) whether or not actual work time is lost.

2. Ratings in charges for time lost depend on number of men on the team and hazard of employment. Following are ratings per man-hour actually lost as used at this property.

In further explanation of the following tabulation it may be said that for this operation standard loading machine crews are used as a base — small crews, haulage and other operations entailing as they do substantially less or substantially greater hazards, are either penalized for each man-hour lost or less severely charged as indicated in the tabulation.

3. A committee composed of the Superintendent, Mine Manager, Assistant Mine Manager and Chief Clerk shall settle all questions arising because of specific questions not covered by the rules.

4. The company reserves the right to distribute prize money to 2, 3, or more winning teams with the understanding that all prize money earned will be distributed. The exact proportioning of distribution will depend on amount distributed and records of teams in the contest. (Note—this rule is to reserve the right to distribute the money to as many teams as the company wishes to declare winner and to prevent the possibility of a small group of men obtaining a large amount of money, which in fairness should be further divided.)

5. Each foreman is responsible for his men from the time they enter the mine until they are outside again.

6. All compensible accident cases which have not been settled at

the close of a contest shall be estimated by the committee, and the estimated compensation in terms of weeks shall be reduced to man-hours and charged against the proper team and foreman at the end of the contest period in which the accident occurred.

7. When a man is injured to the extent that he must work on a job other than his regular occupation, a penalty of one hour for each day on such job is charged.

8. Any man coming out of the mine on account of an injury will be charged for the hours lost provided he is unable to resume work after medical care.

9. When a man on the extra gang is injured and loses time this loss will be charged against the foreman he was working for at the time of the injury, also against the extra gang team.

10. If a man is injured while working on an idle day and not on his regular territory, the injury will be charged against the foreman in charge of the work at the time of the injury, but the injury will not be charged to any team. But in case the injured man's team wins he will not be allowed to share in the money.

11. Should a member of the wire gang be injured during a contest, such injury wil be charged against the extra gang team, but not against any foreman. This rule applies only to the wire men in the extra gang team.

12. Each week a sheet is to be posted on the bulletin board showing the standing of each team and each foreman, for the previous week and the contest to date.

13. All grievances or cases arising out of disagreement on the standings as posted, or injuries as charged, will be heard before the committee and the committee ruling shall be final and binding.

General Results and Comments

To date 11 three-month contests have been completed, in all except one of which the contests have shown savings and resulted in prize money distribution.

A total of about $24,000 has been paid to winning team members and foremen, this sum representing half of the savings over average prior experience. Prizes have been shared by from 118 to 357 men in various contests and have amounted to more than $20 per winning man in some periods.

Our original belief was that in introducing these contests results would show one winning team with perhaps a second or third runner-up in time loss. The actual record has been that out of the 17 teams in each contest, from 4 to 10 of these have come through the period without any time lost or accident cost. The result has been that the company has not been called upon to determine a first, second and third prize winner, but only to distribute the money saved, to teams with a perfect record.

The constant determination and consistent interest shown by these men and foremen have satisfied this company the plan is well worth while in its operation.

THE EVALUATON OF WASHED COAL

By DAVID R. MITCHELL
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This discussion is confined to the use of coal for steam-raising purposes and any comparisons made must be considered as applying to one size, or in the case of mixed sizes, such as screenings, to coal having the same quantitative distribution of sizes.

Those chemical properties of coal which must always be considered as factors in evaluation are moisture, ash, and calorific values, while for some uses and in some plants fusion point of ash, sulphur, and volatile matter content may be factors of importance. In addition, variations in or uniformity of such chemical or physical properties as friability, caking, or agglutinating values, slacking and weathering indices, grindability, plastic range, swelling index, oxygen and hydrogen content, and chemical and physical properties of the ash must often be considered. Any or all of these properties may be modified or improved by cleaning the raw coal.

To illustrate the importance any one of the last group of properties may assume, I wish to cite a case which was brought to my attention a short time ago. Two coals, competing in the same market area and having exactly the same size characteristics, analyzed as follows:

	Coal A	*Coal B*
Sp. gr.	1.32	1.32
Total moisture	4.0	4.0
Ash—dry	9.5	7.6
Sulphur—dry	1.05	2.00
"H" value	15,300	15,000
Ash softening tem...	2,670	2,400
SiO_2	51.4	45.0
Al_2O_3	33.8	28.4
Fe_2O_3	8.3	22.6
CaO	2.4	2.7

By any method of chemical valuation known, coal A should be equal to or command a premium over coal B, yet in practice coal B sells at a premium of 10 or 15 cents per ton over coal A. The ash from coal A tends to be carried up into the tubes and has a bad habit of making what might be termed "bird nests"; whereas coal B clinkers somewhat, yet stays on the grates. This is probably a case where specific gravity of ash might be the controlling factor. A specific gravity determination of the ash from these two coals gave 2.77 for coal A and 3.22 for coal B.

It is not enough that the coal mining companies have an occasional proximate analysis made including sulphur and B.t.u. values, but a systematic study of all of the above-mentioned properties should be made. "Know your product" is a slogan that should be adopted if marketing of coal is to be carried out intelligently and effectively.

Due to the present uncertain state of our knowledge, lack of experience data, and to variations in effect of many of these properties in individual plants, a primary evaluation of washed coal should only be concerned with moisture, ash, and calorific values. Certain premiums or penalties may be applied for variations in sulphur, fusion point of ash, volatile matter or other characteristics for particular plants.

Washed coal may be evaluated as compared to unwashed coal by the three methods which follow:

1. By a comparison of calorific values in which the "as received" or "as fired" B.t.u. content should be used. Such comparisons may be expressed as a direct ratio, cents per million B.t.u.'s or B.t.u.'s per penny. This method is obviously not accurate, since plant efficiencies are ignored. This method needs no further elaboration.

2. An efficiency or "effective B.t.u." basis which gives an expression for the useful transfer of heat units into steam. This method will be explained in the following discussion.

3. Effective B.t.u. plus operating costs plus relative plant capacity as reflected in overhead charges, such as interest, depreciation, etc.

Establishment of Relative Values From Efficiency Data

Many consuming plants have established or are establishing a relative scale of values to aid in economical buying of their coal requirements. Figure A shows how such values can be set up in graphical form. The values used for curves A, B, C, G, P, Q, and R have been calculated or taken from figures presented by Chapman and Mott [1] of the Electric Supply Department of the Corporation of the City of Sheffield, England. Curves D, E, and F were added to this chart from data published by Patterson [2] for 15 large mechanical stoker plants.

The establishment of such values as shown in this chart is dependent on moisture, ash, and B.t.u. values, the relation of dry ash to dry B.t.u. being worked out from the efficiency data found to apply at this plant.

Moisture may affect the value of a coal in three ways. First, by directly changing the B.t.u. value of the coal; and, second, by reducing the heat available from combustion by the amount necessary to vaporize the water and heat it to stack temperatures; and, third, increasing the volume of stack gases. Since steam coals are usually tempered with water to get the highest efficiencies, it is doubtful if any moisture penalty should be considered unless the amount present is above about 3 per cent free moisture.

If washed coal is drained or dried to approximately the same moisture content of the raw coal, the moisture content need not be considered in evaluating washed coal in terms of unwashed.

Ash directly affects the B.t.u. content of the coal in proportion to the amount present. In addition there are additional heat losses due to high ash because of loss of carbon in ashes, loss of carbon up the stack, loss of sensible heat in the ashes, and a general increase in operating cost and drop of plant efficiency. In comparing a high-ash coal with a low-ash coal, the amount of ash to be handled, theoretically, is not in direct ratio to the ash content but considerably more. Take for instance two coals of the same "H" value, one containing 20 percent ash and the other 5 per cent. For the same heating effect 100 pounds of 20 per cent ash coal will produce 20 pounds ash and 80 pounds combustible, while there will be required $\frac{80}{.95}=84$ pounds of

[1] The Cleaning of Coal, Chapman and Mott, p. 610.

[2] Chemistry and Industry, 1923, pp. 42, 904.

the 5 per cent ash coal containing 4.2 pounds of ash giving a ratio of 1.5 instead of 1.4 as shown by their actual ash content. The actual ashes produced are greater for the high-ash coal than for the low-ash coal, the difference being thus increased beyond the simple difference indicated by their ash percentages.

B.t.u. values are in approximate relation to ash content. However, it should be noted that in cleaning coal there is usually very little loss in the total heat content of the coal as mined because the removable impurities have little or no heat value. Figure B shows typical washability curves for a coal from Perry County, southern Illinois, with inclusion of dry B.t.u. distribution and recovery curves. The dry ash or moisture-free value of this coal is 15 per cent. By washing to get a dry ash of 10 per cent, a coal recovery of 92 per cent is indicated, but the actual calorific value recovered is 98.6 per cent, while the dry B.t.u. value has been increased from 11,700 to 12,550 B.t.u. per pound.

A series of curves have been prepared as shown in Figure C, showing the relation between efficiency and dry ash values.

Efficiency values may be obtained for any plant by the relation

$$100 \times \frac{\text{Effective B.t.u.}}{\text{As fired B.t.u.}}$$

A great number of test data was reviewed for different types of plants, the probable top efficiency being near to that shown where the curve has been extrapolated to zero dry ash. A curve was drawn through these points, some of which are shown, and extrapolated to zero ash at one end and at the other to approximately 43 per cent dry ash, which is about an average for values given by different authorities at which a coal becomes worthless for steam-raising purposes. Curve No. 4 of Figure C after Abbott is a mean curve between efficiency and plant capacity, as modified by dry ash.

With a full realization of the limitations of any general method of evaluation of any general method of evaluation derived from these average curves for particular types of plants or for an average of all plants, the following method of calculation is not offered as a final method but simply as a guide for rough, general approximations and with the hope that this presentation may stimulate interest in this problem of evaluation and result in the collection and presentation of experience data along this line by those in a position to do so.

It is to be noted that these curves have the same general shape. So that rather simple mathematical formulae can be written for that position of the curves between 5 and 30 per cent dry ash. The formulae for these curves between 5 and 30 per cent dry ash are as follows:

1. Efficiency $= 90 - 0.027$ (dry ash)^2
2. Efficiency $= 88 - 0.035$ (dry ash)^2
3. Efficiency $= 79 - 0.036$ (dry ash)^2
4. Efficiency $= 70 - 0.043$ (dry ash)^2
5. Efficiency $= 68 - 0.026$ (dry ash)^2

Avg. formula $= 79 - 0.033$ (dry ash)^2

These formulae can be applied to get the relative efficiency of a washed coal over unwashed and this must be multiplied by the B.t.u. content to get the effective B.t.u. values. The ratios of the effective B.t.u. values will then give the relative value of the low or high-ash coal in terms of the other and can be applied to any delivered price to determine the difference in value to the ultimate consumer.

Taking as a practical example the coal of Figure B, and assuming the same moisture content for washed and unwashed coal, we have the analyses shown in Table I.

TABLE 1

	Dry Ash	Dry B.t.u.	M	As rec'd B.t.u.
Raw coal	15.0	11,700	10	10,500
Clean coal 92% recovery	10.0	12,550	10	11,300
Clean coal 84% recovery	7.9	12,920	10	11,630

By applying the average formula above we get relative values of 71.6, 75.7 and 76.9, respectively. These are then multiplied by the "as received" B.t.u. values and for purposes of comparison the effective B.t.u. so found together with values obtained by a direct B.t.u. ratio are shown in Table II.

TABLE 2

	Efficiency	As rec'd B.t.u.	Effective B.t.u.	Rel. value ratio effective B.t.u. values, raw coal as 1.00	Actual B.t.u. ratio raw coal 1.00
Raw coal	71.6	10,500	7,520	1.00	1.00
10% ash coal	75.7	11,300	8,550	1.14	1.08
7.9% ash coal	76.9	11,630	8,950	1.19	1.11

If raw coal at point of consumption costs $4 including freight, the following table shows amounts that could be paid for washed coal for equal cost provided no other factor entered the picture.

	Price for cleaned coal according to ratio of effective B.t.u. values	Price cleaned coal according to ratio of as received B.t.u. values
10% ash coal	$4.56	$4.32
7.9% ash coal	4.76	4.44

It is probable that if the actual ash reduction is small at the cleaning plant, there might not be enough increase in value of the coal to pay for cleaning. However, if by cleaning, increased mine working time is possible the lowered mining cost may be sufficient to more than pay for the cost of cleaning. Figure D taken from the 1935 report of the U. S. Coal Commission illustrates this point.

It is further to be noted that the only properties of coal used in this analysis are ash and B.t.u. values. Moisture is involved to the extent that it changes the ash and B.t.u. values from as-received to a dry basis. The evaluation of all other physical and chemical characteristics is believed to be a problem for the particular plant or use to which the coal is to be used. It would suggest the following approximations for special cases.

Moisture: Deduct approximately 1 per cent of the delivered price for each 1 per cent above that normally in the coal bed. This figure is arrived at from the fact that 1 per cent of moisture would displace

1 per cent of the calorific value of the coal.

Sulphur: Deduct or add approximately 0.5 per cent of delivered price for each 0.5 per cent above 1.5 per cent sulphur. No penalty or bonus is recommended for coal of less than 1.5 per cent sulphur.

Fusion or ash softening temperature: This is one of the most important of coal characteristics and one of the most difficult on which to place any definite value. Low-ash fusion point coals are desirable for some uses while for other uses high fusion ash coals may command a premium. Penalties or premiums exist which are of the order of 1 per cent of the value of the coal at destination for each 100° F. difference in ash fusion temperature.

Relationship of Plant Capacity and Operating Costs to Evaluation

A few of the most efficient steam raising plants have worked out definite cost schedules due to variations in ash in the particular coal consumed. Ricketts[3] has developed formulae for the plants of the New York Edison Co. and the Union Electric Light and Power Co. of Cincinnati, Ohio. This material is presented in Figure E and involves plant capacity, ash handling costs, as well as modification of B.t.u. values due to ash. Two sets of formulae have been devised, one neglecting investment and the other including investment charges. The reader is referred to this reference for details of this method of evaluation. It might be mentioned, however, that the increase in value of low-ash coal over high-ash due to including investment charges is of the order of 2-3 cents per ton for each per cent of ash decrease.

[3] "A Rational Basis for Coal Purchase Specifications," E. B. Ricketts, Proc. A. S. T. M., 22, II, 1922.

PREPARATION OF COAL AT DELTA COAL COMPANY, ILLINOIS

By MERL C. KELCE
General Superintendent, Delta Coal Mining Company

The coal tipple and washery unit to be described herein is situated in Williamson County, Ill., about 12 miles southeast of Marion. The plant is owned and operated by the Delta Coal Mining Company, of Kansas City, Mo. The unit was designed, erected and put into operation by the Link-Belt Company of Chicago. The plant was contracted for on September 15, 1934. The first steel was raised on November 9, 1934, and on December 27 the first coal was loaded out into railroad cars. The washery was not put into operation until January 14. For a plant which has a rated capacity of 400 t.p.h. and which puts out seven sizes of coal, this is an exceptionally short erection period.

Coal is obtained from the Illinois No. 5 seam, the mining rights to about 900 acres of which have been leased. The seam beneath this property has an average thickness of about 50 inches and lies at an average depth of about 35 feet. In the immediate vicinity of the tipple, this depth ranges from an outcrop to about 50 feet. The coal itself is unusually free from bone material and is relatively hard. While the larger sizes fracture into the characteristic cubes, the small fragments are inclined to be wedge-shaped. The sandstones and shales overlying the coal have been generally softened by weathering and are not solid enough to constitute much of the impurities brought in with the new coal. The stripping shovel pulverizes these rocks readily and any spoil which rolls back onto the seam is cleaned away by a bulldozer. Fire clay is found beneath the coal and this, along with pyritic lenses, comprises virtually all of the material which must be removed over the picking tables and in the washery. The ash content of raw 3-inch x 48-mesh coal runs about 18 per cent and this size constitutes about 60 per cent of the coal handled. The specific gravity at which washing is done is 1.50.

Mining the coal is carried on under the open-pit system, a 10 cubic yard Marion electric shovel removing the overburden and a 2¾-yard Marion electric shovel digging the coal and dumping it into 15-ton hopper-bottom trailer trucks. These trucks transport the coal to the tipple site and dump it into a concrete hopper of 4,000 cubic feet capacity. The hopper is fitted at the bottom with a 42 inch reciprocating feeder to insure a uniform feed to the R.O.M. belt conveyor. At the discharge end of the feeder a short section of lip screen lets the fines drop onto the belt ahead of the lumps and thus undue wear on the belt is eliminated.

The reciprocating feeder is operated through a Link-Belt P.I.V. Variable Speed Transmission, the speed of which is remotely controlled by the washbox operator. A small motor is mounted on the speed reducer and this is connected by a chain to the speed control knob on the reducer. A synchronizing generator on the shaft of this motor drives an indicator on the control board. Push buttons determine the direction of rotation of the speed-adjusting motor.

The 42-inch belt runs on Link-Belt troughing idlers equipped with Timken bearings and Alemite fittings, and is completely protected from the weather by an enclosed gallery connecting the dump hopper and the preparation plant. It has a center to center length of 192 feet and operates on an 18° incline, at the top of which incline it discharges onto a set of triple and double deck, all-steel, steel hanger shaker screens. The screens are driven through a V-belt drive to a fly-wheel type pulley on the eccentric shaft and two pairs of opposite throw cams. The tubular eccentric arms connect to trunnion bearings on the screen frames. The upper screen is 24 feet long with 16 feet of 3-inch round openings and a middle deck of 2-inch round holes. The bottom deck is blank except for a shake-back chute to the vibrating screens. The lower screen is 27 feet long, upper deck of 7-inch equivalent lip openings and a blank lower deck. Arrangement is made at the discharge end for delivery to the lump picking table. Shake-back chutes deliver to the egg and nut tables. A fly gate permits 3-inch by 2-inch nut to go either to the nut picking table or to the washer along with the 2-inch by 0-inch.

The picking tables are of the reciprocating type and are supported by 1-inch by 10-inch long-leaf yellow pine boards. They are driven at a speed of 120 r.p.m. by tubular connecting rods from a single eccentric shaft on which the cams are set at 120°. The tables are 4 feet wide by 22½ feet long, and are fitted near the discharge end with a short section of screen through which degradation is removed. Fly gates permit the coal from any table to be dropped into the mixing conveyor instead of going over the fixed chutes to the loading booms. There are four hinged loading booms, three of which are 48 inches wide and the other 42 inches. Twelve and one-half feet of each boom is horizontal and stationary. The other 19 feet is hinged, being raised and lowered by Milwaukee boom hoists. Coal is moved on the booms by scraper conveyors whose flights are triangular in cross-section to avoid carrying material back along the bottom run. The lump boom will handle 400 t.p.h. of r.o.m. or 80 t.p.h. of plus 6-inch lump. The egg boom will carry 400 t.p.h. of 6-inch by 0-inch, or 80 t.p.h. of 6-inch by 3-inch. The No. 1 nut boom will move 320 t.p.h. of 3-inch by 0-inch, or 60 t.p.h. of 3-inch by 2-inch. The No. 2 nut boom will carry 240 t.p.h. of minus 2-inch, or 35 t.p.h. of 2-inch by 1½-inch.

Now that we have followed the normal flow of the sizes of coal which do not go to the washery, let us return to the point where the coal to be washed is separated from that which is hand-picked, namely the r.o.m. shaker screens. The coal which is to go through the washery is removed in the upper screen and delivered via shake-back chutes to a pair of 4-foot by 8-foot double-deck vibrating screens of the positive drive type. The top deck of each screen is a relieving deck to give a more effective screening action to the bottom deck, where the actual separation of sizes takes place; that is to say, the coal passing over the lower deck is remixed with that which goes over the upper deck. The top deck screen cloth has ⅞-inch square openings and the lower deck has ½-inch square openings. Considering the pitch at which these screens operate, a ½-inch square opening is equivalent to a ⅜-inch round opening. The screens are used only when separating ⅜-inch by 0-inch coal from 2-inch by 0-inch and have a normal capacity of 180 t.p.h., of which 40 t.p.h. is ⅜-inch by 0-inch. When crushing lump or egg to 3-inch and recirculating it to the r.o.m. shakers, the feed to the vibrating screens will be 233 t.p.h. of which 55 t.p.h. is ⅜-inch by 0-inch. They are set at an angle of about 22° and are suspended from the building structure by cables. A 5-horsepower motor is mounted on the subframe of each screen and transmits power to the drive shaft through V-belts. The material passing over the vibrators discharges into the upper run of the raw coal conveyor, while the minus ⅜-inch coal goes to the lower run of the raw coal conveyor and then to the No. 1 slack conveyor. This flight conveyor discharges the slack into the No. 2 slack conveyor, which drops the material over a chute into the railroad cars beneath. A fly gate at the head of the head of the chute throws the coal into an auxiliary chute discharging up track to prevent spillage when changing cars. In the event it is desired to wash the ⅜-inch slack along with the plus ⅜-inch material a fly gate on the shake-back from the r.o.m. shakers by-passes the vibrators and the coal is chuted over a pantleg chute directly into the raw coal conveyor. The row coal conveyor is a 24-inch by 10-inch flight conveyor, the upper run of which elevates 200 t.p.h. to the washer while the lower run carries the ⅜-inch slack back to the No. 1 slack conveyor. If it is desired to size the coal without washing, a rack-and-pinion gate in the conveyor trough is opened and the coal dropped into the by-pass conveyor. This conveyor delivers 200 t.p.h. of 3-inch by ⅜-inch or 140 t.p.h. of 2-inch by ⅜-inch coal directly to the sizing screens, by-passing the wash box. When lump or egg sizes are being crushed to 3-inch and smaller it will handle 190 t.p.h. of 2-inch by ⅜-inch.

Let us assume, however, that the plant is operating normally and the minus 3-inch coal is not by-passing the wash box. In this case the rack-and-pinion gate mentioned immediately above is closed and the coal passing over the vibrators is elevated to the wash box. At the head end of the raw coal conveyor is a sliding plate in the conveyor bottom, the purpose of which is to discharge the coal evenly over the inlet sluice of the wash box.

A detailed description of the Link-Belt Simon-Carves washer would readily consume far more time than is allotted here, so we shall present only a brief discussion of it. The wash box itself is essentially a U-shaped tank with a partition paralleling the sides of the U, but not reaching to the bottom. On one side is a perforated plate on which the bed of coal rests. Water is admitted near the top of the opposite side and compressed air at the top. Air is alternately admitted and released through a slotted piston valve, thus imparting a pulsating motion to the material being washed without applying the suction which accompanies the ordinary plunger type of washer. The curved section of the U forms the hutch, which is kept free from an accumulation of fine refuse by a screw conveyor. The wash box at Delta is made up of five such cells, each one of which is in itself a washer. Each cell is provided with an air and a water inlet. At each end of the wash box is a dewatering elevator for the removal of reject material from the hutch and elevator boot. The refuse elevators and eccentric shafe to which the air valves are connected are driven by chains and sprockets from a single motor and speed reducer unit. The washer is divided into two main sections, each section having a screw conveyor in the hutch. The primary section is composed of two, and the secondary of three cells. The air valve eccentric drives of the primary section are set 180° apart from those of the secondary. At either end of the box, directly beneath the lip of the inlet and outlet sluices, are located rotating starwheel gates which draw off the refuse as it builds up on the perforated plates. In the primary end these plates are set up at a slight upgrade so that the refuse moves downhill over the plates counter to the direction of flow of the incoming material. Between the second and third cells a dam rises above the perforated plates to prevent the surging back and forth of water and coal from primary to secondary ends. In the secondary end, the plates slope downhill so that refuse and coal flow in the same direction. The depth of refuse bed which is most favorable to efficient separation of refuse and coal is maintained automatically. The automatic control system consists of an aluminum float and a Faratron relay unit. The weight of the float is adjusted by trial to the specific gravity necessary for it to find its position of equilibrium at the top of the refuse bed. Through the hydrometer float, Faratron relays actuate a motor and thrustor which rotate the refuse star-wheel gate at varying speeds. Thus it can be said that the refuse bed controls its own depth and maintains a uniform thickness. A ratchet mechanism on the shaft of the refuse gates gives a wide range to the rate at which refuse is removed. The heaviest rejects fall to the bottom almost at the instant raw coal enters the washer and are drawn off by the primary refuse gate. Rejects which escape the primary gate are carried through the washer and removed at the secondary end.

Washed coal enters the outlet flume and is sluiced to the classifying screens. The outlet sluice is lined with reinforced glass in order to facilitate flow of material. The washery products are sized on a set of flexible hanger classifying screens turning out five fractions. The upper screen is 7 feet by 24 feet with about 18 feet of ¾-inch round holes in the upper deck and 8 feet of ⅜-inch holes in the lower deck. The lower screen is 6 feet by 26 feet with 12 feet of 1½-inch and 8 feet of 2-inch round holes in the upper deck, the lower deck being blank. The screens are driven by fir connecting rods from two pairs of opposite throw eccentrics at about 150 r.p.m. and have a rated capacity of 175 t.p.h. of 2-inch by ⅜-inch or 3-inch by ⅜-inch feed. The discharge end is arranged for loading 2-inch by 1½-inch into the mixing conveyor or onto the No. 2 nut loading boom. The 1½-inch by ¾-inch fraction goes over a shake-back chute to the mixing conveyor while ¾-inch by ⅜-inch pea coal can be loaded directly into railroad cars over a spiral chute or into the mixing conveyor. A collecting hopper beneath the classifying screens gathers water and minus ⅜-inch coal, from which hopper they are moved by gravity to a battery of two groups of three dewatering screens in series. Each screen has a single deck 4 feet by 5 feet set at about 3° downhill. These screens are made up of grass wedge wire mounted on a frame which is vibrated by an eccentric at the rate of about 1,500 r.p.m. The screens have openings of ½-mm and through them water and minus 48-m material is removed. The remainder, ⅜-inch by 48-m, is discharged directly from the dewatering screens into the mixing conveyor.

Water and 48-m coal is collected in a gathering hopper beneath the dewatering screens and flows by gravity to an 18-foot steel conical pump sump. A horizontal centrifugal pump capable of pumping 3,000 g.p.m. against a static head of 55 feet throws the liquid up into a 45-foot diameter conical settling cone. In this cone the slurry is allowed to settle out and the clarified water runs by gravity back to the washer. Slurry which settles out is pumped directly to the sludge pond and wasted. Slurry may be recovered if desired by pumping it back to the dewatering screens.

The mixing conveyor is a 36-inch by 10-inch flight conveyor on 116-foot centers, horizontal except for a 9-foot rise at the lump crusher. The conveyor permits progressive mixing of any or all sizes, whether washed or raw, for loading on any track. It will also carry all sizes to a single-roll 30-inch by 54-inch crusher for reduction to 2-inch. The crusher discharges into the bottom run of the mixing conveyor, in which it is returned for loading or for delivery into the gravity-discharge elevator conveyor for recirculation over the r.o.m. shaker screens.

A refuse and bone coal conveyor, having two compartments in the upper trough, carries refuse from the washer and picking tables to the refuse bin in one compartment. In the other, bone coal from the picking tables is transported to a 30-inch by 36-inch single roll crusher. The bottom run returns the crushings and discharges them through a rack-and-pinion gate into the G-D elevator for recirculation to the main shakers.

If for any reason it is not desired to use the washer, the material usually going to it may be diverted directly to the classifying screens by means of the by-pass conveyor. Obviously, in such an event the minus ⅜-inch coal must be removed by the vibrating screens. A spray box normally used for washing fines from the washed coal passing over the sizing screens may be used to keep down the dust and at the same time keep the gathering hopper free from an accumulation of degradation.

Additional crushing and handling equipment has been ordered but not as yet installed. This will consist of a Williams ring crusher capable of reducing 6-inch lump to minus ¾-inch, and a box car loader for loading on what is at present the run-around track. Provision has been made for the future installation of air-cleaning tables to handle ⅜-inch by 0-inch coal.

A Westinghouse slip-ring motor is used on the run-of-mine belt conveyor. All other motors are Westinghouse high, normal torque or general purpose motors.

Fresh water for the washer is pumped into the settling cone from a nearby surface drainage pond.

In closing, a comparison of specifications and actual performances might be of interest. The overall capacity of the entire plant is rated at 400 t.p.h. It is doubtful if the plant has ever handled a *smaller* amount than this since coal was first brought up the run-of-mine belt. The washer box, which, incidentally, is the largest single box of its kind in the world, was designed to handle 175 t.p.h. Repeated tests on the raw coal conveyor show that coal is being fed to the washer at rates averaging about 250 t.p.h. and at times reaching 300 t.p.h. In spite of handling this great overload, the washer is turning out a cleaned coal which is exceptionally free from undesirable material and a refuse in which the percentage of material which would float at 1.50 is very low. The average ash content of 3-inch by 0-inch raw coal is slightly over 18 per cent. Analyses of the washed product have shown that the ash has been reduced almost to the amount of ash inherent in the coal at a 1.50 gravity. In one instance, it was necessary to add ⅜-inch by 0-inch raw slack because a customer registered the complaint that the washed coal he had purchased was so low in ash as to endanger his grates. The moisture content of dewatered ⅜-inch slack is low enough to reduce to a minimum the possibility of coal freezing in cars in the winter.

MODERN TRUCK HAULAGE IN STRIP MINES

By L. RUSSELL KELCE
Vice President, Hume-Sinclair Coal Company

When strip mining of coal was first begun it was the farmer who produced it from outcroppings on his or neighboring farms, and it was only natural that he use wagons pulled by horses or mules to transport the coal to market. Then as time went on mining men became interested and they installed strip mines which were mechanized to the extent of small excavating machines for removing the overburden and used small mine cars like those used in their underground mines and pulled them in trips with mine mules to their crude preparation plants. This small investment proved that stripping of coal was successful as well as profitable.

The next step was to find some way to increase the capacity of their stripping units and to strip greater depths and harder overburden, which would increase the amount of tonnage available at their locations, so the evolution of mechanized strip mining began and has advanced at a very rapid pace until today it is a large industry producing now in excess of 22,000,000 tons per annum. As time has marched on in this rather new industry you can now find some very modern and highly mechanized plants, as much so, as you will find in any industry.

The excavating units of today are outstanding in engineering and performance and we, who spend our time operating these modern units, look with pride upon the wonderful improvements that we now have, compared to a few short years ago. The old adage "that the bigger they are the harder they fall" has not been true with these bigger machines as our records show us that these present machines weighing 2½ million pounds don't fail nearly as often or as seriously as the smaller machines of yesterday.

The foregoing remarks appear to be a detour from the caption of this paper, but in fact they are very much related, as our stripping units absolutely control the balance of our operations; that is, we cannot load, haul, prepare, or sell our coal unless it is uncovered. The amount of coal we uncover determines the capacity of all the other units to keep in step and if we did not have the large excavating units that we have today it would not be advisable for me to give this paper, as the production would be so small that no one would be interested.

At the beginning of this article I made some mention of haulage and its beginning with wagons and then small mine cars pulled by pit mules, then I followed with excavating machines and their remarkable advances in removing the overburden, and I don't want you to think that haulage did not progress just as rapidly, but I do want to bring out that the method in which it did advance was a great deal more varied than in the case of the excavator; that is to say, there were more different opinions as to the method that should be used and there still are today. Although our companies are operating 100 per cent truck haulage at this time, we don't say nor think that all other types and kinds of haulage are wrong as we feel that each and every mine has a different problem and should adopt the method that is most advantageous to its conditions, and in some instances truck haulage would not be feasible or practical and some other method should be used.

The haulage of strip coal from the pit to the preparation plant has developed from the wagons and small mine cars of one and two ton capacities, then to five ton cars pulled by small narrow gauge steam locomotives on up to 40 and 50 ton standard gauge cars and large locomotives.

Our companies went through this entire cycle and felt that our system at the time was the best for our plants, until in June, 1932, we decided to install a new strip mine in Northern Missouri where the body of coal was four miles from the railroad with a series of steep hills lying between, and we were confronted with a very difficult problem of transportation. After many surveys, we came to the conclusion that we would try hauling this coal by trucks and trailers to a tipple located on the main line of the railroad. We had great difficulty in obtaining any accurate figures on a system of this kind as there were very few truck operated strip mines and most of these were operating with individual contractors with one or two trucks on a per ton basis, and none of them seemed to know what it did cost. We gathered all of the information we could from the truck manufacturers and purchased seven 2-ton medium priced trucks, each to pull a 6-ton semi-trailer with automatic doors in the bottom to dump the load, which idea was taken from our large mine cars. We then built our roads of burnt mine shale as a base and covered them with 4 inches of crushed rock or gravel, keeping our grades to a maximum of 8 per cent on short hills and 5 per cent on long grades. At first we experienced the usual experimental disappointments and as we look back over those first few months of the operation of those trucks, I feel sure had it been possible for us to quit these trucks and go to some other system, we would have done so, but necessity forced us to keep on and as the days went on our roads improved, our employes became educated to the art of driving and maintaining these units and after 90 days of use we found that we had attained the costs and production that we had planned and estimated. The improvement kept on and after six months of experience we pointed to our so called experiment with pride. We began to notice that there were a lot of advantages to this system over the rail and car practice. No longer were our stripping and loading units located on the end of a "Jerk-Water" railroad that ran only when there was revenue traffic and the only other means of travel in bad weather between our tipple and mine was human-endurance, but we now had paved highways to each and every pit; our employes drove their cars to their place of work and arrived there on time and fresh. In bad weather they would save almost an hour a day going and coming to work.

We increased our supervision due to accessibility over the rail system; we built a travelling machine shop on a truck and in case of an emergency repair job it was only minutes until the mechanics and their tools arrived. The fast and dependable highway might even save lives when medical care is very urgent; automobiles are always available wherever and whenever men are working and doctors and the hospital are only minutes away. All of us know what that means.

The 6-ton semi-trailer unit that we first used was our first guess as to a proper capacity unit, and when these were in operation regularly, we began to wonder why larger units would not be better, so we purchased a 17-ton semi-trailer unit, using a tandem axle to carry the load. This unit weighed empty approximately 13,800 pounds and loaded, 47,800 pounds. We purchased a 7½-ton tractor truck weighing approximately 12,200 pounds, making a gross load of 60,000 pounds. This unit was objectionable in its turning radius and we experienced some trouble in maneuvering in the pit. Also, the amount of dead weight compared to the pay load, we thought, was too great, being 26,000 pounds dead weight for 34,000 pounds of pay load, or 1-ton of dead weight for 2,615 pounds of pay load. Our next experiment was a 15-ton pay load semi-trailer unit of a single axle design. This trailer weighed 10,800 pounds light and 40,800 pounds loaded, pulled by the same size unit weighing 12,200 pounds, making a gross load of 53,000 pounds, or 23,000 pounds dead weight for 30,000 pounds of pay load, which was 1-ton dead weight for 2,609 pounds of pay load. These units proved to be very satisfactory in that the over all wheel base was cut down, allowing short turning in the pit without skidding the rear wheels, which is done with a tandem axle unit. However, we were still interested in less dead weight per ton of pay load and we purchased an aluminum trailer of 20-tons capacity with a single axle, that weighed only 8,000 pounds empty and 48,000 pounds loaded, pulled by the same type tractor truck weighing 12,200 pounds, making a gross load of 60,200 pounds, which figures dead weight 20,200 pounds and a pay load of 40,000 pounds, or a ratio of approximately 1-ton dead weight to 2 tons of pay load, which was the mark we had hoped to reach. This unit caused us some trouble due to failures of the aluminum, which we don't feel was the fault of the material as much as the design, and we are now considering a new aluminum unit of the same capacity, which we feel sure will stand up.

Our companies are now operating the following semi-trailer units:

6—6-ton	36
2—10-ton	20
4—12-ton	48
20—15-ton	300
1—17-ton	17
1—20-ton	20
—	——

34 units with 441 tons of capacity.

Our expected tonnage to be transported by these units for the year 1935, is 1,625,000 tons, and the total miles to be travelled will be 488,446 miles for 118,590 trips—an average of 4.12 miles and 13.7 tons per trip. This is all based on the total average and varies on length of round trip haul from 2 miles to 8 miles, divided into 5 mines operating in Oklahoma, Kansas, Misouri, and Illinois. Each mine has different conditions, the seam of coal varying from 17 inches to 52 inches. Some have a rock bottom under the coal, which is a great advantage for truck haulage; others a soft fire clay, which is too soft for a road and a bench of coal must be left for a road, which coal is recovered on the next pit.

I am reciting all of the above to acquaint you with the different problems that we have, and to show that our experience does not restrict us to one mine and one condition, and we feel that each and every mine has saved money over the railway system of haulage. Not always does it show up in a direct comparison of our haulage costs, but reflects it in our loading costs, due to the increased tonnage loaded per hour and the uniform tonnage per hour. This is due to several reasons, one being that an accident to a haulage unit means only a decrease in your tonnage per hour in the per cent that that one unit bears to all the units, and if an additional stand-by unit is carried, the only loss is the time in going to the garage, starting the extra unit and placing it in service, which requires only a few minutes. Another advantage over rail and car haulage is in the extreme cold weather when the sales office calls up and wants to know how much coal can be given them that day. If you are using locomotives and cars you will say "Well, it sure is cold down here this morning; we had to cut down our cars per trip from 10 to 8; the rails are full of frost, and the switches are freezing on us; I don't suppose you had better figure on nearly as many cars as we got yesterday." The sales manager is greatly disappointed and so are you, but it is a fact and must be faced. However, with truck haulage, the trucks and trailers have been in a steam heated garage all night and out they go at starting time; all of the wheel bearings are Timken or roller bearings, the grease is warm and because it is extremely cold your roads are frozen as hard as concrete and your tonnage will be just as great as yesterday and probably greater. This pleases the sales manager and you, the customer who got his order filled that day, and the directors who look over the operating statement at the end of the month.

The stripping efficiency is usually increased by truck haulage because the loading and haulage units are divorced from the stripping much more than they were. The large shovel doesn't have to wait until the loading track is taken up ahead of it, or carry its dirt over the truck for 24 hours per day. Also, we find it helps the tipple in that the flow of coal to the hopper is uniform and is brought there in approximately 15-ton amounts at short intervals, whereas the rail system brought 200 or 300 tons at a trip at long intervals. This keeps the tipple running steadily at a uniform feed. All of these items are helpful to the operation and, as stated above, bring about savings to the other units and result in a net saving per ton on the coal loaded and tippled although it may not show up on your haulage costs.

To actually give a basis to use for figuring future haulage costs, is almost impossible as each and every mine will be a separate problem, and to take a mine that has an average haul of one mile and use that as a basis for four miles is wrong in that even though you increase the length of haul four times, you would not increase your cost in that proportion; in fact, our experience has taught us that it won't even double it; neither do you need four times as much equipment because it must be remembered that regardless of the length of the haul, you have in each instance the same things to do; that is, load the unit, start it, come out of the pit, travel on your main haulage road, slow down at the hopper and dump it. The only difference between one mile and 10 miles is the length of main line road.

which is travelled at the highest speed. Your grades and the time that it takes to load, which is governed by the thickness of the coal seam and the size of the loader, have a decided bearing on the amount of coal you will transport per unit, as well as the distance you must travel.

Another reason for the inability to furnish an accurate basis for figuring costs is that we have not had enough experience, and we feel that we are still experimenting and that there will be still further improvements in types of trucks and trailers.

One company in Indiana has tried out with very satisfactory results the use of a tractor-truck with one full trailer and one semi-trailer all as one unit.

The proper size of the units for truck haulage has not been definitely determined. The use of Diesel trucks is a possibility, and all of we coal men must not overlook the possibilities of the Sentinal steam truck, which at the present time is manufactured in England and uses coal for fuel.

I fully realize that the strip coal mining men who are here would like to be given some idea as to costs even though it might not be a figure which would be used for your operation and for that reason I will give you the following data taken from our MARK TWAIN mine located in Northern Missouri. The Geological Seams worked at this mine are the Bevier and the Mulkey. These two seams lie approximately 13 feet apart and the Mulkey is the upper, averaging in thickness approximately 12 inches. The Bevier Seam has a total thickness of 50 inches, which includes a five-inch middle band 12 inches from the bottom. This requires separate loading and results in the loading of three seams of coal, the Mulkey, the upper part of the Bevier and the lower part of the Bevier, which makes a very complicated problem; together with this, all of the coal that we load must be transported approximately four miles to the preparation plant over a good gravel and oiled road, but winding up and down over the hills. It is necessary for us to use all of the gears in the transmission, varying our speed from a few miles per hour to the governed speed of 30 miles. The final approach to the hopper is a grade that rises 72 feet in a distance of 1,400 feet, making slightly more than five per cent. Of course, the return trip is made at high governed speed. With all of these difficulties this mine had an actual operating cost as shown in the accompanying table.

	Per Ton	*Per Mile*
Machine Shop Expense	.0028	.0044
Repair Labor	.0056	.0087
Repair Materials	.0072	.0113
Gasoline	.0170	.0265
Oil and Grease	.0039	.0061
Tires	.0164	.0256
Drivers, Road Labor & Supervision	.0405	.0631
Insurance	.0027	.0042
Total	.0961	.1499

This figure reduced to a ton-mile figure, using the round-trip mileage against the total tons of coal hauled, equals $.0128 per ton-mile. This figure would increase if the length of the haul decreased and would decrease if the haul were lengthened. All of these figures are before interest and depreciation and are taken over a period of one year with a total haulage investment of approximately $90,000.00, which is made up as follows:

8 15-ton Semi-Trailer Units with Truck .... 3 6-ton Semi-Trailer Units with Truck	$55,800.00
1 Road Maintainer and Tractor	4,000.00
1 Garage and Equipment........	2,500.00
4 miles of main line roads and necessary gathering roads (approx.)	28,000.00
	$89,300.00

With the above equipment this mine produced approximately 350,000 tons of coal and the lost time delays caused by trucks or trailers was 55/100 of one per cent.

We are figuring our depreciation on the basis of 100,000 miles per unit, which at this mine will be about four years. Our roads are depreciated over the life of the property, as we find that with proper maintenance, which is charged to expense, these roads improve with age. We maintain a definite and strict rule as to inspection and maintenance of all our units. Each day a unit is operated a daily report must be filled out by the driver, showing the number of trips, miles traveled, all delays and information as to the mechanical operation of his unit. Also, the service man turns in a daily report, showing what service the unit was given. This is not left entirely up to him, but he has certain printed instructions to follow, and furthermore he is to report to the maintenance man any mechanical defect. We also have a 3-day, a 10-day, and a 30-day report to cover these parts of the unit which do not require daily inspection or servicing.

There is a major item which I have not spoken of which deserves careful thought. This is the selection of equipment. In our opinion, the type of tractor used in urban and interurban highway hauling, for instance, is not always suitable for our work. In most cases the cubical displacement of the motor is much too small and the motor RPM too high.

This is a rough sketch of what our companies have found out from the school of experience even though we feel that we are still in our freshman year and that there is plenty ahead for us to learn.

There are possibly many details concerning the operation of these trucks which you would like to discuss with us, and we shall be pleased to try to answer any and all questions, either here or by correspondence. Better still, come out to our operations and make any investigations that you care to make. You will always be welcome and we'll never be too busy to show you around.

DISCUSSION ON MODERN TRUCK HAULAGE IN STRIP MINES

By C. W. WOOSLEY
General Superintendent, Pyramid Coal Co.

I feel that Mr. Kelce should be complimented on his fine paper, which has proved very interesting, especially to those of us having or contemplating the same method of haulage. I have listened with much interest to his remarks, realizing they are based on actual experience. He has well covered the experimentations to date and any further remarks might merely be a repetition. I have, therefore, in mind dealing only briefly from the practical knowledge we have obtained from our limited experience.

After much consideration, we decided on trucks in one of our pits. Realizing the fact that it was a venture on which we had very little data, we visited the Huntsville property of the Sinclair Coal Co. They very kindly gave us every consideration and first hand knowledge of costs and also their recommendations with references to the size of equipment. The result of our investigation was the purchasing of five large tractors, and a corresponding number of semi-trailers with automatic drop bottoms, designed to carry 16 tons.

To anyone considering truck haulage, I believe the most essential things to be considered are the size of the tractors and trucks, and the kind of road to construct. Both of these will be governed a great deal by the available tonnage to be mined, also the estimated daily output. With reference to the roads, they must be able to withstand the heavy loads at a fairly high rate of speed, with the idea in mind that as soon as the pit is completed the road would be of no value, whereas trucks will be be moved to some other point of operation.

I think it will be of value to all interested in this method of transporting coal, to give you the result of some of the mistakes we made. Soon after we placed our trucks in service, we immediately became over-zealous and began to put more coal on each unit than the marked capacity, and also to run them faster in order to eliminate the use of a truck and secure greater performance per unit. We placed sideboards on the trailers and were hauling in excess of 18 tons per load. It was not long before we began to experience trouble with our tires, also the overload springs on the trailers began to break and we were continually replacing them. The problem became of a serious nature. The answer and solution was the use of an additional unit, less tons per trip and a reduction in the rate of speed the trucks travel. Since that time we have had practically no delays accountable to either truck or trailer, and have reduced our haulage cost.

We know, as has been stated, that truck haulage in strip pits is still in its infancy and no doubt the future will see quite a number of changes over the methods of today.

We do not yet know the capacity to which we may profitably advance. Trucks of much greater capacity may not be feasible. We do know this has yet to be determined.

Probably the greatest advancement at the present time would be the speeding upon of the coal from the loading shovel to the main road, as the travel in the pit, due to the unevenness of the coal causes most of the time lost enroute. The answer to this I do not have at the present time. However, there were several different methods under consideration, and I feel sure that in the near future much of this lost time will be eliminated.

In comparing truck haulage with steam, we find the former has the advantage of the following items:

First: It is a cheaper method of handling coal.

Second: It permits the stripping of small isolated areas previously prohibitive because of the capital investment necessary to installing railroad tracks.

Third: It is especially adapted to the removal of coal at the end of the pits and also the berm or last cut in an abandoned or worked out pit.

Fourth: The failure of a single unit does not suspend the entire production of a mine, as many times is the case where rail haulage is employed.

Fifth: Operation of rail haulage involves more possibilities for personal injuries to employes.

Sixth: Trucks can be operated efficiently in all kinds of weather, while sometimes cold weather makes the operation of steam railways difficult.

As I previously mentioned, our truck experience is very limited, but I assure you that our entire organization will be more than glad to discuss any problems with you, hoping that we may be of some assistance and realizing thoughts you have in mind no doubt will be of mutual benefit.

EUROPEAN METHODS AS APPLICABLE TO UNITED STATES PRODUCTION

By DR. L. E. YOUNG
Vice President, Pittsburgh Coal Company

These comments on European bituminous coal mining methods will be based on observation made on a brief inspection trip during the fall of 1934. The mines visited were located in England, Scotland, France, Holland, and the Ruhr and Saar Districts of Germany.

In the limited time available, underground inspections were made only in those mines where the seam conditions were more or less comparable to those prevailing in the Pittsburgh district, where underground conveyors were used, and where rigid supports were used at the working faces.

I visited 18 mining plants, and was underground at the face in 13—three in Scotland, three in England, one in Holland, two in the Ruhr District, three in the Saar District, one in the North of France. At all of them, except one mine in England, longwall was being used, and I saw conveyors at work in all of them.

It is not to be understood that any one of these mines visited was a representative mine—possibly some of them are representative of the district in which they are located. Usually, each one had been selected for me because in it I could see a particular type of equipment, or a special or standard method of roof control.

The American operator visiting European bituminous coal mines for the first time is impressed by the extensive surface plants, the fine, permanent buildings, including tipples, head frames, engine houses, offices for all classes of officials, wash houses, canteens, etc. He notes the small mine cars, the large gob piles, the large power plants at many of the mines, and quite frequently he finds large coke and gas plants in connection with the mines. He is impressed by the multiple-deck cages, and the ingenious and efficient caging devices.

The use of steep for supporting shaft bottoms and main roads, and in many instances its extensive use at the face, is a revelation to the American operator. In Britain particularly there has been a substantial reduction in the expenditure for mine timber—at some mines the combined cost of timber and replacement of steel props being less than half the previous cost of timber alone. Formerly Britain used one ton of timber for 65-70 tons of coal produced, whereas we in the Pittsburgh district have been producing 350 tons of coal per ton of timber. According to official reports, 1,800 miles of the 20,000 miles of roadway in British mines are supported by steel arches, and over 900,000 steel props are in use. It is estimated that there are 600,000 tons of steel arches, 16,000 tons of steel props, and about 1,600 tons of steel straps in the mines of Great Britain now. Eleven percent of this steel underground must be reconditioned or scrapped annually.

In British mines there is much rope haulage, and, as the mine cars are narrow, many of the main haulage roads are double-tracked, with no clearance between passing trips.

On the continent many Diesel locomotives are in use in gassy mines. This type of locomotive has been used underground in Europe for 35 years in coal mines. The Departments of Mines of Germany, Holland, France and Belgium have approved the use of such locomotives, and it is claimed they are cheaper, both as to first cost and operation, when compared with storage battery or compressed-air locomotives.

The common type of locomotive in use is equipped with a horizontal, single cylinder, four-cycle engine, which can be run on crude fuel oil, gas oil, lignite tar oil, and most of the vegetable oils obtainable in the tropics. It is of simple, robust construction, practically smokeless and noiseless, and, on account of its small consumption of cheap-grade fuel, and simple and easy control, provides an ideal power unit for rail traction.

The working principle of the engine is such that back-firing and/or emission of flame from the inlet air valve cannot possibly occur. An air filter is provided to trap the dust from the air drawn in through the inlet valve. The exhaust gases, after passing the exhaust valve, are subjected to and cooled by a water spray, and then passed through a gravel filter and multi-fold, flame-proof screen of rustless steel wire. The water spray is maintained by a pump driven directly by the engine. Starting is effected by compressed air from a compressed-air storage cylinder charged by the engine. The valve connections are so arranged that excessive pressure cannot be developed in the cylinder.

At a number mines visited the electrical equipment used underground was operated by alternating current. It is very interesting to note the portable switchboards and transformers, which are kept comparatively close to the working face.

Much riveted steep pipe, of various diameters up to 30 inches, was found in use for conducting the air to the working face. Instead of requiring a fixed amount of air per man at the face, regulations prescribed by the governments usually provide for the quality of the air, as to its content of carbon dioxide, oxygen, and methane.

In Germany particularly, a great many air picks are used to mine the coal, and in one mine in the Ruhr I saw 90 face-men, each with an air pick, loosening coal and loading it onto one face conveyor. According to the latest figures available, more than 90,000 air picks are in use in Germany. In the north of France in 1933 (production 20,000,000 tons) there were more than 31,000 air picks in use on coal, and 8,000 air drills. There were only 10 cutting-machines in use in the district.

The electric cutting-machines observed were generally of the longwall type. By using a longwall cutting-machine, requiring three feet to three feet six inches clearance, it is possible to keep a row of props within three feet six inches of the face. As the coal is being undercut it is the practice to take extra pains to block the coal, and generally the roof; in the deep mines, unless rigid support is placed immediately after cutting, it is almost impossible to remove the row of supports along the gob line.

In some of the mines visited material was brought from the surface for filling the gob. In one mine material was gobbed mechanically; in several pneumatically; in many of the mines which use filling, the material is placed hydraulically. In the north of France one district used 8,400,000 cubic meters of material taken from the surface, for packing in 1933.

The use of conveyors has been increasing very rapidly in Europe. In Britain the tonnage handled by conveyors in 1933 was 62,000,000, which was two and one-half times as much as in 1928. The last official British report (1933) shows 3,717 coal-face conveyors, 1,039 gate conveyors, and 564 gate-end loaders.

At an English mine when I commented on the large expenditure which was being made on a conveyor loading station, I was told that the loading head would be in service at the point for 12 years, and would handle 2,500,000 tons during its location at that point.

At a mine near Sheffield there was one straight face 2,700 feet long, and on it were three pairs of face belts, each belt 450 feet long, discharging to so-called gate-loaders; these face belts were advanced daily. This means concentration, coordination, well trained workmen, and splendid supervision.

In the Sheffield district I saw in several offices of operating officials, small black boards on which were entered, hourly, the number of cars loaded at each important loading head in the mine. These bulletins showed also the production on each of the preceding shifts during the 24-hour period. The flow of coal from each producing unit was reported by telephone from each loading head, and there was evidence that the organization was highly efficient.

At a mine in the Saar I was given a chart showing the detailed schedule for a section, for men going to work during the 24 hours of the day, in order to main long faces in production; there were 14 starting times, and the schedule covered 21 classifications of labor. On the cycle there were 264 men employed with a production of 1,250 tons.

The number of working places in the well-managed European mines has been reduced greately in recent years. An official report in 1934 for the Ruhr, states that they are now using about 30 percent as many working places as in 1927 for equal annual tonnage; the average daily output has therefore been trebled. The Germans are suggesting advancing long faces at the rate of 14 and three-quarter feet in a day of three working shifts.

The International Labor Office at Geneva has published some very interesting data for Great Britain, the Netherlands, the Ruhr, the Saar, France, Belgium, Czechoslovakia, and Poland, showing annual earnings of miners, average labor costs, average output per worker. The essential facts are shown on accompanying charts.

Permit me to suggest that we, as operators and engineers, may well examine European methods, equipment, and practice as to the following:

1—Multiple-shift operations and the scheduling of work.

2—Concentration of production on long or stepped faces.

3—The use of conveyors of various types.

4—The use of Diesel locomotives in gassy mines.

5—Use of alternating current underground.

6—Qualitative rather than quantitative ventilation at the face.

7—Use of steep pipe for conducting air to the face.

8—Use of steel for roof support.

9—Analysis of roof movement along break lines.

It is not my thought that we should attempt to adopt any of the European practices completely as standard, but undoubtedly for some of our conditions European methods can be adapted safely and economically.

Presented at Indiana Coal Mining Institute, June 22, 1935.

POWER AND ENERGY AT THE COAL MINE

By PROF. C. C. KNIPMEYER
Rose Polytechnic Institute

The industrial attainments and economic progress of a community can very logically be measured by the extent of its power applications. It has frequently been pointed out that the wealth, prosperity and economic strength of nations follow in the order of the use of power in these nations. Backward countries invariably have few and crude power applications. Progressive countries apply power, electrical or mechanical, in every kind of industry and muscular power requirements are reduced to a minimum.

Muscular energy costs are at day labor rates, which are quite familiar to us all. A sturdy man of considerable vigor and endurance, turning a crank or lifting loads, can work steadily all day long at a rate not to exceed one-eighth horsepower, and do one horse-power-hour of work per day. In electrical terms, he would work at a rate of less than one-tenth of a kilowatt and in an eight-hour day do about three-quarters of a kilowatt hour of work. His muscular efforts, then, purely as muscular energy, are worth only one or two cents per day. Herein lies the great economic advantage of machine power. When it is realized that a small ten horse-power electric motor supplies the power of eighty men and uses only seventy-five cents to two dollars worth of electric energy per day, then an appreciation of the economic advantage of machine power is forcefully felt. To put it very simply; human muscular energy costs from one hundred to five hundred times as much as electrical energy.

It is this low-rate cost of electrical energy which gives enormous economic advantage to those who apply electricity to power needs. We quickly accept these applications without full appreciation of their value, taking them as a matter of course and, in failing to realize our blessings, use them extravagantly and grumble because these blessings are not even greater than we find them.

There is perhaps as much complaint about electricity bills as about the weather. Our complaints about the weather are generally quite misdirected, and do not reach headquarters where weather presumably is controlled. Our complaints about electricity bills are generally aimed directly or indirectly at the power company. We are inclined to feel that if the power producer gave us fair treatment then the whole trouble would be cleared away.

If the rates of the power producer are too high, either he is making too much profit or he has inefficient production. It is the business of the national and state governments to regulate utility profits through adjustment of rates based upon a study of the producer's books, and it is the power producer's business to operate his power plant efficiently. It cannot be said today that the power producer is making excess profits and, speaking generally, it cannot be said that his large plants are inefficient. More efficient plants will be built in the future, but we cannot fairly complain of the steady progress that has been made in the past and is being applied at the present.

Instead of complaining over electricity bills on the basis of rates and dropping the problem when we are convinced that we have the lowest rates available as fixed for the producer by the Public Service Commission, we should make a careful study of all the power consuming machines in the plant or mine and all the conditions concerning their operation that might affect electrical consumption. It is indeed important that we see to it that we get the lowest possible rate in cents per kilowatt-hour, but it is quite as important that we reduce to the lowest possible figure the kilowatt-hour consumption per ton of coal mined. Both figures are involved in that final and most important figure of electrical cost per ton output.

An electrical power contract very properly includes (1) a tapering rate per kilowatt-hour, (2) a demand charge introduced directly or through a load factor feature and (3) a power factor clause. The tapering rate is proper because the greater the consumption the lower the price which the consumer should have to pay and which the producer needs to receive to give a fair return. The demand charge, however introduced, is proper because the producer must have power plant, transmission line and transformer capacities all to supply the large demand. In other words it is more expensive to take care of a consumer who makes large power demands for limited periods than one who has moderate power demands but carries a steady load. Also a power factor feature is logical because with low power factor the extra current, which contributes nothing to power, reduces generator, transmission line and transformer capacities, it increases power losses for the producer as well as for the consumer and it adversely affects voltages. It is therefore proper to reward customers with high power factor loads and to penalize those with low power factor loads.

Whatever can be done to reduce power demand can be done very simply after all power economies have been accomplished. The problem then consists of doing what is possible to avoid bunching of loads, in other words; taking some loads off the peaks and putting them on at other periods. Night cutting reduces day peaks, the use of storage battery locomotives charged at night instead of trolley locomotives avoids day peaks, a trolley locomotive haulage schedule which will prevent two heavy pulls at the same time is a great help, and the operation of pumps at night is good.

Power factor improvement also is a simple matter where part of the load consists of synchronous motors or synchronous converters or both. Increased field excitation of these machines with due regard to the loads they carry and to their operating characteristics will make them take leading currents in sufficient amount to neutralize the lagging currents taken by induction motors and thus bring the power factor up toward one hundred per cent. A synchronous motor applied to a fan makes an ideal corrector of power factor for the customer, because it operates twenty-four hours per day at the correction duty. Where correction by synchronous machines cannot be fully carried out and the power factor reward is sufficiently attractive, capacitors or static condensers may well be recommended. Advance in the art of capacitor manufacture has been so great in recent years and costs so much reduced that in many cases they will pay for themselves in six months' time.

Through reduction of K.W. demand and increase in power factor we have simple means for securing some reduction in the power bill. But the most promising possibilities for reducing costs lie in actual economies in K.W.H. consumption. Incidentally, such economies in K.W.H. also reduce the K.W. demand. If an intelligent and honest effort is made there is hardly a place about the mine where energy is consumed that economies cannot be made with little trouble and expense.

The ventilation of the mine is generally accomplished only by a large expenditure of energy. The fan is a heavy, steady load, applied twenty-four hours per day, every day of the year. Its total K.W.H. consumption per month or per year is far greater than generally realized. The fan makes little fuss and the air flows smoothly and noiselessly. It seems so easy to move air. But if a K.W.H. meter were applied to an electrically driven fan or a steam flowmeter to a steam driven fan, in most cases the mine operator would be treated to a surprise and a shock.

A certain ventilation job requires a certain flow of air in cubic feet per second and a certain pressure, usually measured in inches of water to produce that flow. Just any fan will not fit those requirements any more than just any shoe will fit your foot. Under favorable conditions a well designed fan can operate at seventy-five per cent efficiency Under unfavorable conditions the same fan may operate at only half that efficiency and many mine fans are so operating today.

The efficiency of a fan is the per cent of the driving power given to it which the fan actually delivers to the air which it discharges. This power given to the air is computed from the flow of air in cubic feet per second and the pressure at which the flow takes place. Imagine a fan with perfectly shaped or streamlined housing and blades and having all surfaces absolutely without friction, taking the air in gently and smoothly with no swirls or eddies or blow-back, and having that air pass through and out just as smoothly and free from disturbance. Here you have a fan approaching perfection. But large changes in the speed for which it is designed or in the amount of pressure of air it must supply may find it far from perfect. An accurate efficiency test of power input and air power output is easily made with proper instruments and should be made in every installation, as a valuable check on a high cost feature of the average mine.

We are today receiving much education on automobile streamlining. That education should help us understand more clearly the problem of air flow in mines. The laws of variation between fan speed, fan power, volume of flow, velocity of flow, pressure and resistance are not entirely simple and they have special application for each individual case. It is possible to make a very complete and accurate survey of the air system in a mine with a sensitive barometer, anemometer, water gauge and electrical instruments, which will give complete data on the resistance and load at every part of the air system. Such a survey will give the horse-power required in each part separately, even to such details as a sharp turn or an overcast. From such a survey accurate deductions can be made as to the possibility and feasibility of reducing loads and losses in various parts of the air system. Every horse-power of fan load costs roughly ten dollars per month in energy and every horse-power of air resistance load in the mine costs twice that amount per month. To know that a poorly designed overcast is costing ten dollars per month in energy, a certain sharp turn, five dollars per month, an easily relieved choke, five dollars per month, the rough surface of an air shaft twenty dollars per month or dirt in an air course resulting from falls, thirty dollars per month is almost sure to result in the application of proper corrective measures. Guess work in these matters is no longer necessary. Precise data can be obtained on fan operation and on the distribution of load on all parts of the air system. From these data very definite determination can be made as to what corrections are justified by comparing costs against savings. Often air load reductions will reflect back upon a greatly overloaded fan and increase fan efficiency. In fact a reduction of one horse-power in air load will reduce power delivered to fan by two or even three horse-power when the fan is overloaded and operates at very low efficiency. In this connection it should be remembered that it is better to get more air by reducing air resistance than by increasing fan speed.

A careful study of hoisting conditions will usually disclose possibilities of energy saving. Whether the hoist is steam or electric an easy control of power and brake increases efficiency of operation, and a higher natural speed of hoist than the mine requires reduces efficiency. A hoist steam engine having no cut-off and more reserve power than necessary will take less steam if the travel of the reversing link is reduced.

A slip-ring induction motor hoist should not only have the proper amount of secondary grid resistance but this resistance should be properly spaced between contactors. Testing motor input with a graphic wattmeter having a high speed chart will allow intelligent adjustment of this resistance with the utmost nicety to give smooth acceleration and minimum energy consumption on the start. A little energy saving on the start multiplied by the large number of starts per month will give a large figure.

Electric haulage generally contributes considerably to the power bill, and often is carried in a wasteful fashion. Locomotives with a top speed higher than needed are extremely wasteful of energy because the operator will have to run too much of the time on resistance or with brakes applied. Smaller wheels, a change in gear reduction or even a change in field coils will reduce full speed. A single motored locomotive is always wasteful of energy because it has only one efficient running point, namely: top speed, while a two motor locomotive has two efficient running points with all grid resistance out, namely: half speed with motors in series and full speed with motors in parallel. On the two-motor locomotives the controller should be so notched as to fall most easily into these two efficient running positions and the operator should understand that the other positions introduce resistance in which electrical energy is wasted and are to be used as little as possible. Many motormen, finding that they have easier and smoother operation and sometimes better traction by keeping brakes on much of the time while motor is pulling, will be guilty of carrying on this wasteful practice. This may become a serious loss.

Fortunately for haulage economies, low bearing friction is usually maintained in mine cars. But it is a sorry fact that not all persons in responsible charge understand how greatly the haulage load is increased by dirt on rails. By hand-pushing a single empty car first over clean rails and then over the same rails dirty should convince anybody that dirty rails can seriously run up power bills.

One of the greatest economic crimes about a coal mine is the charging of one hundred volt storage batteries independently from a two hundred fifty volt supply. This practice wastes sixty per cent of the electrical energy in the charging resistance. By charging two batteries in series only twenty per cent is lost in resistance and the two batteries are charged as cheaply as one. The practicability of series charging has been successfully demonstrated. To be sure, it may require a little more judgment, intelligence and care on the part of the man who does the charging, but, considering the high cost of batteries, and the degree to which their life can be shortened by improper treatment, they should never be in the hands of incompetent men.

It is quite safe to assert that many cutting machines consume in a certain cutting operation twice the electrical energy they should consume. Dull bits not only make slower progress but they drag harder. If they go fifty per cent slower and drag fifty per cent harder the cut will take one hundred twenty-five per cent more electrical energy. It is appallingly false economy to do without expert bit-tempering and sharpening at any mine. Cutting machines often drag heavily not only because of dull bits but also because of unnecessary friction on cutter chain and other parts. These losses are not trifles and they should have intelligent supervision.

Lifting considerable amounts of water from a deep mine requires much work. Good pumps of proper design will quickly pay for themselves in savings over poor pumps. The cost of pumping is often excessive due to necessity of operating large generator units at times for pumping only. In such cases alternating current motors for pumping should replace direct current motors.

Generally speaking, the greatest possibility of energy saving about a tipple is in keeping bearings clean and well lubricated. Most of the tipple load is friction in bearings and, unless watched, this load can become considerable. In a tipple, dirt works into bearings and lubrication works out very easily. Careful and frequent attention here will not only save energy but save bearings also.

Getting electric current to the point where it is to be used cannot be accomplished without some loss. Even wire absurdly large for the job has some resistance and therefore some loss. For a short transmission distance the wire must be large enough that it will not overheat. For a long run the wire must be large enough that the voltage drop is not excessive. A ten per cent voltage drop means also ten per cent loss in power and energy. Also this ten per cent drop in voltage to lamps reduces the light over thirty per cent and the lamp efficiency twenty per cent. Low voltage reduces the speed of direct current motors and heavily loaded induction motors. It reduces the efficiency and capacity of all motors. It makes them draw more current and makes them more liable to burn out.

The only charge to be placed against copper for transmission is interest on the investment because depreciation is practically nothing. If too much copper is put into a line, then the interest charge is increased more than the value of the energy saved. Too little copper makes the energy loss in the line too high. The total cost of interest and energy is least when the two costs are about equal. Investment in copper is generaliy to be considered a safe and good investment.

An inadequate transmission, besides wasting energy, slows production, discourages machine operators, increases machine repair bills and increases power demand. It should never be tolerated. Fluctuating lights are a sure indication of a poor circuit. Where rails are used for a return, no amount of positive copper will compensate for poor bonding, for current must be gotten back through the bonds or through poor stray paths. Poor circuits are in part responsible for the excessive electrical repairs common to the coal mining industry.

Where electrical consumption and the consequent power bill are as large as at the average mine it is always desirable to know its distribution. Metering of the various loads, hoist, fan, tipple, motor-generators, converters, etc. can be done by special means very cheaply. When this metering is carried out, an analysis of the conditions is quite sure to result in substantial savings, along with improved operation.

Never were high efficiency, good engineering and close economies more vital to the mining industry than now and never before were they so easily accomplished, or their lack so inexcusable.

Presented at meeting of Rocky Mountain Coal Mining Institute, Denver, Colorado, March 18, 19 and 20, 1935.

BENEFITS ACCRUING FROM THE WEARING OF GOGGLES BY UNDERGROUND AND SURFACE EMPLOYES AT PROPERTIES OF THE UNION PACIFIC COAL COMPANY

By V. O. MURRAY

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When I began preparation of this brief article under the title announced, four simple questions presented themselves as the best medium for the discussion, namely:

1. How costly were our eye injuries?
2. Did we want to prevent these eye injuries?
3. How can the eyes of mine and surface workers be saved?
4. What plan was followed?

The following table gives the number of accidents, together with the compensation paid during the nine-year period 1925 to 1933, inclusive:

Year	*Number of Accidents*	*Compensation Paid*
1925	15	$ 3,447.60
1926	25	3,889.69
1927	13	5,197.86
1928	13	323.74
1929	15	255.00
1930	19	3,264.00
1931	14	4,932.02
1932	13	6,211.72
1933	4	1,960.49
9 Years Total....	131	$29,482.12

The small amount of compensation paid in 1928 and 1929 was due to the absence of a major eye injury in either year. The relatively small sum paid in 1933 represents payment for all accidents occurring from January 1st to April 24th, inclusive, after which, with the completion of our sight-protection program, no further accident to eyesight occurred up to the present moment, March 12th, 1935.

From the above, it can readily be learned that compensation paid was rather a material amount, especially when authoritative statisticians tell us that compensation costs are about only one-fourth (¼) of the total cost involved. The other items that should be considered in the actual cost of an accident should probably include hospital and medical attention, loss of wages to the victim, loss to society, etc.

The second question, "Did we want to prevent these eye injuries?" can be easily answered affirmatively, as the primary object of the management was more deeply concerned with the social loss and the suffering resulting from these 131 eye injuries covered by the nine-year period. We know that there are some 15,000 "industrially blind" persons and a much larger number of partially blind as a result of eye injuries. Annually, some 2,000 workers lose the sight of one or both eyes in industrial accidents, and a serious eye injury occurs almost every minute of every day and night throughout every week of the year in our country. In our own particular case, it was imperative that some thought be given to the protection of eye-sight, as the mines were getting deeper, with a corresponding increase of cover, causing the coal to burst and fly in the workers' faces, and, with the advent of mechanization in the mines, such as cutting machines, electric motors, generator sets, trolley locomotives and mechanical loaders of various types, there was an increase of eye hazards in the repairing of these machines in both underground and surface shops.

The third question, "How can the eyes of mine and surface workers be saved?" is naturally and logically answered by, "Why not try the goggle?"

Preparatory to establishing the compulsory use of protective glasses, a careful study of all available glasses and goggles was made, many of the supervisory staff and workmen offering to try out the numerous samples submitted. We had practically decided on two types of goggles for underground use, and another for surface use, but, to make doubly sure that these were the best suited for our conditions, we procured the services of two experienced and prominent safety engineers (one from a large optical company, the other from Union Pacific Railroad Company) to enter the mines and shops, to observe the conditions and character of employment with relation to sight requirements. As a result of this study, the super-armor-plate-glass type *without side screens* was chosen for all workers *other than those employed in machine-shop repair work and tipples.* For men engaged in the class of work excepted super-armor-plate glasses *with side screens*, or the cup type goggle, were made standard. It should also be added that all employes engaged in the various welding operations had, with their advent, been supplied with protective colored glasses and face masks.

A skilled oculist and optometrist was employed to make the eye-sight examination of 1,742 men. Of the number examined, 436, or 25 per cent, were found to have 20/20, normal vision, without glasses. The rest, 1,306, or 75 per cent, it was ascertained, were suffering from defective vision in a major or minor degree. Of the 1,742 men examined, 593, or 28.3 per cent, it was learned, had major defects requiring correction.

A total of 113 men, or 6.48 per cent, was found with eye-sight in bad condition, certain of the defects developed having been present since birth, others being caused by disease and accidents, some of which occurred in boyhood or outside the mining industry after maturity, with a number properly chargeable to accidents in and about the mines. These 113 cases have been divided into 4 classes, as set forth below:

1. Men who, preceding the completion of the survey, had suffered the removal of one eye, and who were wearing an artificial eye. There were seven (7) in this class, one of whom lost an eye while the survey was under way.

2. Men other than those in Class 1 who are either totally blind in one eye or who have light perception and projection only in one eye. Twenty (20) men were in this class.

3. Men who suffer poor vision in one or both eyes with or without glasses. Seventy-two (72) men were classified under this heading.

4. Men who suffer from a progressive eye disease, and which will, unfortunately, in all probability, grow worse. Fourteen (14) men were so reported.

Upon completion of this survey, corrective glasses were furnished to all employes requiring them, and, in several cases, workers were placed in different occupations where they would not be compelled to work alone and as far remote from danger as possible.

During the eight-year period, 1925 to 1932, inclusive, 11 employes lost almost wholly or totally the sight of one eye. These accidents, when considered in connection with the greater number of minor injuries received, represent a record of personal injury, human suffering and social loss, which more than justifies the mandatory use of protective glasses by men working in and around coal mines wherever located.

We are all familiar with the chorus of objections and difficulties raised when mention is made of mandatory rules that are really capable of governing the eye accident situation. Some of these are: "Employes object to wearing goggles—it is absurd to require all employes to wear them—no eye accidents occur on many jobs, or at least very few—if the employe himself were more efficient and careful" and so on indefinitely.

But, to the candid or clear-thinking individual, the absurdity of the situation does not lie in the adoption of the so-called "drastic" rules to protect eyes. We do agree, of course, that the enforcement of adequate rules is not always easy, but, fundamentally, this is a management problem, and must be dealt with like any other which concerns production, costs, wages or hours of labor. Eye injuries may or may not be rare in or around the mines, but the penalties when they do occur are so heavy to industry, the individual worker and to society, that a vacillating attitude is unthinkable.

From our experience gained by the mandatory use of goggles (that is, from May, 1933 to the present date) I think it is not out of line to state that whenever a mining management definitely makes up its mind to stop eye accidents, they will be stopped. This is a conviction based upon our own accident records.

The cost of furnishing goggles to all employes is not prohibitive. The average cost per employe, including examination and glasses ground for correction where required, was $3.21 per pair. This is, indeed, a small amount when one eye injury can amount to several thousand dollars.

In conclusion, I wish to state that most of the material gathered for this article was taken from Mr. Eugene McAuliffe's paper entitled "Corrective and Protective Eye Goggles for Coal Mine Employes."

SUMMARY FACTS ON THE COAL RESOURCES AND COAL INDUSTRY OF ILLINOIS

(Reprinted by permission from a pamphlet published by the State Geological Survey Division of the Department of Registration and Education, and prepared in collaboration with the Engineering Experiment Station of the University of Illinois, on the occasion of the meeting of the Coal Division of the American Institute of Mining and Metallurgical Engineers, held in St. Louis, Missouri, October 28 and 29, 1935. Anyone desiring to publish excerpts from this article is requested to credit them to the original pamphlet.)

Geography of the Coal Deposits

The Illinois coal field as a part of the Eastern Interior Coal Field extends into the states of Indiana and western Kentucky. At least 60 per cent of the area of this coal field lies in Illinois. Solid black areas on the map (Fig. 1) show the extent of the main mining districts.

Geology of the Coal Deposits

Structure

The main structural features of the Illinois coal field (Fig. 2) are:

(1) Illinois basin: The trough of the basin runs from LaSalle County on the north to White County on the southeast, where the base of the "Coal Measures" lies about 2,300 feet below the surface and No. 6 coal lies at a depth of about 1,000 feet.

(2) LaSalle anticline: Best developed in LaSalle, Champaign, Clark, and Lawrence counties, fading out both to the north and to the south.

(3) Western Illinois area of gently dipping or flat-lying strata west of Illinois River.

(4) DuQuoin anticline: Extends from a short distance north of Carbondale to a short distance north of Centralia along the Third Principal Meridian, a structural terrace on a monoclinal dip to the east.

(5) Marshall-Sidell syncline east of the LaSalle anticline extending northward from Lawrence through Vermilion County.

(6) Campbell Hill-Cottage Grove belt of warping and faulting extending across the southern Illinois coal fields from Jackson to Gallatin County.

(7) Ozark uplift, producing a general southward rise of strata in southern Illinois and some conspicuous faulting.

(8) Eagle Valley syncline within the Ozark uplift in southern Gallatin County.

TABLE 1.—MAGNITUDE OF DISTURBANCES AS ENCOUNTERED IN MINING OPERATIONS

Structure	Width of structure (mile)	Maximum dip	Magnitude of Structure (feet)	
			Folds	Faults
LaSalle anticline (west flank)	¾	45°	500	none
DuQuoin anticline:				
Centralia	1 to 2	3-4°	220	110
DuQuoin	1 to 2	8½°	300	40
Cottage Grove (faulted zone)	½ to 1	(*)	200	100
Eagle Valley (local mines only)	4 to 6	20°†	700†	(?)

* Very irregular.
† Outcrop.

Igneous Dikes.—Dikes of igneous rock are encountered in Harrisburg (No. 5) coal in Saline County near Harrisburg and Eldorado, and in Herrin (No. 6) coal in Franklin County at West Frankfort. The maximum width is about 300 feet, but in general the dikes do not exceed 25 or 30 feet in width. Six or eight such dikes have been found in Saline County and a single occurrence is reported in Franklin County. So far as known none comes to the surface. They produced some coking and mineralization of the coal where the bed was penetrated.

General Structural Conditions.—Local irregularities are more important than the gentle regional dip

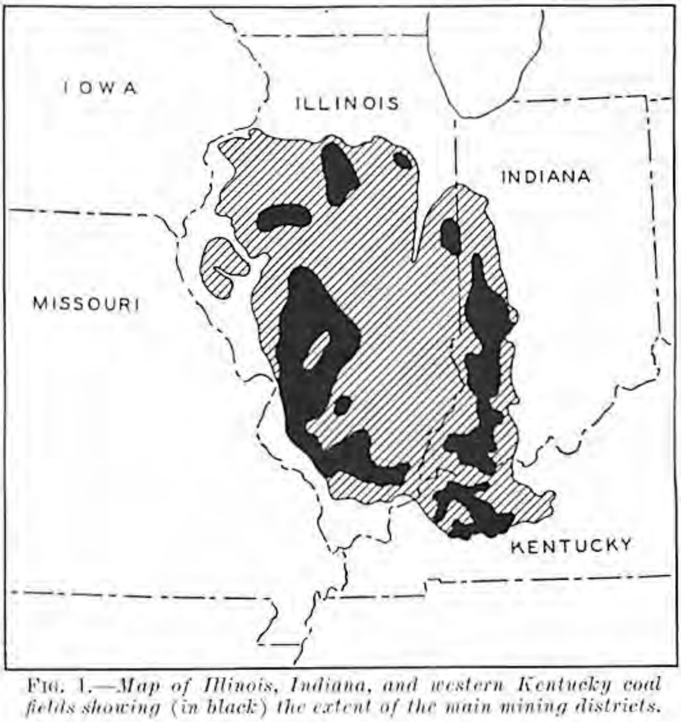

FIG. 1.—*Map of Illinois, Indiana, and western Kentucky coal fields showing (in black) the extent of the main mining districts.*

except possibly along the southern margin of the field where there is a definite northward dip.

Coal Beds

The commercially important coal beds of the State occupy a restricted and central position in the Pennsylvanian geologic column. Stratigraphically they lie in a group of strata (Carbondale formation) not exceeding 500 feet in thickness, with 1,000 feet of Pennsylvanian strata

FIG. 2.—*Structural features of the Illinois coal field.*

both above (McLeansboro formation) and below (Pottsville formation). In addition there are a large number (30-40 or more) of coal horizons scattered through the "Coal Measures" some of which locally reach a thickness of 25 to 30 inches and are locally exploited.

The seven commercially important beds are listed in Table 2.

TABLE 2.—COMMERCIALLY IMPORTANT COAL BEDS.

Coal Bed	No.	Thickness (feet)	Usual thickness where worked (feet)
Danville	7	0-5	4-5
Herrin	6	0-14	6-8*
Springfield	5	0-6	4-5
Harrisburg	5(4?)	0-8	4½-5½
LaSalle	2	1½-3½	2½-3½
Murphysboro	2(1?)	0-8	6-8
Rock Island	1	0-6	4-6

* Often 10 feet in southern Illinois.

Relative Importance of Coal Beds.—In general, operations in each mining district are restricted to a single bed. No commercial mine operates more than one bed from a single shaft, although there are a number of mining districts where such operation would be possible. The outstandingly greater importance of No. 6 bed as a source of the coal produced in Illinois (Table 3) results from its exceedingly widespread uniform thickness of more than five feet.

TABLE 3.—COAL MINED FROM VARIOUS BEDS IN 1934.

Coal No.	Total Illinois production: Tons	Per cent
1	381,400	1.0
2	1,810,749	4.7
5 (Springfield)	2,728,428	7.0
5 (Harrisburg)	6,505,721	16.8
6	27,130,266	70.3
7	98,927	0.2
Total	38,655,527	100.0

Mining Conditions as Determined by the Geology

Depth.—Depth of the operating mines in Illinois ranges down to 732 feet (Pana, Christian County). Coal was formerly mined at Assumption in the same county at a depth of a little over 1,000 feet (coal No. 1?).

TABLE 4.—NUMBER OF SHIPPING MINES OF DIFFERENT DEPTHS IN ILLINOIS IN 1925, 1931, AND 1934.

Depth in feet	No. of shipping mines: 1931	1925	1934
0-60 or 70 (strip mines)	19	16	26
0-99 (slope, shaft or drift mines)	50	21	30
100-199	62	38	31
200-299	42	38	29
300-399	31	17	17
400-499	24	20	20
500-599	10	6	8
600-699	12	8	8
700-732	6	3	3
Total	247	166	172

Roof and Floor Conditions.—The typical roof of Illinois coal beds consists of black shale ("slate") and a cap-rock. Almost of equal importance is a gray shale roof, generally present in localities where any bed has unusual thickness, as in the Franklin County field (No. 6 or Herrin coal), the Harrisburg district (Harrisburg coal), and the Vermilion County district (No. 5 or Grape Creek coal). In general, the sulfur content of any bed is lowest in those areas where the coal thickens under gray shale. No. 2 coal has both black and gray shale in most areas, except Grundy and Will counties where no black shale is present.

In general, Illinois mines are dry. Water, where present, generally comes from the surface deposits.

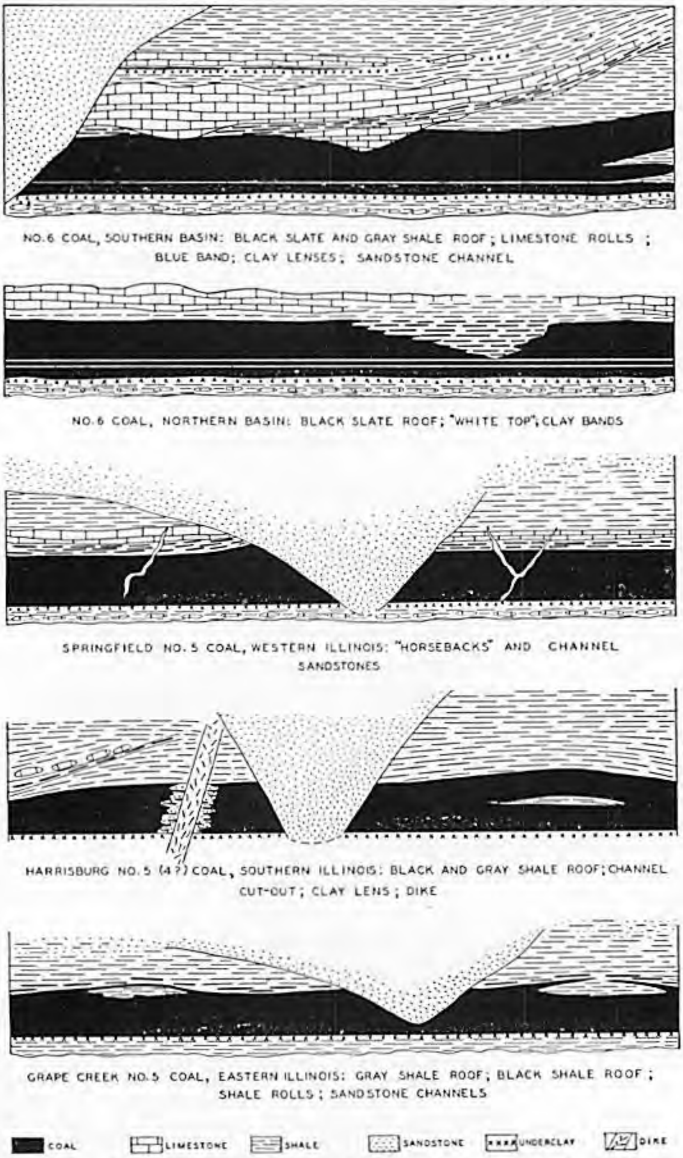

Fig. 3.—*Characteristic bedded irregularities in some Illinois coals.*

Bedded Irregularities.—Bedded irregularities that are of importance in the coal beds are as follows (Fig. 3):

"White-top" in No. 6 coal in western Illinois (clay infiltrations in the top of the coal bed).

"Horsebacks" or clay veins in No. 5 coal in Peoria-Fulton and Springfield district.

Sandstone cut-outs in Springfield (No. 5) coal in Peoria and Vermilion County districts, in No. 6 coal in Montgomery and Christian counties, and in Harrisburg (No. 5) coal in Saline County.

Lenticular structure of No. 1 coal in western Illinois and probably in Murphysboro district.

Clay bands (blue band) in both No. 6 and No. 7 coals.

Underclay usually underlies all Illinois coals of commercial importance. Immediately below coal No. 2 in parts of western and northern Illinois there is refractory clay which is usually a composite of several underclays. The underclays of the other commercial coals are not refractory, so far as known, due to their content of calcium carbonate and potash.

TABLE 5.—ORIGINAL AND PRESENT AVAILABLE RESOURCES OF THE TRADE DISTRICTS AS OF 1926*‡

District	Coal bed	Sq. miles	Millions of Tons: Coal per sq. mile	Original resources	Coal mined	Depletion	Coal remaining	Percentage of: Recovery †	Depletion
1. Wilmington	2	270	3.30	891	45	47	844	95	5.3
2. Third Vein (LaSalle)	2	1067	3.85	4,108	140	147	3,961	95	3.6
3. Fulton Peoria....	5	1356	4.95	6,702	102	217	6,485	47	3.2
4. Springfield	5	1184	6.60	7,814	123	246	7,568	50	3.1
5. Grape Creek........	6	99	6.60	653	93	163	490	57	25.0
6. Central Illinois..	6	4776	7.70	36,775	656	1,312	35,463	50	3.6
7. Centralia	6	241	6.60	1,590	30	55	1,335	55	3.5
8. Franklin-Williamson	6	884	9.90	8,751	360	766	7,985	47	8.8
9. Big Muddy..........	2	......	......	....	......	......	....	....	100.0
10. Saline County	5	270	5.50	1,485	80	148	1,337	54	10.0

* Coal Report: Dep't. Mines and Minerals, 1926.
† Allen, C. A., Coal losses in Illinois: Illinois State Geol. Survey, Coop. Min. Ser. Bull. 30, 1925.
‡ Reprinted from: Bement, A., Illinois Coal, Illinois State Geol. Survey Bull. 56, Table 3, p. 38, 1929.

Underclays are generally thin (6 inches to 4 feet) but of sufficient thickness and of such a character that undercutting can be done in the clay. There are some exceptions to this condition, however, requiring undercutting in the base of the coal.

Gaseous Conditions.—Moderately gaseous coal is found chiefly in southern Illinois districts.

Original Resources and Reserves

An estimate of Illinois' original coal resources and the percentage of their depletion as of 1926 is given in Table 5.

The reserves of coal in Illinois, 2 feet or more in thickness, are nearly equal to the combined reserves of the neighboring states (Fig. 4).

Classification of Illinois Coals

Rank Classification

By rank classification is indicated those differences in the pure coal materials due to geological processes, whereby the coal material is changed from peat through lignite and bituminous coal to anthracite or even to graphite. All Illinois coals are classified as high volatile bituminous coals in accordance with the specifications for rank classification recently adopted by the American Society for Testing Materials, as shown graphically in the accompanying chart* (Fig. 5). All Illinois coal produced by shipping mines belongs in groups high volatile B and C; coal belonging to group high volatile A is found in the Eagle Valley field but it is not produced for shipping.

Geographic Distribution of Rank—A fairly definite and progressive increase in rank occurs toward the southeastern boundary of the coal field (Fig. 6). The rank indices shown on the accompanying map represent the moist, mineral-matter-free B.t.u. expressed in hundreds of B.t.u. to the nearest hundred units.

* Anthracite coal and low medium volatile bituminous coal is classified on the basis of dry mineral-matter-free fixed carbon. Coal of group high volatile A bituminous is classified on the basis of dry mineral-matter-free fixed carbon (less than 69 per cent) and moist mineral-matter-free B.t.u. (more than 14,000). Lower rank coals are all classified on the basis of moist mineral-matter-free B.t.u. Low volatile boundary was changed from 77 to 78 in 1935.

Variations in Moisture

Moisture variations of Illinois coal correspond fairly well with and largely determine the variations in the rank of the coal, hence it will doubtless be observed that increase in rank is accompanied by a corresponding decrease in moisture (Fig. 7). The moisture content of Illinois coal in the bed varies from between 15 and 18 per cent for the lowest rank coals to less than 8 per cent for the highest rank coals in the State.

Ash Content of Illinois Coal Beds

The ash content of Illinois coal beds as determined from analyses of face samples based upon 252 mine averages is 9.78 per cent (as received). A large proportion of Illinois coal is produced where the coal beds contain less than this average, and a great deal of the washed coal and of the larger sizes of coal contains even less.

Ash Softening Temperature.—The ash softening temperature of much of the coal produced in southern Illinois is about 2200° F., in some instances as much as 2400° F. Coals produced elsewhere in the State yield ash, generally fusing at 2000° to 2100° F.

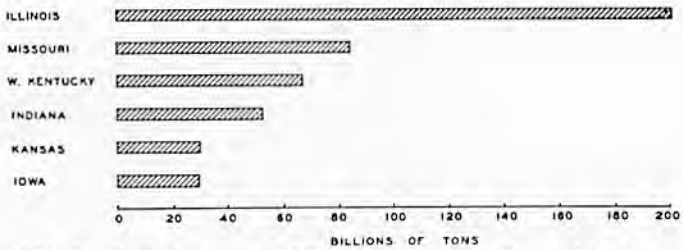

Fig. 4.—*Coal reserves of Illinois compared with neighboring states. (Data from U. S. Geological Survey.)*

Sulfur

Although much Illinois coal is of somewhat higher sulfur content, there are relatively large areas in which coal containing less than 2 per cent of sulfur is produced. These are in Jackson (coal No. 1, formerly called No. 2), Woodford and Will (coal No. 2), Saline (coal No. 5), Vermilion (Grape Creek [No. 5] coal), and Franklin-Williamson (coal No. 6) counties.

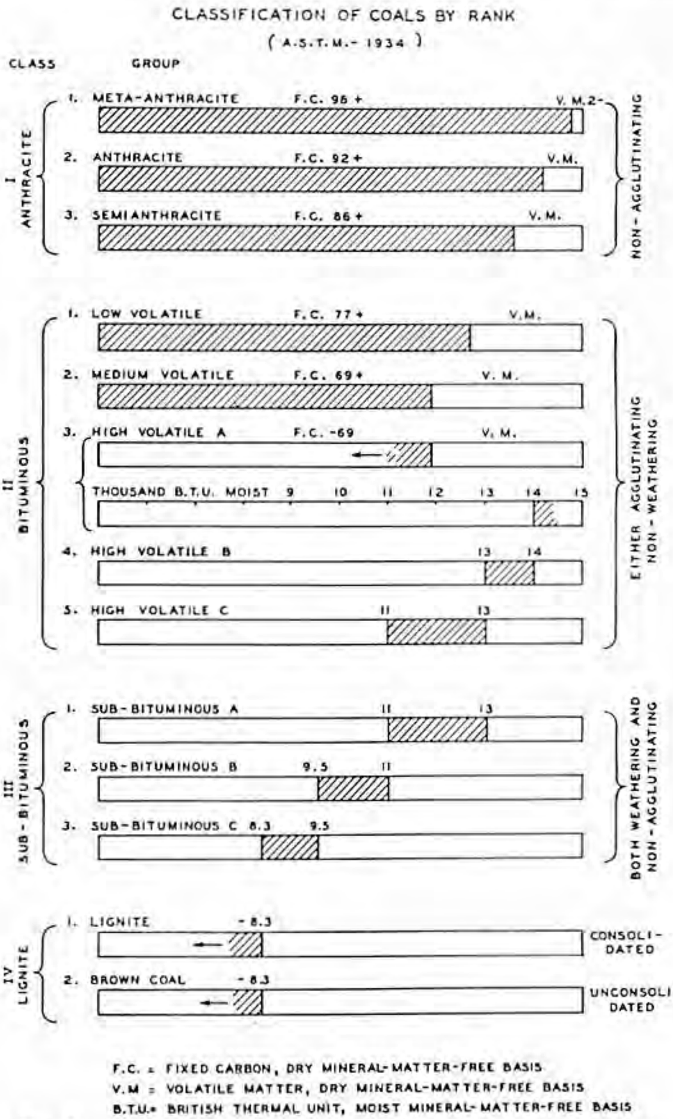

FIG. 5.—*Terms of the specifications for the classification of coal by rank as stated by the American Society for Testing Materials (Designation D388-34T).*

Type of Coal

Illinois coals are almost entirely of the normal banded bituminous type. The principal banded ingredients, in their order of abundance, are: clarain, vitrain, and fusain (mineral charcoal). Figure 8 shows bands of clarain and vitrain. Durain

FIG. 6.—*County average rank indices (moist mineral-matter-free B.t.u. values expressed to the nearest hundred B.t.u.) for Illinois coals; high volatile A—rank index above 140; B—130 to 139; C—110 to 129.*

or splint coal is of rare occurrence, but is found occasionally and particularly in coal No. 6 bed in Franklin and Williamson counties. Occasionally this same bed contains lenses or benches of cannel or canneloid coal, particularly in northern and western Illinois.

Laboratory study of the distribution of banded ingredients in pre-

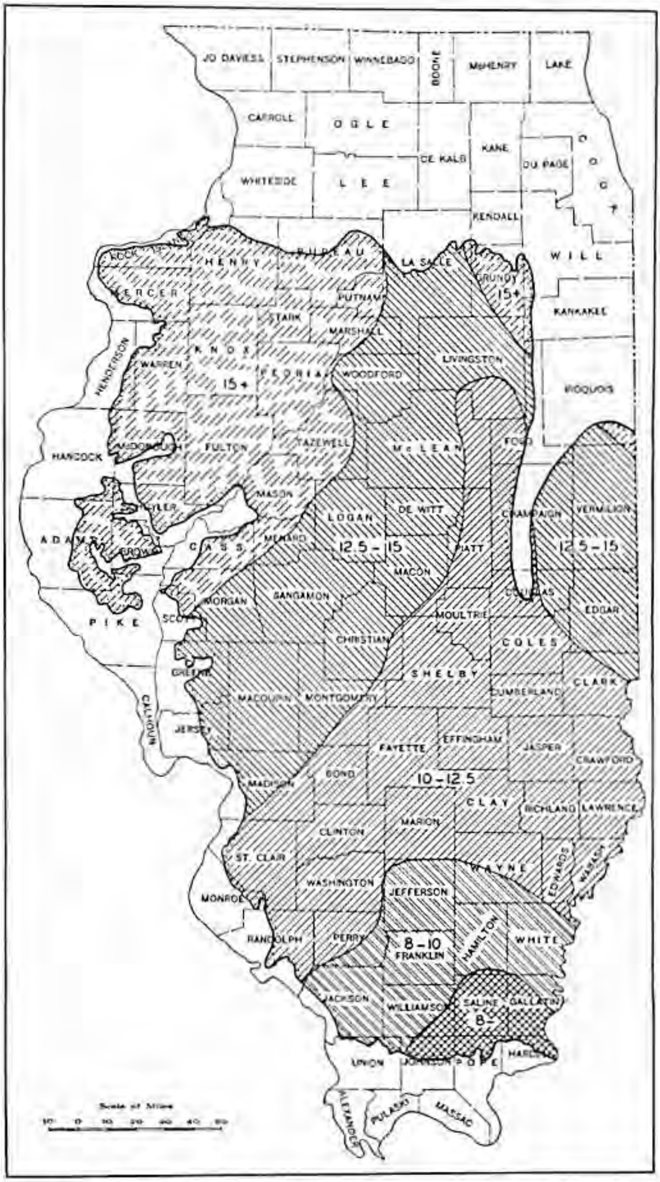

FIG. 7.—*Map showing variation in percentage of moisture content of Illinois coals.*

pared coal indicates that preparation modifies the composition of Illinois coals. Commonly fusain makes up 75 per cent or more of the dust smaller than 200-mesh. Vitrain, because of its brittleness and the type of particle it produces, tends to concentrate in certain small sizes. Sizes other than those marked by concentration of fusain and vitrain are rich in clarain.

Production of Illinois Coals

Illinois' share of the total U. S. production of coal is shown graphically (Figs. 9 and 10). Illinois ranks third in coal production among the states, being exceeded by Pennsylvania and West Virginia. Ninety-five per cent of the coal produced in this State finds an outlet in Illinois, Wisconsin, Minnesota, Iowa, Missouri, the Dakotas, Nebraska, and Kansas. Two-thirds of the coal produced in Illinois is marketed in the State.

The quantity of coal mined by strip mining methods in Illinois is slowly increasing (Fig. 11). The unusually high percentage of output in 1932 was due to the suspension of shaft mining for several months.

A high percentage of Illinois coal is produced by large mines (Fig. 12). In 1929, 74 per cent of Illinois production was obtained from mines having an annual output of

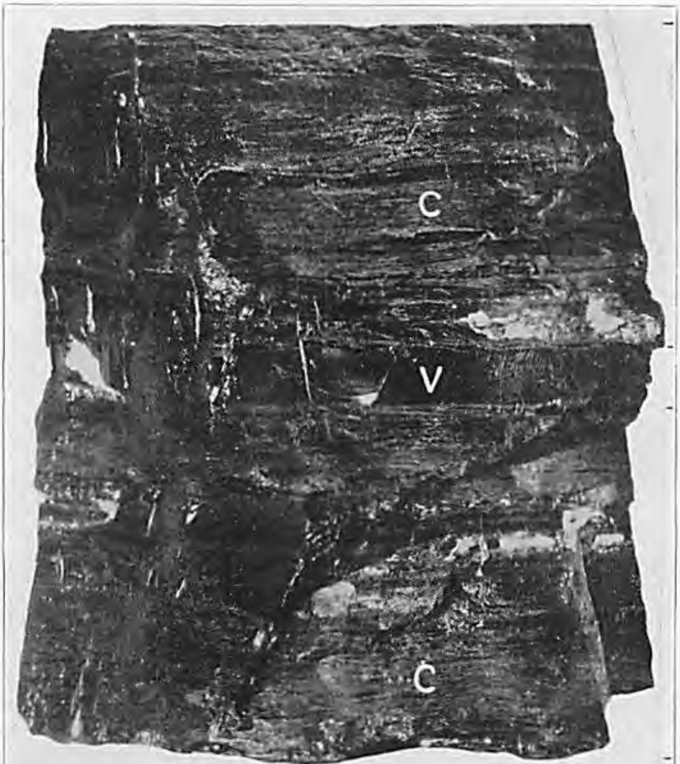

Fig. 8.—*Block of No. 6 coal showing bands of vitrain (V) and clarain (C).*

200,000 tons or more, whereas, in the national coal industry the percentage was 67.

Increased output per man per day has brought about a decline in the number of days worked per year (Fig. 13).

PRESENT TRENDS IN PRACTICE

Mining

Underground Mining.—One of the most interesting current developments in the underground mining of coal in Illinois is the search for economical means of breaking down the coal at the face in a way to yield a maximum amount of lump coal. To this end cardox and airdox are in use in some large mines, and recent tests on hydraulic breakers have been promising. Methods which could be used during the working shift are very desirable, and further developments along

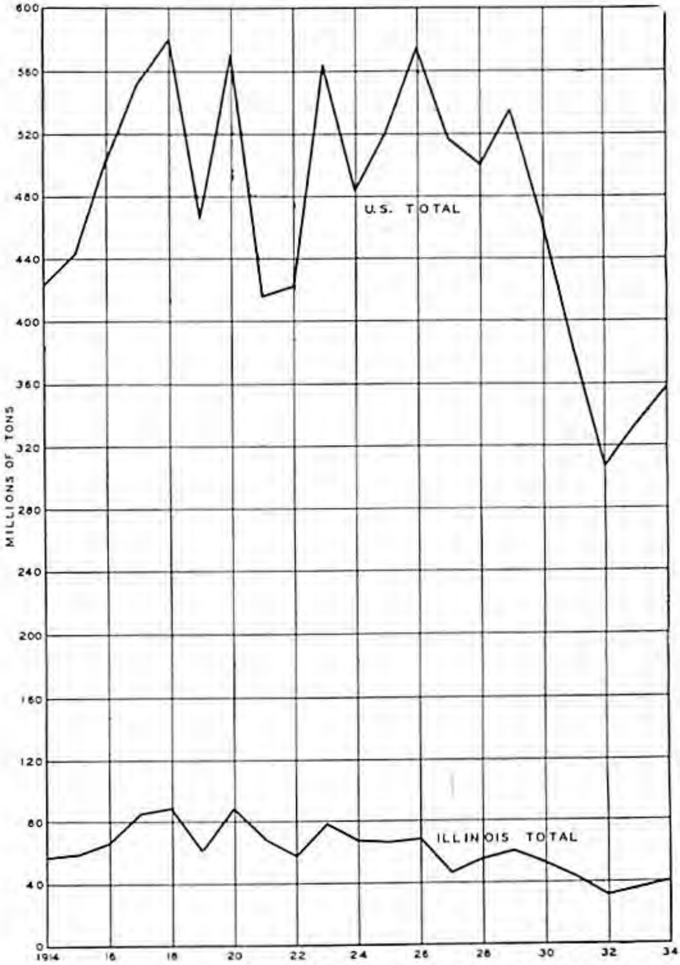

FIG. 9.—*Coal production in the U. S. and Illinois, 1914-1934. (Data from U. S. Bureau of Mines and Illinois Department of Mines and Minerals.)*

this line are expected. Most of the coal is mined with fixed explosives.

Several new types of electrical coal drills have been developed to drill holes to accommodate the varied types of blasting units. Some of these are track mounted. Related to them is a track-mounted hitch-cutting machine which is used on long haulage roads to cut hitches in the ribs near the roof to serve as supports for cross-bars. This obviates the necessity of using leg pieces to support the bars.

Coal cutting is closely related to blasting and it may surprise some to know that, despite the introduction of several new types of shearing and cutting machines, the proportion of mines undercutting their coal and of the State's tonnage undercut have been declining in recent years. In 1934, according to the report of the State Department

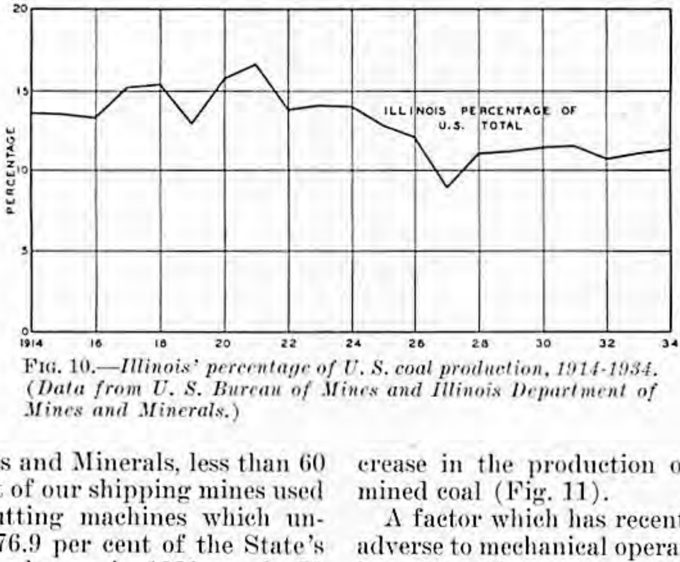

FIG. 10.—*Illinois' percentage of U. S. coal production, 1914-1934. (Data from U. S. Bureau of Mines and Illinois Department of Mines and Minerals.)*

of Mines and Minerals, less than 60 per cent of our shipping mines used undercutting machines which undercut 76.9 per cent of the State's output, whereas in 1929 nearly 70 per cent of the mines used machines to undercut more than 85 per cent of our coal output. Part of this decrease in proportional tonnage of machine-cut coal is due to the increase in the production of strip-mined coal (Fig. 11).

A factor which has recently been adverse to mechanical operation has been the arbitrary abandonment, in some districts, of devices such as loading machines as a temporary make-work move. This has operated to reduce the relative importance of mechanical loading, for in 1931,

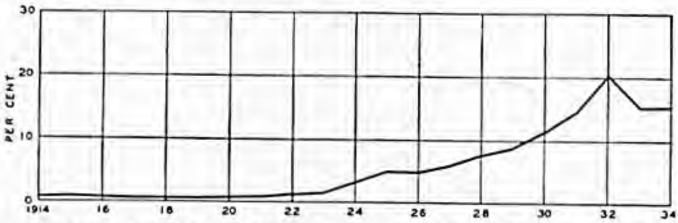

FIG. 11.—*Percentage of Illinois coal mined by stripping methods, 1914-1934. (Data from Illinois Department of Mines and Minerals.)*

nearly half (49.0 per cent) of our shipping mines used mechanical loading devices to load 61.4 per cent of the tonnage, whereas in 1934, less than one-third (27.9 per cent) of the mines used such equipment to load 48.1 per cent of the shipping-mine tonnage. Nevertheless, a lively interest in mechanical operation is being displayed at the more progressive mines, with the result that in several mines, cutting, drilling, blasting, loading, haulage, and hoisting are virtually entirely mechanized. This calls for an increasing amount of technical supervision and co-ordination.

Long faces are being used in a few Illinois mines to facilitate the use of mechanical-loading devices, but roof conditions and the necessity of supporting the surface tend to restrict the adoption of other than the conventional room-and-pillar method of working.

Few significant changes are to be noted in haulage and hoisting, although many mines have gone to or are going to heavier rolling stock and rails. In at least one instance, the rails in the main-haulage track have been welded end to end, rather than bonded, to insure good electrical connections.

Strip Mining.—In strip mining, the size of the stripping unit is steadily increasing with each installation, a 21-yard dipper now being in service in western Illinois and a still larger shovel is said to be under construction. The present trend toward shovels of greater dipper capacity, made possible by the use of strong light aluminum alloys, will permit profitable stripping at relatively higher ratio of cover to thickness of coal, thus enlarging the potential strippable coal resources.

Some strip mines have tried side-hole drilling preparatory to blasting the overburden, but it has not been uniformly successful. A variety of explosives have been used in blasting, some operators preferring fixed explosives and others liquid oxygen.

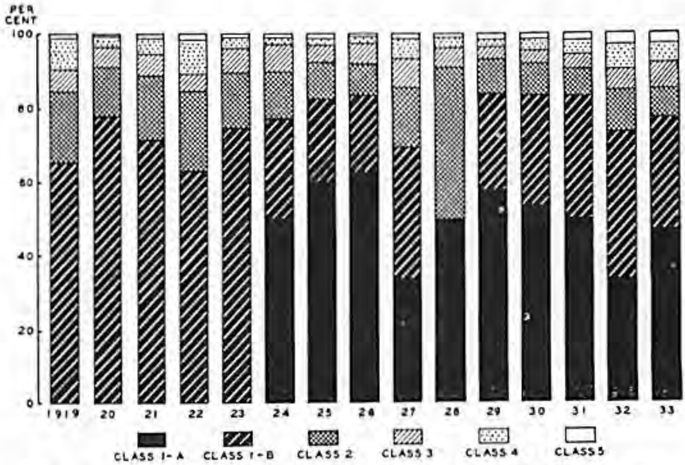

FIG. 12.—*Coal output by size of mines, 1919-1934. (Data from U. S. Bureau of Mines, Mineral Resources of the United States.)*

Class of mine: 1A—more than 500,000 tons; 1B—200,000 to 500,000 tons; 2—100,000 to 200,000 tons; 3—50 to 100,000 tons; 4—10,000 to 50,000 tons; 5—less than 10,000 tons.

Preparation

Coal preparation in Illinois has been characterized in the past chiefly by the excellence of hand picking and screening facilities, some mines being equipped to prepare 40 or more different sizes of coal. Due to this fact mines in the Illinois coal field have long been recognized as having superior screening facilities.

Present trends in preparation

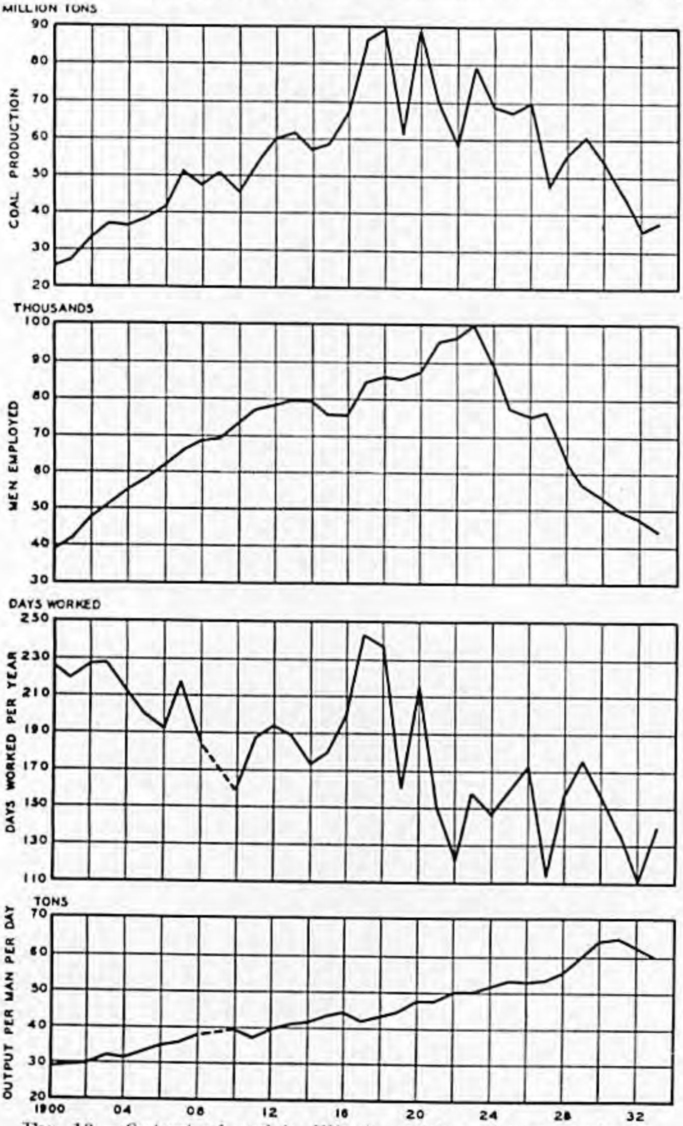

FIG. 13.—*Output of coal in Illinois, number of men employed, output per man per day, and number of days worked per year, 1900-1934. (Data from U. S. Bureau of Mines, Mineral Resources of the United States.)*

center around mechanical cleaning, dedusting, and surface treatment by chemicals or oils.

In regard to mechanical cleaning, the second bituminous coal washer in the United States was erected in Illinois in 1870. Development for a number of years was fairly rapid, and in 1908 Illinois ranked first as compared with other coal producing states in the total amount of washed coal. A consistent increase in amount of coal washed in Illinois was the rule until 1917, after which year the amount of washed coal rapidly declined until in 1929 only 527,000 tons were washed, out of a production of 61,000,000 tons. Beginning in 1930 a revival of interest in coal cleaning began, with at least one new modern coal washing plant being erected yearly to the present time.

TABLE 6.—LOCATION, TYPE OF EQUIPMENT, AND CAPACITY OF COAL CLEANING PLANTS IN ILLINOIS.

Company	Plant Location	Type of Mine	Capacity (Net tons per hour)	Type of Equipment
Bell and Zoller Coal and Mining Co.	Zeigler	Shaft	1,000	Chance sand-flotation cones—Air flow separators
Consolidated Coal Co.	Mt. Olive	Shaft	140	American (1907)*†
			50	Foust rewashing plant (1912)†
Delta Mining Co.	Carrier Mills	Strip	400	Simon-Carves washers
Marion County Coal Co.	Centralia	Shaft	50	Menzie†
Midland Electric Coal Co.	Atkinson	Strip	480	Montgomery Vissac (Pyrite recovery)
Midland Electric Coal Co.	Middle Grove	Strip	600	Simon Carves (Allen and Garcia design)
Northern Illinois Coal Co.	Coal City	Strip	435	Koppers-Rheolaveur
Peabody Coal Co.	DuQuoin	Shaft	150	Norton washers
			50	American Pneumatic tables (dedusting)
Peabody Coal Co.	Taylorville	Shaft	150	Simon Carves washers
United Electric Coal Co.	DuQuoin	Strip	600	Koppers-Rheolaveur
Universal Coal Washing Co. (Pyramid Coal Co.)	Pinckneyville	Strip	100	McNally-Pittsburg

* Illinois Experiment Station Bull. 69, pp. 82 and 86, 1913.
† Installed before 1931.

Most of these plants have been of the Baum-jig type, although some Rheolaveur, Chance, and mechanical jig plants have been erected. Some of the new washing plants are the largest in existence and include all the latest improvements in cleaning, sizing, mixing, and transporting the coal and refuse (Table 6).

Wet cleaning is practiced in most of the plants. Dry cleaning has been experimented with to some extent, the largest commercial installation being that of the Stump Air-Flow Cleaners at the new preparation plant at Zeigler.

Dedusting receives more and more attention, both as a sizing process only and as an adjunct to more efficient cleaning in mechanical preparation plants. Illinois operators were among the pioneers in dedusting. The plant of the Chicago, Wilmington and Franklin Coal Company at West Frankfort embodies many new and interesting features designed by the engineers of that company.

Surface treatment is receiving attention at the mines. Several preparation plants are equipped to treat coal of any size. Recent trends seem to be in favor of oil, with various calcium chloride compounds being used to some extent.

Other items of importance in the field of preparation that are receiving considerable attention are the drying of washed coal—centrifuges, filters, and heat driers are in use; face preparation, which includes various interesting modifications of methods to break the coal down without production of excess fines; recovery of valuable products from the refuse from hand picking and mechanical cleaning; utilization of dust; and briquetting and coking.

Coking

After operation of an experimental plant at East St. Louis, the Radiant Fuel Corporation erected a battery of ten Knowles sole-flue ovens at West Frankfort and are at present constructing two additional batteries of eight ovens each at the same place. The convenient location of the plant with reference to the coal permits the production of coke soon after the mining of the coal and it is claimed that the construction of the ovens makes possible a rapid coking process, at the same time avoiding too high a final temperature which would cause excessive shrinkage and undesirable fingering. A satisfactory domestic fuel coke which, because of the low final temperature of coking has excellent burning characteristics in domestic heating furnaces, is being produced from Illinois screenings produced at neighboring mines. A ready market is found for the gas in the local gas distributing systems which lie away from the trunk lines bringing natural gas into the State.

Current State Researches on Illinois Coal

By the Departments of Mining and Metallurgical Engineering and Chemical Engineering, University of Illinois.

Utilization of Coal Mine Waste

An investigation is being made concerning the feasibility of recovering coal, pyrite, or other valuable constituents from picking-table, cleaning-plant refuse or other mine wastes.

Mine Ventilation

Two studies are being carried on in mine ventilation: (1) The resistance of mine timbers to the flow of air; and (2) a survey of the ventilation characteristics of typical Illinois mines.

Removal and Recovery of Waste Products

An investigation has been in progress for several years on the removal of sulfur compounds from waste gases.

By the Illinois State Geological Survey in Cooperation with the Department of Mining and Metallurgical Engineering of the University of Illinois.

Characteristics of the Fine Sizes of Coal

The State Geological Survey in cooperation with the University Department of Mining and Metallurgical Engineering is carrying on an investigation of the characteristics of fine sizes of Illinois coal, with particular reference to the following: (1) The effect of sizing on the chemical character and heat value of the coal, particularly on the ash and sulfur content; (2) The general washability characteristics of the screenings produced from Illinois coal; and (3) The degree of concentration of the banded ingredients—vitrain, clarain, durain, and fusain—in each of the screen sizes and gravity fractions.

By the Illinois State Geological Survey

Character of Ash-Making Materials

Careful systematic investigations of the minerals separable by gravity methods from No. 6 bed coal in Franklin County (Fig. 14) has indicated that this material consists almost entirely of the three miner-

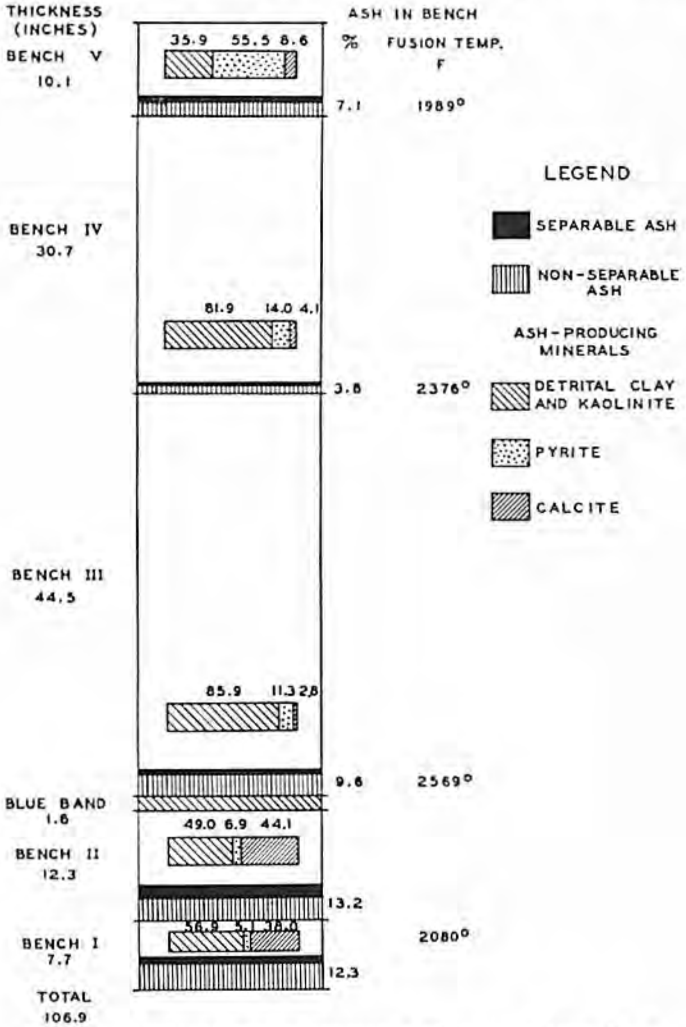

FIG. 14.—*Results of gravity separation of minerals from No. 6 bed coal in Franklin County, Illinois.*

als, pyrite, calcite, and kaolinite, the last partly in the form of clay. These minerals probably make up more than 95 per cent of the original source of the ash. The unseparable mineral matter is probably essentially the same as that which can be removed. The organically combined mineral matter is probably minute in quantity. Selective removal of pyrite and calcite would tend to raise the softening temperature of the ash.

Effect of Coal Preparation on the Ash-Fusion Temperature

The study of the effect of coal preparation on the ash fusion point of Illinois coals is also being undertaken, using the samples of the gravity fractions obtained in the studies of washability characteristics above described.

Classification and Selection of Illinois Coals

The recent adoption of a standard for the tentative classification of North American coals by rank and grade has made possible the preparation and publication of a bulletin (No. 62) setting forth a method of selection of Illinois coals by the domestic consumer on the basis of the number of B.t.u. available per unit of cost. The general scheme of selection follows that recommended several years ago by Professor S. W. Parr. Included in the same bulletin is a general compilation of analyses of face samples of Illinois coals, and tables giving mine and county average values.

Constitution of Coal

In line with similar investigations in this country and abroad, the Illinois State Geological Survey is carrying on studies on the nature of the plant components of which our coals are composed. Complete columnar sections of No. 6 bed coal have been obtained in sixteen representative mines working this bed in southern Illinois. The identification of the plant constituents is accomplished by making thin sections, the study of polished and etched surfaces, and the separation of resistant components by maceration. Such studies are preliminary to chemical investigations of the nature and properties of the components. Similar studies of other North American coals are under way at the United States Bureau of Mines Experiment Station at Pittsburgh. The general purpose of such studies is to obtain a better understanding of the nature of the coal complex in terms of its constituent components, with a view to a better adaptation of Illinois coals to specific uses and to discovering new uses.

Briquets without Artificial Binder from Illinois Screenings

The Illinois State Geological Survey has developed a process whereby Illinois coal fines may be briquetted without a binder, thereby producing a fuel in more marketable form. Tumbling tests to determine the mechanical strength of such briquets made under laboratory conditions indicate that the strongest briquets are produced from the coals of relatively intermediate or low rank for which the problem of disposal of the fines is probably the most pressing. Briquets of sufficient strength to withstand ordinary handling can be produced in the laboratory from any Illinois coal. Also it has been found that smokeless briquets may be made by a slight modification of this same process from Illinois coal fines from which about 15 per cent of the very low-temperature volatile matter has been removed.

Coke and Gas-making Properties

The Illinois State Geological Survey has in progress an investigation of the gas, coke, and by-product making properties of Illinois coals throughout the State. The conditions for the production of good quality coke from Illinois coals are that the coals be coked as soon as possible after their removal from the face and that the coking process be as rapid as possible. Too high a final temperature, which would cause excessive shrinkage and undesirable fingering, should be avoided. It is highly desirable that the coals be cleaned before they are coked.

Geophysical Prospecting

Preliminary field tests with electrical resistivity apparatus indicate that the presence and possibly the depth of coal at shallow depth can be ascertained under favorable conditions, such as the parallelism of the coal bed to the surface and the presence of overburden differing in electrical resistivity from that of the coal. At least one company has been experimenting with the method as a possible means of lowering drilling costs.

The determination and delineation of areas of coal at shallow depth in western and central Illinois is now being carried on. Large tracts of such coal are being rapidly absorbed by operating companies. A recent development in the Illinois strip-coal industry is the entry into Illinois of several companies formerly operating in the Kansas-Missouri-Oklahoma fields.

PROCEEDINGS OF ILLINOIS MINING INSTITUTE FORTY-THIRD ANNUAL MEETING

FRIDAY, NOVEMBER 8, 1935

Held at Hotel Abraham Lincoln, Springfield, Illinois

MORNING SESSION
10:00 O'clock A. M.

President Sandoe: Members and friends, we are about to open the Forty-third Annual Meeting of the Illinois Mining Institute.

It gives me pleasure to introduce to you Hon. John W. Kapp, Jr., Mayor of Springfield, Illinois.

Mayor Kapp: I thank you very much, gentlemen. Mr. President, gentlemen of the Illinois Mining Institute, as Mayor of the City of Springfield and on behalf of its citizens, I want to extend to you a most cordial and sincere welcome.

It is really unnecessary for me, by word, to tell you how proud and happy the City of Springfield is in having this organization as our guest today. In this audience I can see a great many of our citizens of Springfield, and I can tell and you can tell by the smile on their faces that we really extend to you a sincere welcome.

Springfield, as you gentlemen all know, is the Capitol City of Illinois. We have located here the Capitol group of buildings. Briefly, I am going to outline them to you. The State Capitol, in which is located all of the State Offices of the State —I mean by that the Governor's Office, the State Auditor's Office, the State Treasurer's Office, the Superintendent of Public Instruction, the Secretary of State's Office, and the various divisions. I am unhappy to say to you that the State Legislature is not in session. I would like to have had you gentlemen see that august body sitting, so that you could see how the laws of the Great State of Illinois are made. I know that some of you probably have had that privilege, but we do think the visitors to Springfield are privileged in seeing the Legislature in session.

Then we have the Centennial Building, that building in which is located the Highway Department and the various functions of the Highway Department, and also another reason I would like to call it to your attention is the Hall of Flags. In the Hall of Flags is a flag for every military organization that ever served under the Great State of Illinois. I know some of you men had the privilege of serving in the last War, and I know you will be thrilled by seeing the Flag under which you served.

Then the Supreme Court Building, in which the final law of Illinois is determined.

Springfield is also rich in history, gentlemen. We have located here the home of Abraham Lincoln, located two squares east and one square south of this hotel. I know you could spend a few hours or a few minutes in going down and paying that home a visit.

Then we have the reconstructed Tomb of the Immortal Lincoln, located just north of the City. I would ask you to pay that Tomb a visit, and be, I know, inspired by the spirit of the Great Lincoln, that spirit we need so much today.

Located just twenty-two miles from Springfield is the newly constructed city—you might say it is a city now—of New Salem, reconstructed as of yore, of New Salem. I know you men who are able today to turn on the electric lights by the turn of a switch would certainly be thrilled and inspired by seeing how the pioneers of Lincoln's day had to live.

I am very, very happy to see the Mining Congress or the Mining Institute of the State of Illinois meet in Springfield, and I hope you select Springfield as your Convention City each year. I think Springfield can afford to you a more interesting and more educational problem and sights than any other City in the State of Illinois.

The State Mining Division of the State is always happy to cooperate with you. The University of Illinois and the State Geological Society are always happy to cooperate with men interested in the mining business.

I myself can truly say to you that I know some of the pitfalls, you might say, of the mining industry, having been engaged in that business myself.

I want to express to you gentlemen a sincere thought that the men who operate the Coal Industry in the State of Illinois are high class, brave men of industry. I know of no other industry that probably has the hazards that the Mining Industry really has. You have carried on during this period we call the depression bravely and nobly, and have furnished labor to men, and I think the State of Illinois should do everything possible to make the mining business of this great State a real success.

Along that line, I would just like to mention to you that I am sincerely interested and I think everyone of you here should be sincerely interested in helping the mining business by seeing that a law is passed in this State which would put a tax on natural gas. I think and I think sincerely that natural gas, which is a laborless fuel, certainly should help us carry on in this labor problem, and this unemployment problem we have in Illinois. I think every man in this room should make the effort to contact his Senator or his Representatives and attempt to have the Governor include, if you will, in the third special session of this Legislature and mention in his call the matter of being able to tax natural gas for the sake of unemployment and for other reasons. I think we are ready for it in this State.

I am very, very happy to be with you this morning. I hope you enjoy this Convention. I know it will be of an educational character. I know you are here for that reason. We of Springfield want to make your visit pleasant and I hope each and every man in this room carries home with him a pleasant memory of his visit here to Springfield, and that you will return to Springfield many, many times.

I thank you.

President Sandoe: Your Honor, on behalf of the Mining Institute, I want to thank you for your invitation and the courtesies we have received in Springfield. We have met here several years, and if in the future we receive the same treatment as in the past, I say continue coming here.

The minutes of our meeting are always printed in the Year Book, so that you will have your opportunity of receiving the minutes when you get your Year Book, and we will not read the minutes at this time.

I do want to caution you that the first thing we would like to request is that every one attending this meeting register. It is the only official method we have of keeping track of the attendance at meetings. The very simple thing to do is register, and we would like to have every one do it.

Those who are going to the football game, there are some tickets, I think. Professor C. M. Smith has the tickets for the football game, and if you will see any of the officers of the Institute they will be glad to find some tickets for you.

For the dinner this evening, the hotel will have to know about how many there will be attending the dinner. There are a great many people here, and we will probably have a capacity crowd. You can either notify any of the registration desks or the main desk, telling them if you are going to attend.

We have the reports of the officers, and as President for the last year, there have been a great many things we have tried to do, some of which we succeeded in and some we did not. We tried to oppose gas coming into the State and tried to have a tax put on gas. We tried to do the things we thought the Institute stood for and things we thought you would want us to do. The Executive Board handled most of the matters, through the Secretary. The Secretary has a report, and I would like to say before he makes his report, and I think all the past Presidents will bear me out in this statement, that we have a Secretary who is second to none. Without this Secretary I don't know what a fellow coming into the job of President would do. He will give you all of the time you ask for, do anything you want him to do, and I think more credit is due him than anyone else in the Institute for the success of the Institute.

I ask the Secretary for his report.

REPORT OF SECRETARY

November 8, 1935.

To the Officers and Members of the Illinois Mining Institute:

The Institute has had a very satisfactory year which is now closed and has maintained its position in membership and financial standing.

Our membership has increased in a satisfactory manner, the total number of members being 575. During the year it was called to the attention of the Secretary that Mr. Thomas R. Stockett, who was the treasurer of the Institute at its inception, was actively in charge of Spring Canyon Coal Company at Salt Lake City, Utah. In accordance with the policy of the Institute, Mr. Stockett was regularly elected an honorary member and was so notified.

The year showed a very satisfactory profit, as will be noted from the financial report to be submitted shortly.

During the year the Institute has co-operated with many organizations throughout the country in an endeavor to improve the position of the Bureau of Mines and also to secure and safeguard legislation helpful to the coal industry.

The boat trip—as will be vouched by those who attended—was highly successful, and an interesting and instructive session took place on the boat.

During the year two of our members, Mr. W. H. Slingluff and Mr. C. B. Spicer, passed on. Letters of condolence were despatched to the bereaved families.

I wish to express my appreciation to the members, officers, and executive board for their helpfulness throughout the year.

Respectfully submitted,
B. E. SCHONTHAL,
Secretary.

President Sandoe: Do you want to take any action on the report of the Secretary? If not, we will now take the report of the Auditing Committee.

Secretary Schonthal: The report of the Auditing Committee is as follows:

REPORT OF AUDITING COMMITTEE

ILLINOIS MINING INSTITUTE CASH STATEMENT

November 1, 1935

Balance in Bank November 1, 1934	$2,628.99
Total receipts 1935: Dues, interest on bonds, yearbook, boat trip..	4,352.19
Total	$6,981.18
Total disbursements 1935: Printing, postage, telephone and telegraph, etc., including $72.00 for rehabilitation of Bureau of Mines	3,500.34
Balance in Bank November 1, 1935	$3,480.84
Balance in Bank November 1, 1934 per above	2,628.99
Profit for year 1935	$ 851.85

Life Membership Account

Balance October 31, 1935	$ 206.01

The foregoing is found to be correct:

W. J. AUSTIN,
D. H. DEVONALD,
J. A. GARCIA,
Auditing Committee.

Bonds Owned by Illinois Mining Institute

One—Chicago, Burlington & Quincy Railroad Co.	$1,000.00
One—Missouri Pacific Railroad Co.	1,000.00
One—Western Union Telegraph Co.	1,000.00
Two—U. S. Treasury Certificates, $1,000.00 each	2,000.00

President Sandoe: Are there any questions on the report? If not, it will be filed and received as read.

Under unfinished business, we will have the second reading of a resolution. I will ask the Secretary to read the resolution.

Secretary Schonthal: Second reading of the Amendment to Section 5, Article IV, Constitution and By-laws of the Illinois Mining Institute, corrected to read as follows:

Amendment to Section 5 of Article IV, Constitution and By-Laws of the Illinois Mining 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.

This resolution was offered on the boat trip, and according to the By-laws must be presented at the meeting prior to the Annual Meeting to be adopted. I would like to offer this for adoption, if anyone will make such a motion.

President Sandoe: What is your pleasure?

Mr. Peter Joyce (Springfield): I move the adoption of the resolution.

(Which said motion was duly seconded and unanimously adopted, and the Resolution was declared to be unanimously adopted.)

President Sandoe: Next we have on the Order of Business the election of officers. I will ask the Secretary to read the report of the Nominating Committee.

REPORT OF NOMINATING COMMITTEE

Read by Mr. Schonthal.

October 29, 1935.

To the Officers and Members of the Illinois Mining Institute:
Gentlemen:

In compliance with the duty assigned your Nominating Committee, we, the undersigned members of said committee, hereby nominate the following Officers to conduct the affairs of our Institute during the next fiscal year:

OFFICERS

President—T. J. Thomas, Chicago.

Vice President—W. J. Jenkins, St. Louis.

Secretary-Treasurer—B. E. Schonthal, Chicago.

EXECUTIVE BOARD

W. C. Argust, Taylorville.
W. J. Austin, Chicago.
Carl H. Elshoff, Springfield.
Charles F. Hamilton, Chicago.
John E. Jones, West Frankfort.
Dr. M. M. Leighton, Urbana.
James McSherry, Springfield.
Fred S. Pfahler, Chicago.
C. J. Sandoe, St. Louis.
H. H. Taylor, Jr., Chicago.
Harry A. Treadwell, Benton.
Paul Weir, Chicago.

Respectfully submitted,

LEE HASKINS,
FRED S. WILKEY,
GEORGE C. MCFADDEN,
Chairman.

President Sandoe: Members, you have heard the report of your Nominating Committee. What is your pleasure?

Mr. John A. Garcia (Auditing Committee): I move that nominations be closed, and that the Secretary be authorized to cast the ballot of the Institute for the nominations.

(Which said motion was duly seconded and declared to have been unanimously adopted.)

Secretary Schonthal: The ballot of the Institute is cast.

President Sandoe: And they are elected.

Now, the reason we went through this as fast as we did is because you were so late getting in the room. We do not want to pinch the program.

I am now going to turn the meeting over to our Past President, Mr. D. D. Wilcox, of the Superior Coal Company, as Chairman.

Chairman Wilcox: Gentlemen, I appreciate this honor, but I do say to you I think the important thing is to get through the program. Mr. President and Mr. Secretary, with that introduction I will start on this program as it is given to me.

The first address on this program pertains to safety. I think it is proper that comes first. I think it is also proper that the Company be represented which has done as much for safety as any other concern I know of. I do understand, however, that the Program Committee insisted this be a paper and that it be read before it was given, so that we would be sure that the man reading it would confine himself to the language of the paper instead of using some of the language he used around the mine.

I want to introduce to you Mr. Paul Halbersleben, General Superintendent of the Sahara Coal Company, whose paper will be on "Selling Safety."

Mr. Paul Halbersleben (Sahara Coal Company): Mr. President, Mr. Chairman, and Members of the Mining Institute, I have raised the question of which was the best place to talk from, whether out in the middle of the floor or in front of the microphone, and if I can make myself heard I will talk from here.

After that rather doubtful introduction, I will probably hold myself pretty closely to this typewritten sheet I have here. With that warning, I will not divert from right there, and will talk carefully.

As the title indicates, this paper will deal more with the promotional features of the Safety Program which have been carried out by the Sahara Coal Company rather than details concerning equipment and management, which we still consider the foundation upon which any successful Safety Program must be placed.

SELLING SAFETY

By PAUL HALBERSLEBEN
General Superintendent, Sahara Coal Company, Harrisburg, Illinois

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As the title indicates, this paper will deal more with the promotional features of the safety programs which have been carried out by the Sahara Coal Company rather than details concerning equipment and management, which we still consider the foundation upon which any successful safety performance must be placed.

Any selling or advertising campaign faces direct competition with Hollywood, World's Fairs and radios. We found that our bulletin board news flashes were a poor substitute for Fox Movietone news reels or Lowell Thomas. Instead we used bulletins drawn by one of our own miners. The men watch those bulletins as much as a parent does the work a child first brings home from school.

I had a chance, too, to watch the selling of the product we produce. I believe they consulted a name expert and are now convincing the coal retailer that there is more customer satisfaction in shoveling Sahara into a furnace than if the coal were a nameless one. We believe that the coal miner, too, will respond to some similar appeal and it was on this theory that much of our work has been done.

During my association with the Sahara Coal Company we have followed through a number of plans for promoting safer mining. The first was the installation of stations at the various mines with men in charge of rescue and first aid apparatus together with underground safety inspectors. The presence of a State Mine Rescue Station in the County did not necessitate a continuance of the Company equipped stations. With their abandonment there was greater stress laid on safety inspection work, road clearances, condition of equipment, timbering, ventilation and other parts of the mine management were watched carefully by a competent safety inspection department. There was no marked improvement in our accident prevention. Accidents did not seem to occur, in my opinion, directly as the hazard existed. In other words, our men were hurt as frequently in the good top as in the bad top sections. If a driver was hurt it was not with a pit car that had a bumper off but one that was in good repair. The first thing we did to get at this from the other angle was to go out on a program of 100% training for first aid. With the assistance of the State Department of Mines and Minerals and the Federal Department, we were able to train practically every man employed by this company.

During that period we worked up a general mental condition among the miners in this County similar to what I believe Billy Sunday and other great evangelists attempt to effect in the areas they go into. Demands were made for classes everywhere throughout the County. Some of our men became proficient as instructors and as zealous in their work as any of the Holy Roller preachers who frequent this area. I doubt if any mining community has seen a safety revival as large in proportion and as intense in feeling as existed in Saline County during the period the first aid classes were in session which was about six months and for the year following when our company had first aid teams in training for a general contest. Attempts following this to revive a comparable interest in first aid training failed. The automobile manufacturer seems to solve this problem with the buying public by bringing out new models each year. This year he has cut down the 12-month period between new models to a shorter period in order to stimulate buying at more frequent intervals than in the past. That was the thing we faced following our first aid program which resulted in our operating the properties for a considerable period of time including one calendar year without a fatal accident.

The next plan we tried was the payment of a bonus to the foreman and to certain individuals in the section whom we designated as safety men and whose duty it was to take care of safety material. Payment to that section was made on the basis of man-hours worked, 1¢ credit being given for each man shift worked and $1.00 penalty for each man shift lost as a result of injury. This was done so the large and small sections in the hand loading mines would have an equal chance for the premium money. The first aid men were changed each month so that as many miners as possible would participate in the premiums. If the section failed to pay a bonus, we paid the first aid men a minimum of $5.00 so that if they lost some time as a result of the work, they would be compensated for it. This system had its drawbacks mainly because it did not reach the miner often enough and he would not enthuse over any system that just gave the foreman a bonus. The two men designated as first aid men in the section would give good assistance and were advertisers for safety but the other man who felt he had no chance of ever being appointed safety man, did not care whether his brother miner got a bonus check or not. We were becoming more and more convinced that the man to get to was the miner himself. We also felt we had to deal with him, not as an individual but as a group. The greatest possible reward to the individual miner for his safe working is his freedom from injury, good health and the ability to work. Compared to that, any bonus that could be offered by the coal company is insignificant. However, if we could make the good, careful miner look after the careless man, I believed we would help solve our problem. During the summer of 1934 our accident experience was not good. One mine worked one month with one lost time accident and then the next month they had a series of serious accidents. August was a period of high cost in accidents. It was then we decided to go direct to each miner with prizes. The hand loading mines seemed to lend themselves easily to a division in various sections and the first pay period the sections as designated where no lost time injuries occurred, each man was given a 12 lb. bag of flour. The flour was put up in cloth sacks and we had printed on the back this slogan: "Safety pays in many ways." The distribution of flour was made on pay days at the mine to those groups of men where there had been no lost time accidents. The second pay period in September we gave to those sections which had operated two pay periods without lost time accident, a 24 lb. sack of flour. If, during the first half of September, a group had been knocked out through a lost time injury, they were still eligible in the second pay period to compete for the 12 lb. sack of flour but not the 24 lb. The chart shows strikingly what happened to the compensation cost in September. With the experience of the automobile manufacturer still in mind, we followed the same plan for the next three pay periods, altering the prizes. The first half of October we gave a 4 lb. pail of lard. For the second half of October, if the section had operated two pay periods without a lost time accident, they were given an 8 lb. pail of lard. Then at the first half of November if they had operated a third pay period without a lost time accident they were given a small ham.

There were a number of direct results from this program. Each man knew that within his group, whether or not he got a pail of lard depended not only on his own ability to continue working but on that of all of the other men in the group. The novelty of a coal company giving the miners something for nothing seemed to appeal and everybody was out to get what he could from the company. The haulage men began to enforce certain practices which the company could only make effective through the discharge threat. Instead of talking safety as safety they talked flour, biscuits, and everything that flour meant to them. The same was true of the lard. Every man not only wanted his first pail of lard but he wanted to get that ham. The result for the five pay periods was that the accident cost plus the cost of all the flour, lard and meat given away was just slightly below that cost which we consider a fair one at our properties based on past experience. The fallacy of the program was that some serious accident or accidents in one section, while eliminating that particular section, might still run the cost out of reason because of the great number of men who would draw the prizes and yet the company be responsible in the case where the men were injured. To, in a measure, get away from that possibility and also to change the program again, we offered lottery tickets to extend to the period of April 1st. Each pay period a certain number of dinner buckets with the "Safety pays in many ways" slogan on them together with the Sahara shield, and safety shoes were distributed to sections by lot. In other words, if sections went through a pay period without a lost time accident, each man received one of the prize tickets. Then a certain number of shoes and buckets were distributed to that section through the drawing of these numbers. All of the tickets were kept to apply on grand prizes to be distributed after April 1st. To carry out the idea used in the flour and lard of making the prize more desirable, for consecutive periods without any lost time accident we gave each man in the section two tickets if it was their second consecutive pay period without a lost time accident, three if it was the third pay period, etc. This did not help them any on the number of shoes and dinner pails allocated per pay period to their group but it would help them on the grand prize. The results from this prize system did not stand out as sharply as those in the case of the flour and lard. It may have been that we had certain expensive injuries which did not occur during the flour and lard period which made the cost go up or the feeling that a man has, that he can buy a ticket on an automobile drawing for a dime any time or by adding a few dimes together get a chance on one of the Derby lotteries. It may be that if we had started with the prize drawings first, it would have been more effective than by following the direct prize system.

There are several angles to accident prevention that I do not grasp. We operated one mine nine years without a fatal accident. Then there were four fatal accidents at that mine in less than two months. I do know that if everybody is talking safety, accidents are reduced sharply. I do not care how they talk it, whether in terms of flour or lard or getting something from a company for nothing, just as long as they talk. Our problem has been to get the men enthused over some such program to the point where they will act as their brothers' keeper. The man's individual safety he feels is his own business and often resents company interference with practices which the company feels are unsafe. Yet he will accept from other miners a suggestion regarding those practices. I believe any safety appeal to be effective must be constantly changed.

We, fortunately, have a young man at the mines who draws bulletins for us. The fact that he is one of our miners makes the men look at the bulletins. Then the fact that the bulletins deal directly with our type of equipment, our men and our problems is a distinct advantage in that we are not competing with commercial bulletins but are recognizing one of their own men.

The one bulletin causing the greatest comment was a listing of the men killed in the mines for a period prior to 1929. Our aim then was to operate that entire year without a fatal accident. This we did as a direct result of the first aid schools and the general safety campaign. We have displayed x-rays of injuries more from the novel nature of the exhibit rather than because of any educational advantages from them. Our safety shoes have averted a lot of injuries and are worn quite generally. We have had very indifferent success with the hard boiled hats. Our men oppose them on the theory that they are the first step to "bug lights."

We have found that our men will set timbers better and with less effort on the part of the management through the use of the wedge cap pieces. These have been adopted.

We have never used a public address system but I believe that a program given by some of the miners would put over the idea of safety in much the same way as the bulletins made by our local miner.

Our greatest success with accident prevention was in the period of first aid training and the prize distribution of last year. We were successful in these two instances because every man was reached by the company and it was to his benefit to see that his fellow workman was a safe workman.

* * *

Chairman Wilcox: Now, this paper is worthy of a lot of comment. It is worthy because it is a practical paper, telling of the practical side of accident prevention. At this time it is open for comment and suggestion and also experiences from some of the rest of you. I would like to see who would like to talk about it first. Mr. Herbert, of the United States Bureau of Mines. I would like to hear what you have to say.

Mr. Chas. Herbert (United States Bureau of Mines): I think Mr. Halbersleben is to be congratulated on his paper, because it is a practical paper. His experience on the first day is similar to the experience of our operations in other districts. It is a means of getting the men to a point of safety-mindedness, and that is what we have got to do. Men as a rule—the human being is not safety-minded naturally. You have got to induce that. You must bring it about. Any method that will get the men to talking along safety lines is the line of procedure you have to pursue.

We have found in addition to the first aid training—Mr. Halbersleben touched on that indirectly. You get some scheme working that will get the men themselves to take part in it. We have seen the safety associations here and there taking an active part. It helps to bring about safety-consciousness on the part of the men. The men discuss the causes of accidents and what they might do to prevent them. We have found that to be very helpful.

You have got to keep everlastingly hammering at the men, and that is one of the functions of the supervising office. Supervising officers themselves must first be sold on safety. Oftentimes they are not, thoroughly. They are interested mostly in getting out coal and not particularly in safety. That is one of the first things we have got to do, we must educate the supervising officers so that they in turn can pass the information on to the men.

As we know, most of our accidents happening are not through dangerous conditions in the mine so much as through dangerous practices of individuals, and that is the thing that has got to be overcome, if we can. I think that is where the supervising officer plays the important part, to recognize these dangerous practices and eliminate them before the injury occurs.

Statistics show that the accidents in which no injury occurs are repeated approximately ten times before someone is injured in a similar accident under similar circumstances. Supervising officers must learn to visualize the injuries in these no-injury accidents, recognize them and eliminate these no-injury accidents, because by so doing they will naturally eliminate the cause of accidents.

I thank you.

Chairman Wilcox: Our own State Department is also interested and helps in the prevention of accidents. I wonder if there is someone here from the State Department of Mines and Minerals who will give us their version of it? I do not see any of their inspectors. Mr. Starks? I thought I saw Mr. Starks there a moment ago. Isn't he here?

A couple of years ago, or possibly more, about that time, I ran into an officer of the then State Department, ran into him in the late unfortunate and deplorable case at Moweaqua. His work there left a lasting impression with me. I am certain he is one fellow that the mining industry and the State will never forget. I would like to hear from Pete Joyce as to this.

Mr. Peter Joyce (Springfield): Mr. Chairman and fellow members, I haven't much to add to what has been brought out in the paper, only to say that the Sahara Coal Company has been in the front all the time in accident prevention. They have pioneered along that line.

With reference to what has been said by Charley Herbert, I think that is the crux of the whole situation. You have to have the supervising authorities at the mine thoroughly sold on "Safety First." The average miner wants to look up to somebody who knows more about safety that he does himself before he will take it to heart. I think the only thing that can be done is to take the splendid work of the Department of Mines and Minerals and the United States Bureau of Mines, together with that of the coal companies, as safety measures, and have the men themselves express themselves as to what could be accomplished in order to eliminate these horrible accidents.

I think it is a crying shame that more progress has not been made. I think it is due to the indifference of some of the Coal Companies themselves. The Departments I have mentioned break their necks in order to go down and organize classes, and I am sorry to say from personal experience that cooperation is absent on many occasions. It is a pretty hard thing to go into a coal town and inculcate these safety-first ideas among the rank and file of the miners unless the fellows on top are thoroughly sold themselves. I think it is a dollar-and-cents proposition and pays better dividends than anything around the mines.

With those few remarks, I will sit down.

Chairman Wilcox: Thank you, Pete. I know you folks will bear with me if I stop for a moment on a personal idea. I want to call upon a man here who typifies to me this Institute from its beginning, a man who for many years has been closely connected with the mining industry. As I remember, he is one of the original members of the first Institute, and that is Mr. W. D. Ryan.

Mr. W. D. Ryan (Arbitrator Coal Operator's Ass'n): Mr. Chairman, I thank you. I did not expect to be called upon here today.

I am very much pleased to have had the opportunity to be with you and to hear this splendid paper presented to you this morning. At the time that campaign started, under the auspices of the coal company represented by our friend who read the paper, I spent a few days in Harrisburg and had the pleasure of addressing seven first aid classes in one evening while the campaign was on.

Mr. Herbert has set forth to you my ideas on this work. Of course, you know I am not with the Bureau of Mines any longer. But let that be as it may, I am still with you, and happened to drop into another position on the first of January. I feel the mine workers and some of the operators of the State—I have got them now where I want them. They have to do what I tell them. It has been so far a rather pleasing experience for me. I find my present position as an arbitrator not a hard one, for I think I understand the contract as well as any of them. I find paragraphs and sections in that contract I helped to write thirty-seven years ago.

I regret very much that the safety movement so well established in this and other States has recently fallen by the wayside. I think if there is any one proposition connected with the mining industry that should be kept in the forefront it is the question of accident prevention. It is regrettable that interest lagged when the depression came on, at a time when more interest had been taken.

I notice that in some places accidents have increased. I want to urge upon this Convention this morning that, while I am in no way now connected with this movement, my heart is still with it and wherever I go, if I have an opportunity I am going to help boost it along and keep it alive.

I have said on many occasions, Mr. Chairman, that the miners cannot carry on a successful safety campaign by themselves. The operators cannot carry on themselves. Your State Department of Mines and Minerals, work as hard as they may, cannot make it a success. The United States Bureau of Mines alone cannot accomplish very much, but all four units working together as they should be working and should continue working can accomplish a great deal.

I do not know that I care to say anything further. I am more than pleased to be here, and I am going to attend as many of your sessions as I can. I wish you the very highest measure of success.

Accidents can be prevented in coal mines. That has been fully demonstrated. I recall—I guess I can't stop—I recall attending a meeting out in Rock Springs, Wyoming, under the auspices of the Union Pacific Coal Company. In fact, I was out there for fourteen consecutive years, helping to conduct a first aid contest that the company is still putting on every year, and I called their attention to a paper written by a representative of the Bureau of Mines some twelve or fourteen years ago—I think about twelve years ago, in which he stated beyond any question that the Rocky Mountain States, Montana, Wyoming, Utah, Colorado and New Mexico, had the highest accident rate of any coal producing section in this country except the anthracite region, the highest rate in the States.

A few years ago, while out there at one of their annual meetings, Mr. Ed Denny, of the Bureau of Mines, presented a certificate to the Company showing that the mines in Southern Wyoming had about the lowest accident rate of any firm in the United States, reduced from the highest to the lowest by all the four units I mentioned a moment ago working together for accident prevention.

If it can be done in that State, my friends, it can and should be done in Illinois. I sincerely trust every man here will when he leaves this meeting today go home and take Mr. Herbert's advice and be safety-minded from now on.

I thank you.

Chairman Wilcox: Thank you, Mr. Ryan.

Up in our part of the country, in the mining industry we have some companies that believe in and practice accident prevention. Personally, I would appreciate a few remarks from Mr. Argust. He knows about their system.

Mr. W. C. Argust (Division Superintendent, Peabody Coal Company, Taylorville): Mr. Chairman, I feel Mr. Ryan and other speakers very well covered it. Accidents can be prevented, and there must be cooperation from all parties connected with the mining industry in the various branches and with the employes themselves.

Chairman Wilcox: Is there someone here who has something to add? There are plenty of you fellows here whom I know have had experience and could add to the wealth of experience that this Institute has collected.

Mr. D. W. Jones (Superintendent Valier Coal Company): I want to ask Mr. Halbersleben to compare the lottery system of giving safety awards and the individual award, whether they can make any changes or improvements from what they have learned.

Mr. Halbersleben: In answer to your question, I believe if you want to adopt the lottery system it will work out all right, but as I pointed out the lottery system has some disadvantages because the Elks Lodge and others offer automobiles on a lottery basis. They sell these tickets for a dime and he does not figure how many tickets will be put out by that Elks Lodge, but feels that is a dime proposition. That is one disadvantage to a lottery system. That which goes into the home has a double-barreled advantage, for you do get the family and the housewife and the child into the safety end of it. Mark your containers so that the containers will carry the safety message. I do not believe it is so much the inherent value of the article. A twelve-pound sack of flour is not very large and does not represent very much money at the time it is given. But they were taken home, and I believe, too, from the side of it, the taking home of something that links the entire household with the safety of the man of the house in the mine, that helps.

Chairman Wilcox: Has anyone else any question he would like to ask Mr. Halbersleben? We will go on to the next paper.

The next is a paper entitled "General Conversion Equipment for Mine Use," by Mr. B. R. Connell, Industrial Engineer, General Electric Company, Schenectady, N. Y. Mr. Connell.

Mr. B. R. Connell (Industrial Engineer, General Electric Company): Mr. Chairman, and members of the Institute, at the present time there are three types of Conversion Equipment applicable to mine service.

GENERAL CONVERSION EQUIPMENT FOR MINE USE

By B. R. CONNELL
Industrial Engineering Department, General Electric Co., Schenectady, N. Y.

There are three types of conversion equipment at present applicable to mining service. These are:

Synchronous Converters.

Motor Generator Sets (usually of the synchronous type).

Mercury Arc Rectifiers.

The first two of these have been in use for many years and their characteristics are, therefore, well known. The design of this type, however, is being studied constantly for new and improved mechanical and electrical construction to improve the general operating characteristics of the apparatus. Among the recent developments in this type of equipment are two which will be briefly described. The rectifier equipment, being of a newer class, will be described more fully later.

One of these recent developments for underground sub-stations is that of the portable equipment. With this, the motor generator set or converter and its transformer and switching equipment are mounted on separate trucks which are self-supporting and allow the apparatus to be readily transported about the mine on the standard mine tracks.

This type of equipment can be made in dimensions to conform to the requirements of the ordinary mine. Special interconnecting main and control cables and connectors are furnished to provide for readily connecting and disconnecting the separate trucks. This portable feature is an important item for mine owners who expect to expand their workings and desire to buy equipment that is readily moved to any point to which the load center may be changed in the future.

Figures Nos. 1 and 2 show a portable set and switchgear equipment.

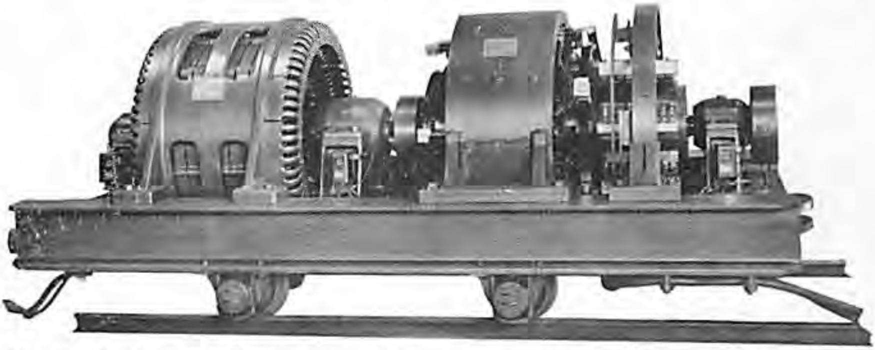


FIG. NO. 1—*Portable Mining Set on Self-supporting Base, 400 Kw.—275 Volts D.C.—4000 Volts A.C. 52 in. Overall height top of rail to top of set.*

Another development which will be of particular interest to the Mining Industry is that of a new cooling and insulating liquid for transformers. For many years, the electrical industry has recognized the desirability of a cooling and insulating liquid for transformers which would have the desirable characteristics of mineral oil but with the additional properties of being non-inflammable and non-explosive. After several years of research this goal has now been reached through the development of such a liquid called Pyranol and of Pyranol transformers designed and built to utilize this liquid.

There are two ways of making a transformer installation. One is to use transformers having oil as a cooling and insulating liquid and to observe the necessary limitations as to location as well as take protective measures required to make the final installation as safe as possible. The other method is the use of Pyranol transformers, whereby the requirement of safety can be met effectively, and usually with material simplification in the installation and with reduced initial and operating cost. The 1935 revision of the National Electrical Code permits the installation of Pyranol transformers indoors with many restrictions applying to oil-insulated transformer installations eliminated.

Pyranol transformers can be supplied for conversion equipment and for general power or auxiliary service. Since 1932 more than 250 units totalling over 46,000 kv-a in sizes from 5 kv-a to 5,000 kv-a have been sold and are giving excellent service.

The third type of conversion equipment, that is, the mercury arc rectifier, is perhaps not so well known to the mining industry as the two types previously mentioned and will, therefore, be described more in detail. Up to the present time the rectifier has not been used very extensively in mining work, probably because very little new apparatus has been purchased in the past few years and perhaps on account of the feeling that it has not been perfected to a point where it would give the service required under mining conditions or for the reason of a lack of information concerning the characteristics of the rectifier itself. Therefore, a brief description of the metal tank mercury arc rectifier with its general characteristics, advantages, limitations and its position regarding present applications to other industries may be of interest.

The development of the steel-tank mercury-arc rectifier for changing alternating current into direct current has now progressed to such an extent as regards performance, life, efficiency, reliability, etc., that it can be seriously considered where conversion equipment is needed. This is shown by the fact that the General Electric Company alone has in successful operation or on order, approximately 312,000 kw. capacity in the United States and Canada. A large majority of this is used in railway service at various voltages from 600 to 3,000 volts, but several equipments are also in use in industrial service, some at 250 and some at 600 volts d-c.

The fundamental valve characteristics of mercury vapor makes possible the rectifier as it is used today. The mercury vapor allows

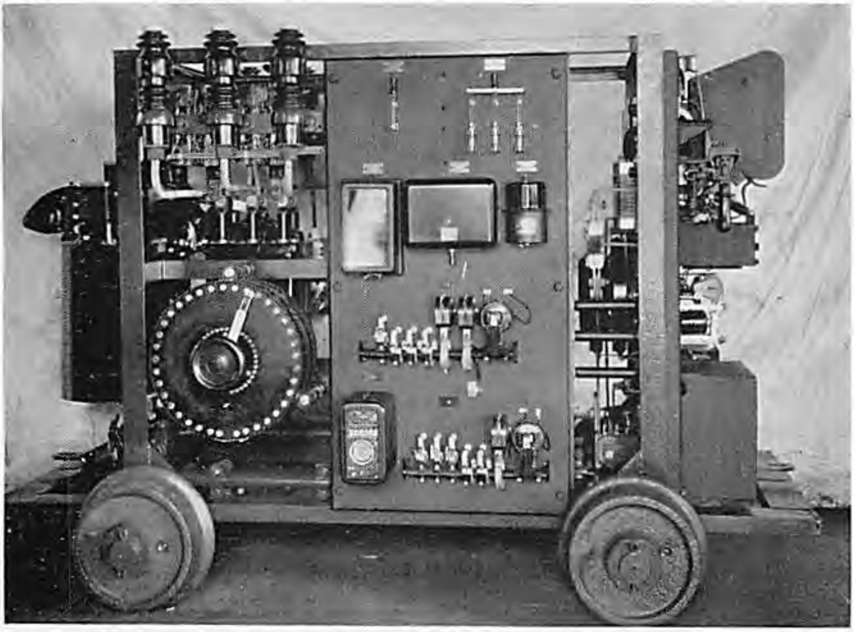


FIG. NO. 2—*Side View of Portable Switchgear Equipment. Full Voltage Starting—150 Kw.—275 Volt Set.*

current to flow in only one direction when voltage is applied and acts as a definite check valve to the flow of current in the opposite direction. It is, therefore, possible to rectify or convert alternating current to continuous current by means of this device when the proper transformer connections are used with a sufficient number of anodes to give a smooth voltage and current output.

The metal-tank mercury-pool rectifier consists essentially of a vacuum tank, a common cathode in the base and a number of anodes, depending on the transformer connection, in the cover with a suitable cooling and exhaust system. The cathode forms the positive side of the d-c. system and neutral point of the transformer equipment forms the negative side.

The vacuum system consists of a condensation vacuum pump to maintain a vacuum of approximately .3 to .01 microns in the vacuum chamber and exhausts into a receiver tank. A motor-operated rotary pump is also supplied which may be arranged to operate continuously or intermittently and is connected so as to keep the receiver tank at the proper pressure. Maintaining of the proper vacuum in the rectifier tank is essential to the successful operation of the rectifier and, therefore, an efficient and reliable vacuum system is necessary and it is also necessary to have a tank as near vacuum tight as possible which is obtained by careful construction and tight joints at all points, where a joint may be necessary.

Figures Nos. 3 and 4 show an external view and cross section of a typical low voltage rectifier.

It is necessary to supply cooling water to the vacuum tank and the condensation pump and that this water be of a proper characteristic so that it will not foul or corrode the cooling passages of the rectifier and pump. In the past, it was often the practice to supply cooling systems from tap water, that is, water which is taken from a supply system to the rectifier and returned into a discharge line of some type. As the water available in a number of locations is not suitable for cooling direct, the present practice is

FIG. No. 3—*External View of typical Low Voltage Rectifier Tank with Auxiliaries.*

to furnish a water-to-water heat exchanger where water is available. With this method a heat exchanger of the tube type is furnished and the tap water is passed through this similar to the arrangement used on a generator air cooler. The cooler may be readily cleaned. A closed circulation system of the cooling medium between the cooler itself and the rectifier tank and pump is maintained. This requires a relatively small amount of water and is treated with a chemical so as to reduce corrosion to a minimum and with this method, cleaning of the tanks, etc., has been found necessary only at very long intervals and results in a much longer life of the metal parts.

When cooling water is not available, as might be the case in a number of mines, a water-to-air cooling system may be supplied. With this method, the circulation system between the rectifier and the cooler is similar to the water-to-water heat exchanger but air is used as a cooling medium on the cooler itself. This is furnished by a motor driven fan somewhat similar to an automobile cooling system.

A rectifier has a number of features which are an advantage over rotating apparatus and some which

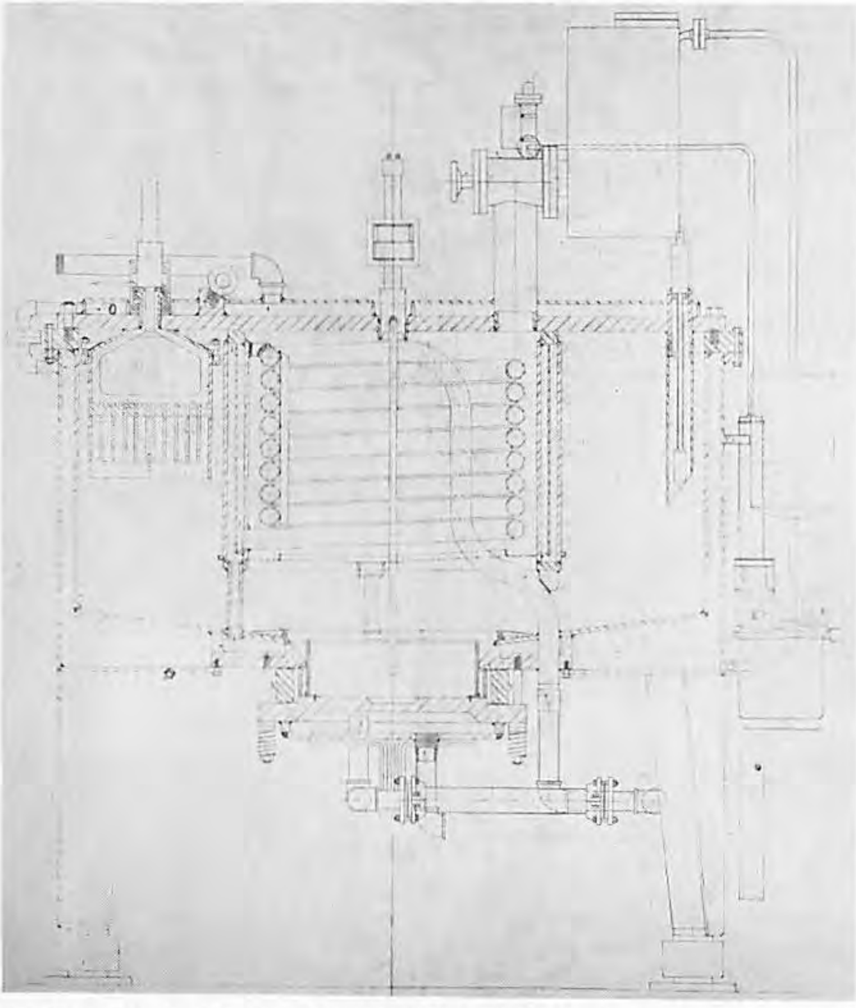


FIG. No. 4—*Vertical Section of typical Rectifier Tank showing arrangement of parts.*

may or may not be, depending on the individual installation.

A rectifier has an advantage of being a static machine with no large rotating parts, is practically noiseless in operation, and will readily withstand the overloads met with in mining service. It has no commutator or bearings that require maintenance, and no brushes to be periodically replaced as in the case of rotating machines. There is no external sparking or arcing which might be an objectionable feature in mine service. The rectifier tank itself, is lighter in weight than correspondingly rated rotating apparatus, and therefore, does not require special foundations or heavy equipment for handling. It has long life and is simple to operate and control. The control may be of the manual or automatic type. Rectifiers can also be furnished of the portable type if required.

While this feature may not be so important for mining service, a rectifier can be furnished with what is called grid control or thyratron action, that is, the d-c. voltage output can be controlled by the use of internal grids. This is used where variable d-c. voltage is required and can be used to furnish compounding to take care of line variation, or to give a flat voltage curve on the rectifier. When grid control is desired, it will require some additional auxiliary equipment and may cause a very slight decrease in efficiency. It also affects the power factor which will be reduced from the standard value by approximately the same percentage as the voltage is reduced below normal rating.

Rotating types of conversion equipment with a commutator were subject to flashovers, which condition has been materially improved in the present day machines.

Rectifiers are also subject to a somewhat similar phenomenon called an arc back, which is essentially a short circuit between anodes or between an anode and a cathode spot.

This takes place inside the tank and it is therefore difficult to determine the exact causes, but manufacturers have continually improved their design so that arc backs have now been reduced to a point where they need not be considered a serious matter in the application of rectifiers. Some rectifiers have a record of a year or more of operation with only a minor number of arc backs; in one case, only

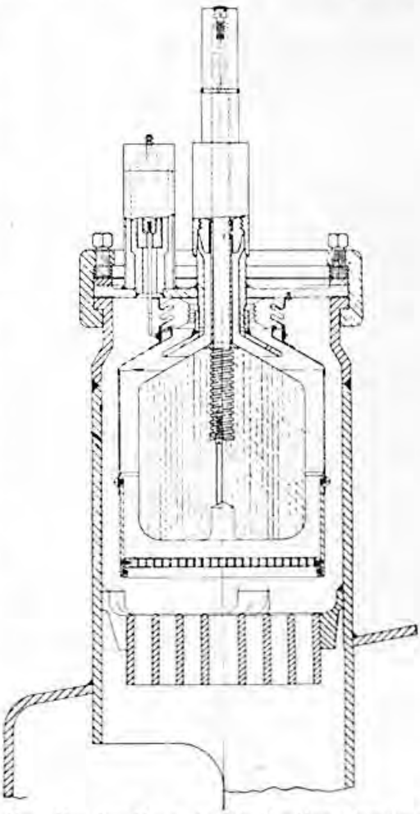


FIG. No. 5—*Main Anode Section showing Mycalex seal, Anode Baffle and Grid Parts.*

FIG NO. 6—*Main Anode and Mycalex Seal.*

one for a year on a 6500 kw. unit. The ordinary arc back does not cause damage to the rectifier itself but causes the circuit breakers to open, as in case of overloads, and this extinguishes the arc.

A proper cooling system and a tight vacuum system assist to a large degree in eliminating arc backs. Therefore, a construction that eliminates all joints possible and that insures a vacuum tight joint where necessary tends to reduce arc backs. The anodes are insulated from the tank, the insulator also acting as a vacuum joint. This insulation consists of a special moulded material known as Mycalex, having high dielectric and mechanical strength. The construction is shown in Figures Nos. 5 and 6. In the design shown in Figures Nos. 3 to 6, the extension collar of the main, starting and holding anodes, are all solidly welded to the removable cover, and joints where required, are all made with a careful machine fit and aluminum seals. This type of construction reduces the leakage of air over that obtained with the removable clamped type and is considered a distinct advance in the art.

A more detailed comparison of certain items for the three types of equipment may be of interest. This is based on the ratings usually supplied for mining service and may vary somewhat for other ratings.

Floor Space:

The total floor space occupied by the three types of equipment, including transformers and necessary auxiliaries, is lowest for the motor generator set with the synchronous converter next and the rectifier slightly higher. The space for the rectifier equipment is divided between the rectifier tank, its transformers and any cooling equipment that may be required. The rectifier tank, itself, requires appreciably less space than the motor generator set or synchronous converter.

Weight:

The total weights of the three types of equipment are approximately the same, depending somewhat on the type of cooling equip-

FIG. NO. 7—*Cathode Assembly showing Insulator and Quartz Rings.*

ment, but the weight of the rectifier itself, which would determine the main foundation, is considerably less than that of a motor generator set or a converter. The weight for transporting can be cut down by removal of the water from the rectifier cooling circuit.

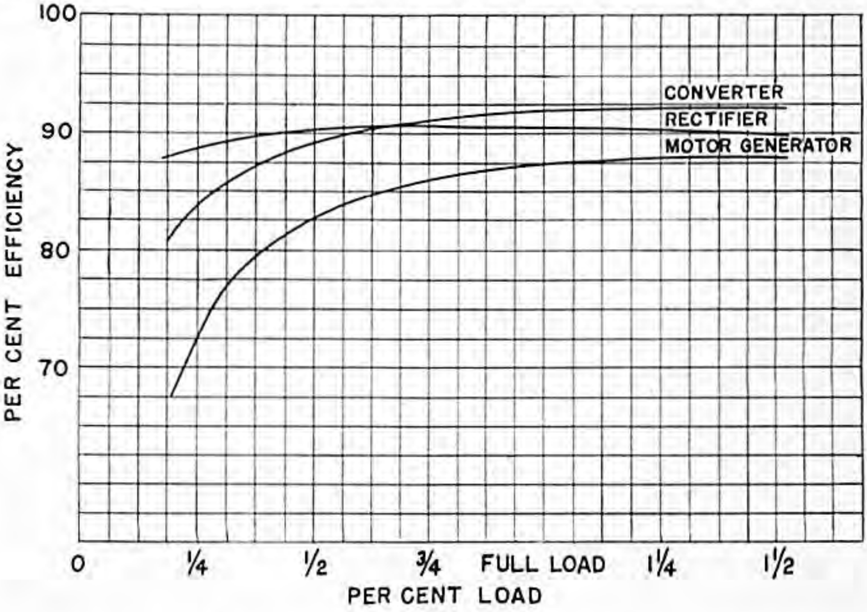
Maintenance:

Maintenance on motor generator and synchronous converter equipment is fairly well known for general mining service and in general will be higher for converters on account of this equipment having both a-c. and d-c. brushes to maintain.

Reliable figures on maintenance of rectifiers are difficult to obtain on the up-to-date type of rectifier which shows a considerable improvement over the older designs. Complete figures are not available at the present time, but data available indicates that it will not be more than for rotating equipment, and should be considerably less.

Efficiency:

The efficiency of a rectifier equipment will be higher at all loads than that of a motor generator set with a considerable improvement at light loads. The efficiency curves of a synchronous converter and a rectifier cross at about the ¾ load point. Above this point the converter shows an advantage, while at light loads the rectifier has an



EFFICIENCY CHARACTERISTICS OF STANDARD SYNCHRONOUS MOTOR GENERATOR SETS, SYNCHRONOUS CONVERTERS AND MERCURY ARC RECTIFIERS WITH TRANSFORMER LOSSES.
RATING 300 KW.-275 V.-D.C.-3 PH.-60 CY.-2300 V.-A.C. 0.8 PF. SYNCHRONOUS MOTOR

FIG. No. 8.

appreciable advantage. This high part load efficiency is of particular importance to mining installations in which the conversion apparatus is operated at light load for considerable periods. This may result in an overall or all day efficiency, that is considerably higher for the rectifier equipment than with rotating apparatus even though the rotating apparatus may have better efficiency at or near the full load ratings. Figure No. 8 shows the comparison of efficiency for these three types of equipment on a 300 kw. rating.

Efficiency of the rectifier is mainly dependent upon what is known as the arc drop, or the voltage across the anodes to cathode. This is the main loss; there are other smaller losses such as the vacuum pump, anode heaters and auxiliary transformers and the main transformer loss.

The arc drop is dependent on the distance from anode to cathode and area of the enclosing tank for the passage of the arc stream. Manufacturers of rectifiers are continually endeavoring to lower the arc drop which would increase the efficiency, particularly for the lower voltage tanks and it is quite possible that considerable improvements can be made in this in the near future. The arc drop is very largely independent of the voltage of the rectifier so that the arc drop for a 250 volt and a 500 volt rectifier would be approximately the same for the same current and, therefore, the efficiency for a 500 volt equipment would be higher than that of a 250 volt equipment. Consideration should therefore be given to the use of higher voltages when possible, if increased efficiency is desired.

Power Factor Corrective Capacity:

It is usual to operate a synchronous converter with a field setting to give unity power factor near full load so that it has small corrective

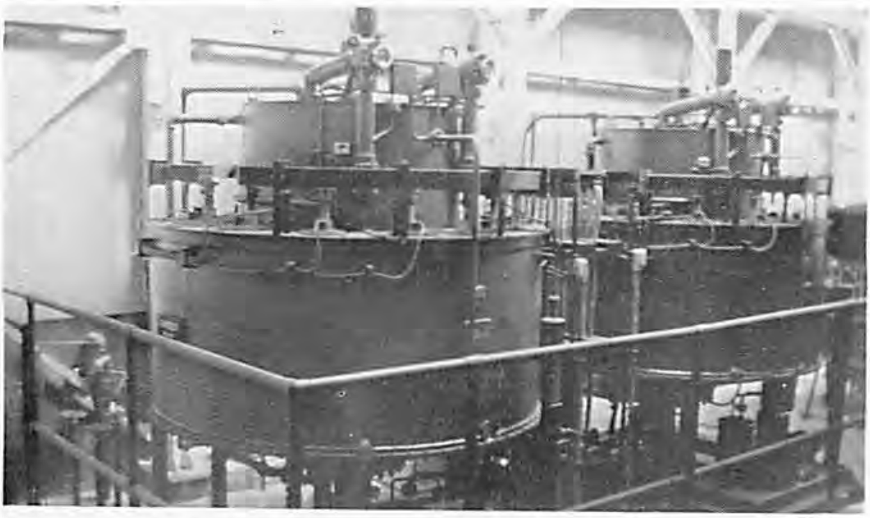


FIG. No. 9—*6500 Kw.—10,000 Amp. Rectifier Consisting of two 3250 Kw.—650 Volt Tanks in Electrolytic Hydrogen Service.*

capacity. Motor generator sets are usually ordered with a rating at 0.8 leading power factor, and therefore have considerable corrective capacity. The power factor of the ordinary rectifier equipment without grid control will be approximately 95% lagging. The rectifier itself does not have corrective capacity, but as it operates so near to unity, it will not noticeably affect the power factor of the ordinary system.

It is evident from the foregoing brief review of the characteristics of the metal tank mercury pool rectifier that it has advantages which should be seriously considered where conversion apparatus is required.

* * *

Chairman Wilcox: Thank you, Mr. Connell. There isn't any use of my trying to pretend or put over the idea I could ask Mr. Connell any very intelligent question. In fact, at times there I had the idea I was back in the House of Magic. I would like to see what Carl Lee has to say. Where is Carl?

Mr. Carl Lee (Chief Electrical Engineer, Peabody Coal Company): Mr. Chairman and gentlemen, those of you who have stayed here evidently have some interest in this subject, and I think with this presentation we have an excellent opportunity to get some new ideas of conversion equipment.

I might say in my observation the manufacturers in years gone by have tried to adapt the so-called industrial equipment to mining service, and in my opinion there have been a lot of mistakes made in that. For example, on the rotating apparatus, we have difficulty in getting it into the mine. This is on account of clearance. The slide showing the set fifty-two inches high shows an improvement along that line.

Only occasionally—recently we had occasion to set in an emergency set, 400 K.W. set, the same as shown except that it is a nine R.P.M. set, and it was impossible to get that set complete and into the station assembled on a truck. We had sixty-five inches height, and in order to get it in we put it on a sled, a steel plate, and dragged it in. It weighs about eleven tons, and I think we used about thirty tons of locomotive to pull it in, and slid it about a mile and a half over the rails.

On switchboards, for example, most switchboards manufactured are somewhere around ninety inches high. Very few of them have a natural height of ninety inches in the coal seam.

The industrial equipment has been designed, apparently, for locations where floor space is a premium and height is the thing they have to spare. They build with that idea, and put in equipment ninety inches high. In a coal mine floor space is not so much a point, but height is often a very serious problem.

Take the transformer for the rotary converter, eighty-four or ninety inches high. You have to take the oil out, lay it on its side, take it inside and reset the transformer, and all of it exposed to the moisture, with the result you have some possible damage to your equipment.

Another point in design, manufacturers of most of the industrial equipment design it for use in atmosphere which is normal, you might say. In the coal mine, inside, or where there are dumps, we have some corrosive steam or gas. The mine gases themselves may be slightly corrosive, and added with that the powder smoke of various kinds where powder is permissible and other explosives add something to the atmosphere which causes a lot of grief. Copper contacts corrode, and oftentimes other small contacts will cause complete failure of automatic equipment, for example.

This presentation of the mercury rectifying is a very interesting thing, and as I say I think it is an excellent opportunity to get some first-hand information.

If the manufacturers are in a position to design these sets for mine use—when I say that I mean portable equipment with suitable height limitations so that we can put them on a truck and roll them in and put them in service, it is worthy of notice. Most of the operators in this State of the larger mines will be interested, for we are reaching the point, and I believe the tendency will be more toward the larger and heavier load in the mechanical mine, particularly at remote distances which means wherever a sub-station is in service—we have the possibility of that sub-station going down and spare portable units would be a very, very desirable thing. If you lose your source of D.C. supply, the section is down, and substantially that means that the mine cannot operate profitably. That is, on a reduced load.

Just a few other small points directly on this paper. Our particular company has for a number of years used clamp type terminals. We have found those very desirable and very satisfactory as compared to solder and bolt or plug connectors. Plug connectors are all right at the start, but most of them somehow do not have sufficient pressure on them or sufficient pressure to prevent corrosion.

These pyronol transformers bring out a point interesting as compared to the first paper presented this morning, namely Safety. We do have a potential hazard in the mine when oil-filled transformers are used. Fortunately, there have been very few cases of those being struck by lightning or the tank destroyed and fire starting. When you have that happen you have a real fire.

The pyronol transformer heretofore has been considered more expensive than oil-filled transformers. I can see no reason why the cost of those might not be reduced by producers. In connection with this transformer, when we get those designed with a minimum height, or rather than a transformer ninety inches high we get one on the trucks forty inches or less in the mines, that will fit in the picture very nicely.

These curves shown for 275 volt equipment, while Mr. Connell brought out the point that the high efficiency and low load is desirable. I will admit that, but in mechanized mining that argument has lost some of its weight, for we have found that in the mechanized mine the ratio of the average over the maximum load is considerably higher. I would say offhand possibly twenty-five to forty per cent. We have more continuous service with mechanized mining than hand loading.

Personally, I would like to see other discussion on this subject, for I believe there is an opportunity to get some real information which we may have occasion to consider in the near future.

I thank you.

Chairman Wilcox: Thank you, Carl. I still have to leave the discussion open to you folks instead of trying to lead it myself. Is there anyone else who has either some question to ask or some comment to make? Well, I shall proceed.

I want to express to this body first my own appreciation, and in a sort of backhand way the appreciation of these gentlemen who prepared these papers. I think your attention and interest have been worthy, and I think the papers have been worthy of that attention and interest.

Before closing, I do want to remind you that the meeting will open promptly at two o'clock this afternoon. I would like to ask the Secretary if he has a statement to make.

Secretary Schonthal: I would like to remind you that Mr. Smith still has a few tickets for the football game. There are several of you who have asked for them.

We would like very much to get the meeting started at two o'clock this afternoon, so that we can finish on schedule.

I would like to make the request that the fellows in the back room come into the meeting this afternoon, for this exhibit is really a test exhibit. If the thing will interfere with the meeting, we will discontinue the practice. It is a test of what will happen. There are many people who do not come in. I think we should have more of a crowd this afternoon than we have had, and the meeting will start at two o'clock.

Tickets for the banquet will be sold between now and this afternoon, and the Hotel is very anxious to find out how many to provide for. That is all.

Chairman Wilcox: The meeting will be adjourned.

AFTERNOON SESSION
2:00 O'clock P. M.

Meeting reconvened.

President Sandoe: Gentlemen, I want to introduce to you Mr. H. H. Taylor, Jr., Vice President of the Franklin County Coal Company, who will be your Chairman for the afternoon.

Chairman Taylor: Gentlemen, we are gathered here this afternoon to hear two very interesting papers. Without further ado, I will introduce to you Mr. Henry F. Hebley, Research Engineer, Allen & Garcia Company, Chicago, who will discuss the "Fundamentals of Coal Cleaning." Mr. Hebley.

Mr. Henry F. Hebley (Research Engineer, Allen & Garcia Company, Chicago): Mr. Chairman and fellow-members, I have prepared a paper here this afternoon practically devoid of any technical jargon.

FUNDAMENTALS OF COAL CLEANING

By HENRY F. HEBLEY,

Research Engineer, Allen & Garcia Company, Chicago. Ill.

In the following article an attempt has been made to describe, in non-technical manner, some of the phases of a subject very much under consideration at the present time;—namely, "coal cleaning." Too often articles are prepared in which highly technical jargon is used, and they lose in usefulness because unfamiliar phrases are adopted, in place of simple language.

Some of the descriptions herein may not be all the technical man could wish, as it is manifestly impossible to portray the exact actions that take place in certain operations without losing in simplicity.

The subject under consideration is very broad, therefore it is only possible to touch the more important points, leaving the others to be described at some later time.

The question usually occurs to us as some time or other "Why clean coal?" Generally, or at least very often, it is because our competitors are cleaning their output;—but the other reason is, a desire to make the coal produced, a better fuel, with less ash and sulphur. A large proportion of ash and moisture, both of which do not burn, or coke, reduces the value of a fuel;—and sulphur, although it is combustible, is a nuisance from any point of view. Therefore, the chief aim in the design of all coal cleaning plants is to reduce ash and sulphur.

In considering how to remove such impurities, it is very helpful to know, in a general way, how such impurities became associated with the coal, to contaminate it. As is well known, all coal had its origin in the vegetation of a bygone age. It would be pointless to discuss the various theories regarding the formation of coal, suffice to say that in that formation, the impurities were taken up.

When wood is burned, there is always something left on the grate; —ashes. When the vegetation was lying in the marshes and swamps, the rains washed down silt and sediment from the neighboring lands, and this mud settled on and around the various coal forming plants. This dirt became intimately mixed with the coal substance. These two sources of impurities are practically impossible to remove;—so it is well to remember, especially in the midwest field, that one can never remove all the ash from coal. The amount that will remain depends on its history during the coal forming and later periods, and to design a cleaning plant for a certain coal requires that tests be made to find out how the ash is associated with the coal.

It often happens that a layer of mud, thicker than usual has lain over the coal-forming vegetation, and it appears in the seam mined as a "parting." It may be only ½" thick, or it may be several inches, as in the famous "blue band" of Illinois No. 6 Seam.

Impurities of this nature can often be removed by freeing them from the coal to which they are attached, and then treating them both in a coal washing system.

Frequently, it has occurred that mineral laden water which has passed over limestone, clay or gypsum, has trickled into the cracks and crevices of a coal seam, and there deposited lime, pyrite, and clay,—further raising the ash content.

All the foregoing impurities became associated with the coal during the processes of nature; but there are other sources of contamination which add to the cleaning problem.

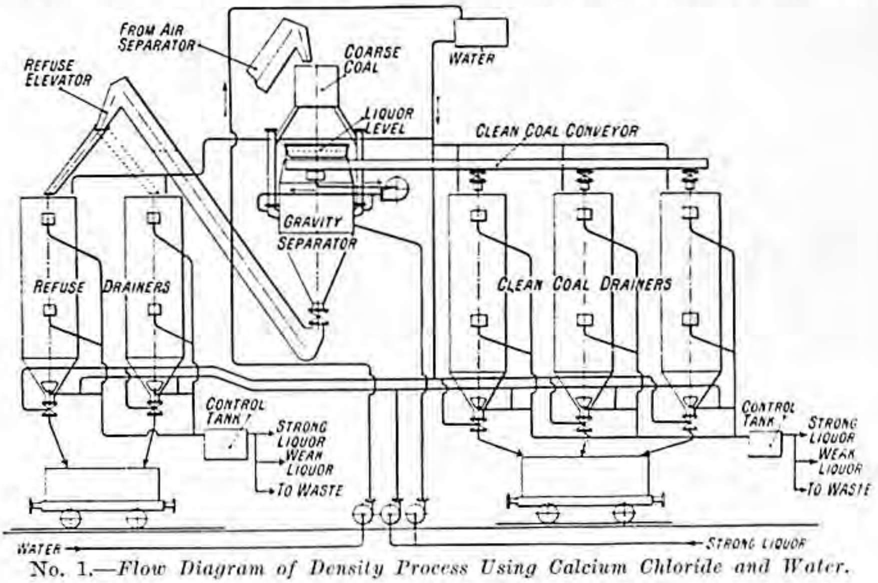
In mining the coal, it may be that the machines are cutting in the fire-clay bottom, in the band; or a shearing cut has been adopted. Such procedures add a quantity of very fine dust to the coal loaded out, and, dependent on the type of material in which the cut was made, may be a dust of practically pure dirt. Summing up then, our impurities come from the natural ash in the wood, the sediments of clay and sand deposited on the vegetation forming the seam,—the minerals, such as limestone, gypsum, pyrite, etc., that are deposited by water, and the dirt, coming from the roof, floor, and cuttings.

Our problem is the removal of the impurities as far as possible, and still to keep the cost of the plant and its operation within reasonable limits.

What principles are there available which will separate the dirt from the coal? A process depending on the principle of density offers one solution. If we take a piece of 4″ x 4″ lumber, 4″ long, and nail a 1/16″ steel plate on one surface, and then toss the steel shod piece of lumber into a tub of water, the piece of wood will float and support the steel plate. Now draw the nails and separate the steel plate from the wooden block, and toss both into the tub of water. The wood floats a little higher out of the water and the steel sinks to the bottom. This is a density separation.

Suppose the wood represented clean coal and the steel plate, a layer of dirt,—then if there was not too much dirt attached to the coal, the combination would float, and there would be obtained "float" coal, with a low percentage of ash. The amount of dirt attached to the coal may have been so great that the coal sank with the associated impurity. Such a product would be "sink" coal, and would be high in ash.

Unfortunately commercial coal, no matter how free from heavy dirt, will not float in water. Therefore a liquid is required which will float the clean coal, and still let the dirt sink. There are many available, but most of them are too expensive to admit being used on a commercial scale, although they are very convenient for testing purposes, where only small quantities are required. Only two will be mentioned here. Carbon tetrachloride, or, as it is so often called at the mine "carbon-tet,"—is a liquid that weighs about 1½ times as much as water. It can be mixed with gasoline, and in this way any range of weight



No. 1.—*Flow Diagram of Density Process Using Calcium Chloride and Water.*

from say 1.3 to 1.5 times the weight of water may be obtained.

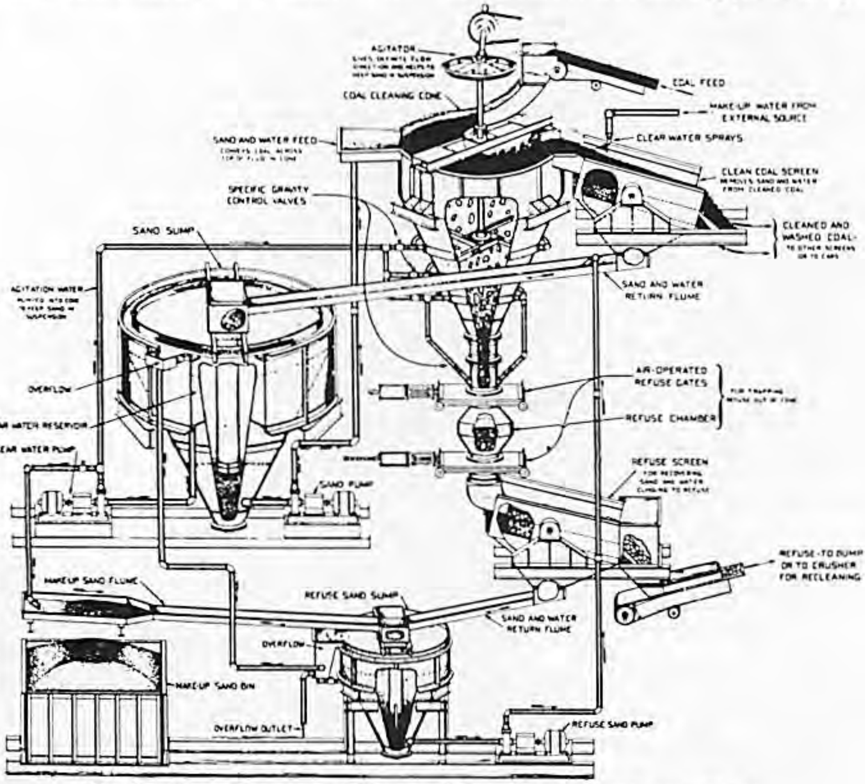
Such a mixture is like gasoline, in that it evaporates, and any sample of coal that has been immersed in it, will dry off very quickly. This is a great advantage in rapid test work.

All are aware that salt-water is heavier than fresh water. The bathing beach at Salt Lake City, where a person cannot sink is a good example. Therefore, if salt could be mixed with water to yield a liquid much heavier than the fresh water, the same end would be obtained. Common salt, present in the ocean and Great Salt Lake is known by the chemical name of Sodium Chloride,—and Sodium is a metal. Unfortunately common salt does not yield a liquid suitable for our purposes.

Luckily there are other salts, belonging to other metals, and the salt of the metal zinc, known as Zinc Chloride, if mixed with water in the proper proportions, will yield a liquid of sufficient heaviness for test purposes.

As, at the present time, the cost of using pure density liquids is too high, the next step is to devise some means whereby the principle of a heavy liquid can be in effect maintained, but using agents which are easily procurable.

Everyone has heard of "quicksand," which is so sodden with water that it will not support heavy



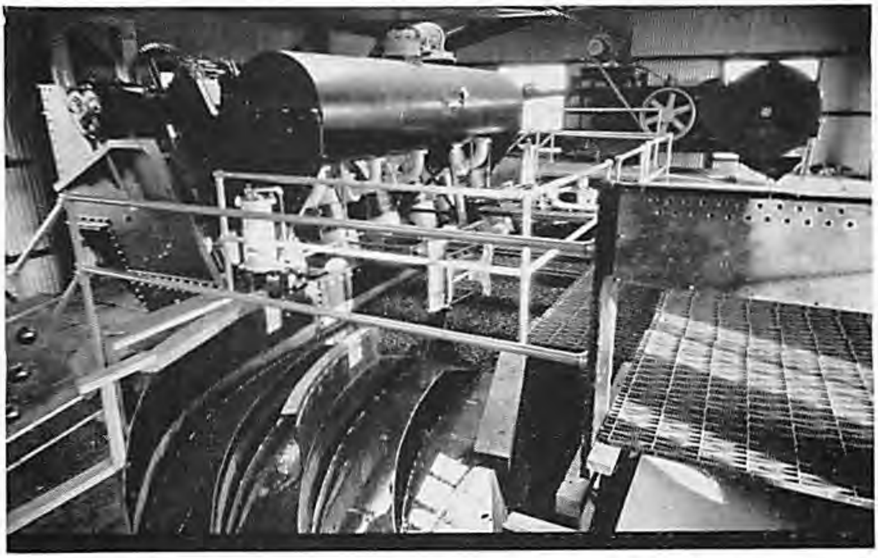
No. 2.—*Flow Diagram of Density Process Using Sand and Water (Chance Process).*

material. By mixing sand and water, and giving the mixture an upward current, a liquid of sufficient heaviness to support the clean coal and yet let the heavy refuse sink through it, is obtained. Sand is not the only material that is in successful use, as finely ground spar, and clay, have also formed the basis of a density liquid.

Generally, these systems place the liquid, of sand and water, in a cone, and the feed is delivered to the surface. The coal that floats is moved off, over a lip, while the material that sinks is removed at the peak of the cone, at the bottom.

With such a system, the feed must either float or sink, and if 6 inch coal is being treated; it often happens that a 6 inch lump has a piece of very heavy pyrite attached to it, which is sufficient to sink it. To lose such a piece as refuse would be extravagant. Therefore, a second cone can be installed, whose liquid heaviness is great enough to float the piece, or it can be crushed, to break the pyrite off, and then sent through the cone a second time, for separation.

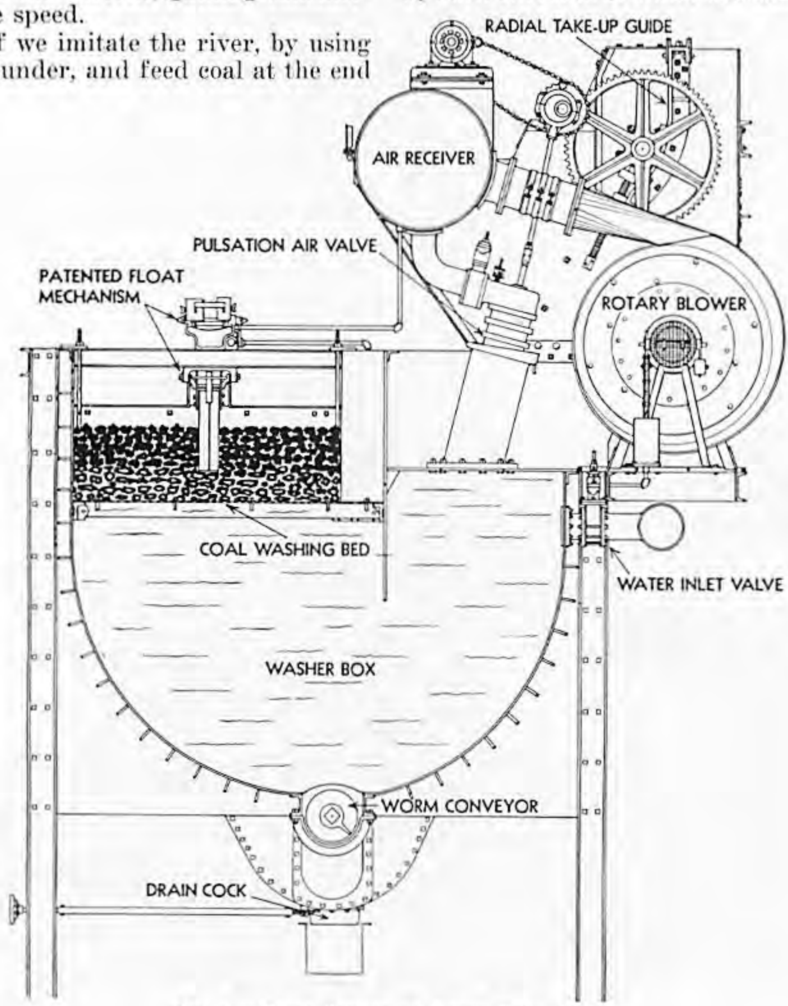
Decades ago it was discovered that if raw coal was placed in openly woven wicker baskets, and the baskets plunged up and down in a tub of water for a few minutes, the coal would come to the top, and the refuse would be on the bottom. The upward current of water, through the wicker basket, as it was plunged downwards, brought about a condition similar to a heavy density liquid, and the coal rose to the top; while the refuse sought the bottom. In a short time, the basket was replaced by a fixed sieve deck, and a piston was worked up and down to cause the upward current. Subsequently, the piston was replaced by compressed air, which, in expanding, drove the water before it to create the same upward surge. Certain other features were added, to improve the action, but, fundamentally, that is the action of jigs.



No. 3.—*Photograph of Discharge from Baum Type Jig.*

Everyone familiar with coal and its impurities has noted that coal itself tends to be in the form of cubes, whereas the dirt is more or less flat, like pieces of shale. If material composed of cubes and flats were subjected to a flowing current of water, similar to a river, it would be found that the flats would deposit on the river bed, and move but slowly down its course; while the cubes would bowl along with the current, gaining considerable speed.

If we imitate the river, by using a launder, and feed coal at the end of it, the heavy flat refuse will sink and move slowly along the bottom. If pockets with slots in the bottom of the launder are installed at intervals down the length of the launder, then the slow moving refuse will drop through the slots, and be trapped out; while the fast moving clean coal has sufficient speed to carry it over the slots to the discharge. As an additional protection against the clean coal dropping out, upward currents of water are some-



No. 4.—*Cross Section of Baum Type Jig.*

times added to the pockets, or boxes.

Such a system is very flexible, as so many arrangements of boxes and launders are possible. The capacity of such a plant is also very large.

The difference in shape between flat shale and cubical coal is used in dry cleaning systems, such as spiral separators, mechanical picking tables, and some tables which use a current of air passing up through the coal on the table to bring about stratification. The difference in friction between shale and coal is also used, to help the separation.

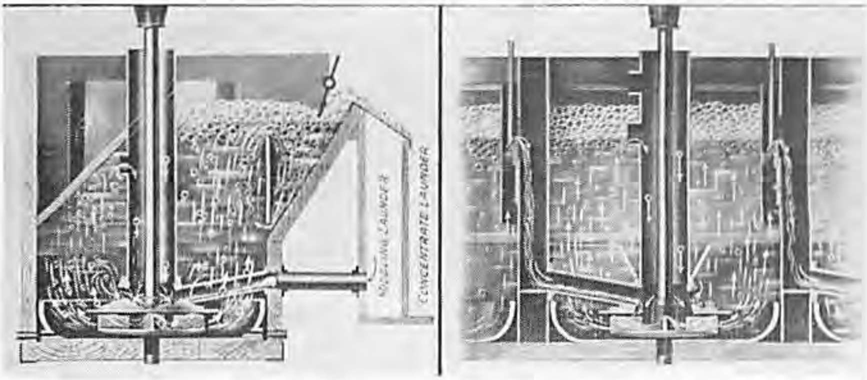
Another property of coal and refuse which forms the basis of separation, consists in the difference in the "springiness" between coal and shale. If coal is dropped on an inclined heavy glass plate, it bounces further than a piece of refuse, especially flat refuse. Such machines require a feed that is very uniform in size, and thus require efficient screening. It should also be borne in mind that each piece of material should have its chance for an unhindered "jump."

When one encounters very fine particles for cleaning two methods offer possible solutions, namely, wet tabling and flotation.

Wet, or concentrating tables, to a certain extent make use of the separating effect of "river flow" previously mentioned; but the heavy refuse is caught by small wood strips and is worked down to one side, while the clean coal jumps the barriers and flows off to another gathering point. The table is tilted, and is oscillated to help the separation.

The principle underlying separation by flotation is very hard to describe, without resorting to technical language; but what follows, although it does not present an adequate picture, will give some indication of properties that are used. Most of you, at some time, have taken an ordinary sewing needle, dried it thoroughly, and then carefully placed it on a raft of cigarette paper, floating in a glass of water. Ere long, the paper became water logged, and sank, leaving the steel needle "floating" on the surface of the water. It was supported by the "water skin."

Probably it has been noted that various materials are harder to wet than others, and it is this property of "wettability" which is used in plain flotation.



No. 5—*Flotation System, in which Oil Bubbles Act as Pontoons to Lift Submerged Coal.*

Later it was found that if oil of various sorts and proportions were agitated, and air bubbles in the form of a froth were formed, that the clean coal in a feed would become covered with sturdy little bubbles, which act as little pontoons to float the submerged clean coal to the surface, where it is skimmed off to be separated from the bubbles. Such is "froth flotation." There are available, various machines depending on the principles described, and although the following list is not to be regarded as complete, it is added to afford examples of each class, so far discussed.

Density Processes: — Chance, Weunch, DeVooys, Lessing.

Jigs: — Plunger or Piston, — Montgomery, Pittsburgh Coal Washery, Stewart; Air Piston, — Link Belt, Jeffery, Pittsburgh McNally.

Launder:—Rheolaveur.

Upward Current:—Hydro-Separator, Robinson Tub, Hydrotator.

Air Tables:—American, Birtley, Kirkup, Raw.

"Jump the gap":—Berrisford.

Friction:—Spiral Separators.

Concentrating Tables:—Deister, Overstrom, Plat-O, Wilfley.

Flotation:—Fahrenwald, Minerals Separation, Elmore.

It must be observed that, although the selection of a specific cleaning process fixes, to a certain extent, the design of the plant, there are numerous very important matters that must receive thoughtful consideration and provision. Neglect of these points can make a plant an utter failure.

Where wet cleaning is adopted, the influence of water is of paramount importance. Clearly an adequate water supply is the first essential, and it may require elaborate systems for settling the fine particles of coal and dirt out of the washery water, which it has picked up during its use in the coal cleaning system.

Water creates a drainage problem, both in the clean coal and in the refuse; as too much water may cause freezing troubles with winter shipments, and efficiency losses during the use of the coal. Let us consider the drainage problem:

As the coal leaves the wet cleaning equipment, it is sized on screens and subjected to the rinsing action of water sprays for removing small particles of dust which may be on the surface of the coal. The coal then experiences a period of draining time, which may be short or long, dependent on the conveying system to the railroad cars.

With material over ½″ in size, the water runs off the surface quickly, and as there is ample space between the pieces of coal, the water can escape as fast as it runs off the surfaces. Generally no trouble will arise from excess moisture with these coarse sizes, and gravity drainage is all that is needed.

The moisture present is on the surface of the coal, so the more the surface present, the more the moisture. As an example, let us take a one inch cube of material, and reduce it to cubes of smaller size, and compare the surfaces developed.

1—1″ cube equals 1 cub. in. and has 6 sq. in. surface.

8—½″ cubes equal 1 cub. in. and have 12 sq. in. surface.

64—¼″ cubes equal 1 cub. in. and have 24 sq. in. surface.

512—⅛″ cubes equal 1 cub. in. and have 48 sq. in. surface.

4096—1/16″ cubes equal 1 cub. in. and have 96 sq. in. surface.

Therefore the same quantity of coal can have vastly more surface, as the size of the particles become smaller. They also have a tendency to pack close together, leaving very small spaces between the particles. When such material has the surfaces of the particles covered with water, it will not drain freely; but will retain the moisture, in a manner similar to a sponge or a water soaked building brick. Natural drainage is very slow and unsatisfactory; but, provided pieces smaller than 1/100 inch are not present, if the material is placed in a perforated basket, and both coal and basket are rotated at a high rate of speed, a large percentage of the moisture will be spun off the coal, and through the holes in the basket. Such machines can reduce the moisture content in the feed from 20% to 7%.

Sometimes it is necessary to resort to other methods of moisture removal, and then the use of heat for drying the coal is the natural thought. This subject cannot be treated fully here; so only a few principles will be stated as guides.

Heat alone is insufficient. Wet coal could be placed in a closed container and brought to the boiling point of water, and after the contents had cooled, and the container been opened, the moisture would still be present with the coal. It is important that the moisture be carried away as fast as the coal gives it up, and to cause coal to give up its moisture, hot furnace gases, tempered by air, are passed through the coal mass. These gases perform a two-fold duty, they provide the necessary heat for changing the water into vapor, and then absorb that vapor and carry it out of the dryer, if the dryer is properly proportioned.

It should be remembered that all air likes to carry water vapor if it can get it; but it can only carry a certain quantity, which depends on the temperature of the air. As an example:—

1 lb. of dry air at 70 degrees F. can carry 0.01578 lb. of moisture as water vapor.

1 lb. of dry air at 150 degrees F. can carry 0.2122 lb. of moisture as water vapor.

1 lb. of dry air at 190 degrees F. can carry 1.0985 lb. of moisture as water vapor.

Therefore, the higher the temperature, the more moisture the gas can carry.

Care must be exercised to see that the gases, once they have absorbed their quota of moisture, do not deposit a portion of it as dew, as this can easily be brought about, by a slight fall in temperature. From the foregoing table, it will be seen that, if the temperature was lowered from 190 degrees F. to 150 degrees F., (40 degrees difference) the air would relinquish 5/6 of the moisture it was carrying.

It should be remembered that water can be removed without resorting to the violent bubbling known as boiling. Every housewife knows that on a "good drying day," clothes hanging on a line will have the moisture removed from them very quickly, even though the atmospheric temperature is only 60 degrees F. A good drying day is a day when the air is hungry for moisture, and when wind is blowing. The moving air of the wind, passing over the clothes, furnishes a clue to another requirement for efficient drying.

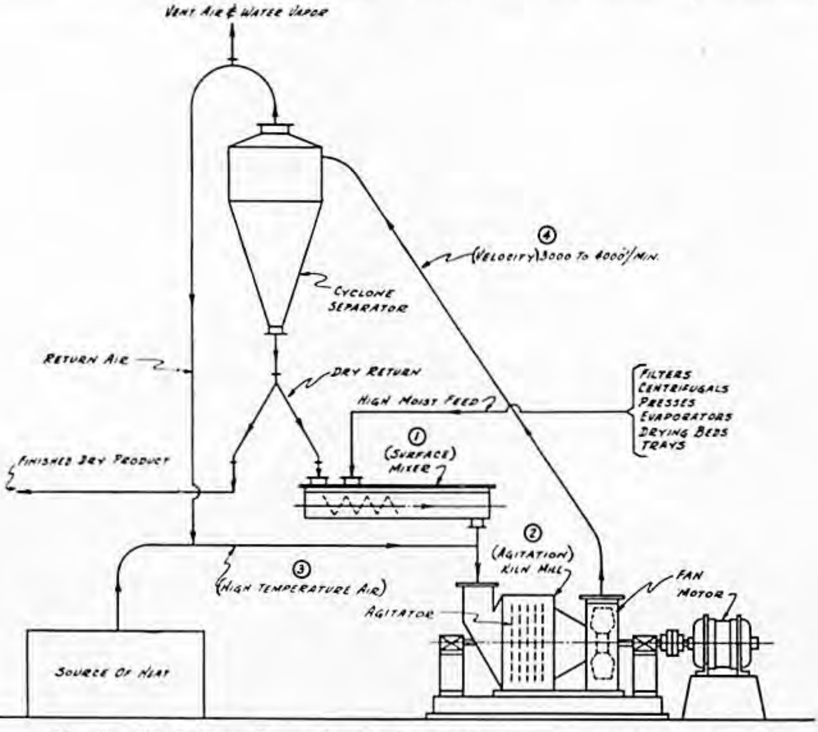
When coal is wet, its surface is covered with a layer of water. The drying gases in passing over the surface create a layer of vapor surrounding the wet surface of the particle. This layer acts as a blanket, and prevents further water from turning into vapor. The remedy is to blow the "blanket" off by making the drying gases pass rapidly over the material.

To indicate the value of rapidly moving gases on drying, the following table has been added:—

Speed of air passing over material in feet per min.	*Relative rate of drying*
750	0.545
1,000	0.728
1,250	0.865
1,500	1.000
1,750	1.180
2,000	1.410
2,250	1.730
2,500	2.000

The rate of movement of the gases cannot be made too great, as any dust that is present may be carried away, causing a dust nuisance. As the drying progresses, the water film around each piece gets thinner, until the high points of the irregular coal surface project through the film and become dry. When such a condition takes place, the rate of drying slows down, as the moisture in the cracks and pores of the coal cannot work itself to the surface fast enough to keep it wet.

Finally, in the third, or final stage of drying, the moisture below the surface is vaporized. This is known as subsurface drying, and it proceeds at the slowest rate. Previously we spoke of a "good drying day"—a day which feels dry, and fresh. The air on a day which is



No. 6.—*Flash Type Dryer for Drying Sludge from Dorr Thickeners.*

"sticky" or humid, has less drying ability. That is, the air contains a great deal of vapor already, and is slow to take up more. Similarly with drying gases, if they are carrying a lot of water vapor, then they will have difficulty in absorbing more.

If the gases cannot take up any more water vapor, they are said to be in a saturated condition, and the slightest drop in temperature will cause dew to fall. As a comparison the table given here shows the slowing down of rate of drying when the gases approach the saturated condition:—

Av. % of saturation of air	*Relative rate of drying*
20	1.0
25	0.95
30	0.87
35	0.81

To sum up: The drying gases should be as hot as the product will allow without spoiling. The velocity should be as high as practicable. The material should be exposed to the gases as much as possible. The saturation percentage should be the most economical. A good dryer will fulfill all these requirements.

The subject of water supply has already been touched on briefly; but it is worthy of further consideration. As the water is recirculated through the washery continually, the fine particles gradually build up, in suspension, until it is necessary to remove them. It is known that if dirty washery water is allowed to stand still for a period of time, some of the solids will settle to the bottom.

Generally the settling time required, for complete settlement, is far too long, and would require enormous basins at a huge cost. Some modification of the process is therefore adopted. No difficulty is experienced with the coarser particles, as they sink rapidly. Individual pieces of the very fine material, however, keep dodging about in the water, instead of sinking. This is especially true of clay particles. Each one seems to develop a protective covering of liquid, and when two of them come close together, they repel each other, and dart off in other directions. If these characteristics are overcome, then the solids will settle and comparatively clear water will result.

To bring about such settlement, lime, caustic soda and starch are amongst the most common materials used, although there are many such materials. How much of each ingredient will be needed, cannot be predicted without testing and experimentation.

In all the foregoing discussion, the measure of performance of any one machine, or of the whole operation, is based on testing, and testing is based on sampling. If the sampling is poorly carried out, then all results based on the samples taken, are just figures, and have no value, whatever.

At the present time, those interested in the study of coal are paying very close attention to this branch of coal cleaning, and all who are associated with this subject should acquaint themselves with the trend toward the statistical method of sampling.

Lastly, we in the middle west have a wealth of information available in the bulletins of both the Illinois State Geological Survey, and the University of Illinois, and if sincere study is given them, the labor will be well repaid.

* * *

Chairman Taylor: Thank you very much, Mr. Hebley. I am sure it is obvious to us in the coal industry in Illinois that there is a great deal of interest being shown at the present time in regard to the cleaning of coal. I think there must be in the minds of most of you a good many questions which Mr. Hebley might be willing to answer more in detail. I would like to call for discussion of this paper just read, and ask for anyone to make remarks about any particular part of the paper or ask any question.

Vice-President T. J. Thomas: We might have that coal shown on the screen again. I would like to know and I think many of us would like to know something about that.

Mr. Hebley: I think it is plain enough to see without the lights being taken off. You will notice there is an exhibit outside the door that the Illinois State Geological Survey has given. There are samples out there of vitrane, clarane and fusane. I do not think there is any durane there. I think Montgomery County is the only one having any of that one. The vitrane coal, you will notice, is the extremely bright, glass-looking material. That is their best coal. It runs low in ash, and has quite a high coke value.

The clarane is streaked. It is our next best coal. It is streaked with little portions of miscellaneous matter, and the general run is rather higher in ash.

The fusane, sometimes known as mineral charcoal, probably went through aerial decay. It was exposed to decay before it was forced down into the swamps. In that way it lost a number of its characteristics which it would otherwise have had. It runs very high in fixed carbon, with practically no volatile matter in it at all.

Fusane is very coarse, like a piece of charcoal, by itself. Due to its porosity, when the ground water has trickled into the swamp the minerals that were contained in it went to the rear portions of the Fusane and mineralized it, and that is the reason we get the high ash content of a great deal of our Fusane in Illinois. You can get Fusane that is fairly low in ash content, but at that time you will find it extremely powdery and very fine. When actually worked in your coal preparation plant you will find it extremely fine material.

Chairman Taylor: Any further questions or discussion on this paper? It seems to me, Mr. Hebley, there are several things of interest that you touched upon that I know if we could think of the proper question it would start discussion.

Vice-President Thomas: I would like to ask one more question. I understood you to say each particular plant or mine or coal would be constituting a study in itself, that may require treatment. Do you mean by that, different treatment so far as the plant is concerned, or different treatment from the standpoint of the liquid that may be used?

Mr. Hebley: You may not want to use liquid.

Vice-President Thomas: I understand that.

Mr. Hebley: In analyzing a proposal in the Midwest where we are not requiring cooking coal but, say, for instance, in metallurgic coal where your sulphur is a very, very important aspect in the whole affair, it may mean you must concentrate on the coal of the various sizes. It may be very clean in the smaller size and dirty in the larger. It may be the larger coal contains stuff that has to be crushed off. That means you must consider in the flow through the plant whether you are free of impurities before you clean or if you will pick off the best.

taking the remainder and crushing it and returning it to the flow.

There are certain characteristics. Franklin County, I do not suppose, would be very much different in digging in four mines in close proximity to each other. You can probably lay down general rules for that. But it depends upon what market you are reaching and how much you can afford to spend and still make money. There is such a thing as trying to get the maximum result and spending so much money it will be eaten up by your capital expense.

Chairman Taylor: There is one particular point I had hoped might be raised here. That is in connection with mechanical picking or cleaning other than the gravity operation or separation. I had hoped somebody might give us a little discussion on work that has been done along these lines. I know there have been a good many attempts made in this State to effect some sort of cleaning by such means. I would like very much to have somebody who has had experience with that type of mechanical picking or separation to discuss it for us. Mr. Treadwell, haven't you ever done anything along that line?

Mr. H. A. Treadwell (Executive Board): Nothing that we consider of scientific value. We have tried spot picking, picking out the flat slate, but the difficulty with that is you get the flat coal with it. There is quite a little flat slate you cannot separate from the flat coal. I think if there is anybody here from Old Ben they might tell us something about the use of the spiralizer they have been attempting to use in Southern Illinois for a number of years. I know that worked fairly satisfactory with them.

Chairman Taylor: Any discussion on that question? If not, I will proceed to our next paper, which will be delivered by Mr. W. D. Langtry, President of the Commercial Testing & Engineering Company of Chicago. Mr. Langtry will offer a paper on "Coal Utilization (With Special Reference to Sulphur Content)." Mr. Langtry.

Mr. W. D. Langtry (President Commercial Testing & Engineering Company, Chicago): When I was asked to prepare this paper, the subject seemed to be so broad that I thought it might be well to specialize on one particular thing. So we did, and it was with reference to sulphur. The question of sulphur at times is quite a controversial subject and it is really surprising what does happen when this question of sulphur does come up for discussion. So with this paper —I do not know that it is entirely new, but we carried on some tests, and the result of some of these figures you will find on these papers that have been distributed here. When we get to that, you can glance at them and see just what they are.

During the past year, there has certainly been a great deal done in the coal industry with regard to making coal better for the customer.

COAL UTILIZATION (WITH SPECIAL REFERENCE TO SULPHUR CONTENT)

By W. D. LANGTRY
President, Commercial Testing & Engineering Company, Chicago, Ill.

During the past year there has certainly been a great deal done in the coal industry with regard to making coal better for the consumer. This has entailed sizing and cleaning, with treating as the finishing touch. It is no trick to get coal sized, but it is a more difficult problem to clean it so that it meets competition and is not ruinous from a cost standpoint.

There is one important factor in the process of cleaning (and by cleaning I mean mechanically, physically, and proper mining methods) and that is the elimination of Sulphur. This pesky ingredient will be found in practically all coal that is produced and ranges from less than half of 1% to as high as 10% in certain sizes from certain localities in the United States. I have seen Sulphur come out of mines in slabs as big as the top of an ordinary office desk, and 4 and 5 inches thick, so large in fact, that in order to remove it from a conveyor it was necessary to use a large sledge hammer to break it to pieces. It has been quite amusing in our experience in the laboratory to have bright, shiny pieces of yellow material brought in, the sender being quite sure that it was gold; and the old saying of "all that glitters is not gold" certainly holds true in this respect, because in every instance this has proved to be "fool's gold." The Sulphur in some coal is microscopic in size; it cannot be detected by the naked eye.

It is not of much importance as to how Sulphur got into coal, nor the why or wherefore, because what the coal industry is interested in is the fact that it is in coal, and what to do about it. Anyone who can discover a practical method for removing Sulphur from coal to such an extent that it will be reduced to practically a nil quantity, has a fortune awaiting him. It is true that coal can be crushed, and by certain processing the Sulphur be materially reduced; but in so doing the character of the coal, so far as size is concerned, is most materially altered, and thus it is rendered impractical according to present-day equipment in plants, there being of course an exception to this, namely, powdered coal.

It may prove of some interest to enumerate some of the things in the production of coal to which Sulphur has a direct relationship:

1. It most seriously affects sales in some respects.
2. It has a direct bearing upon the manufacture of coke and gas.
3. It plays its part in spontaneous combustion and the disintegration of coal.
4. The formation of clinkers in many instances can be traced to the presence of Sulphur (iron pyrite) in coal.
5. I know of many cases where cars of coal have been rejected because the top of the coal had turned white in transit. This was due to oxidation of Sulphur compounds to sulphates.
6. In the presence of water, due to reducing the gas temperature below the dew point, an accumulation of Sulphur in the breechings, smokestacks and equipment will

form sulphuric acid, and thus cause the eating out of metal parts.

7. In the ceramic industry they have to be very careful about coal purchases because the Sulphur will have a tendency to discolor pottery and other manufactured articles of a similar nature.

8. Just recently the smoke department of Chicago has been very much concerned with what might be termed "white smoke" which has been emitted from chimneys adjacent to large office buildings, the fumes of which have been decidedly sulphurous and highly obnoxious, and detrimental to health, as well as having a corrosive effect on metal sash and other structures.

No doubt there are other items which could be stated, but there are certainly enough mentioned here to show the far reaching effects that Sulphur has in coal.

It should be remembered that Sulphur is either organic or inorganic, the former meaning, in simple terms, that form which is other than mineral sulphides or sulphates. In other words, the organic sulphur found in coal is no doubt due to the plant life from which it was formed. The inorganic sulphur, of which iron pyrites and marcasite are the most common forms, is the Sulphur which, as mentioned above, is of the "fool's gold," "Nigger heads" or Sulphur ball type. It is very heavy as compared with the organic Sulphur because it is combined with iron.

In a great many analyses of coal today, when it is to be used for special purposes such as gas and coke making, the Sulphur is divided into the volatile and fixed. It is my impression that many coal companies' salesmen have found it of distinct advantage in presenting arguments, when the question of Sulphur comes up, to state to the buyer that a certain percentage of the total amount of Sulphur in the coal is of a volatile nature and passes off as a gas. Generally speaking, the volatile will be about 50% of the total Sulphur. However, I would like to take this opportunity of straightening out in the minds of some that the volatile Sulphur is just as detrimental in some respects as the fixed, which remains back in the fuel bed or retort. For instance, it is the volatile Sulphur that gas companies must contend with when the gases must pass through a scrubber in order to eliminate the Sulphur gases as they are distilled out of the coal in the process of making coke and gas. It should be remembered that when coal is placed in a closed retort such as is the case in making gas and coke in a by-product plant, the Sulphur does not burn, and this 50% volatile and 50% fixed Sulphur applies only in this method of processing coal into coke and gas. This is called the thermal decomposition of coal, and no combustion whatsoever takes place inside the oven.

It should be remembered that when coal burns in a furnace, stoker, stove, etc., the Sulphur contained therein is also burned, 90% of which will pass out of the fuel bed through the passes in the boiler, and finally out of the stack. The 10% which remains behind is that which will combine with lime generally in the ash, and will stay behind in the ash formed on the grate. The 90% which passes off goes out as SO_2, or Sulphur Dioxide, and SO_3, or Sulphur Trioxide, with the exception of a small percentage which is present as Hydrogen Sulphide, H_2S.

The gaseous Sulphur compounds as they pass from the furnace to the stack may be absorbed in part by soot which has collected in corners and crevices in their path. If these soot deposits are in comparatively cool regions where moisture may also condense, the Sulphur Dioxide will oxidize and combine with the water to form sulphuric acid. This acid is very corrosive to iron and steel, and if allowed to accumulate may cause a boiler to rust out. It must be remembered that the combination of the sulphuric gases with water vapor may take place at steam temperature, and that the dew point of the sulphuric acid formed is above the boiling point of water. Thus corrosion may occur even when the boiler is in service.

In slag tap pulverized fuel furnaces the presence of pyrites in the coal results in the formation of metallic iron and other heavy iron compounds which have caused leaks to develop in furnace bottoms. This molten iron is also very erosive to the spouts used for removing the melted ash from the furnace. Coal with a comparatively small percentage of pyrites will cause this molten iron to accumulate on the furnace bottom. Leaks even in water cooled bottoms have been known to develop, and the iron running out of the hole, where it was adjacent to one of the cooling tubes, has cut through the tube and caused a failure. Underfeed stoker operators have experienced similar troubles when this molten iron sulphide from the pyrites in the coal has run through the air openings in the tuyeres. This experience with molten iron sulphide difficulties is not as common with underfeed stokers as it is with pulverized fuel in slag tap bottoms due to the fact that large quantities of molten ash are not permitted to accumulate.

No difficulty from coal containing pyrites has been experienced in dry bottom pulverized fuel furnaces.

Pyrites in the coal used in all pulverizers has a decided effect upon the maintenance due to the difficulty of grinding this material.

Where chain grate stokers are in use the presence of pyrites is not so detrimental. Coal which is high in this substance, however, does cause a slow eating away of the surface of the grate links. This condition was especially noticeable on the older equipment, which used the heavier grate links on natural draft installations, whenever the grates were permitted to run hot due to improper operation.

In our estimation, only too often Purchasing Agents lay entirely too much stress upon the Sulphur content in coal. Some of them have even gone to the extent of making the statement that they were going to try to get coal with no ash and no sulphur, meaning, of course, they were going to come as near to that as they possibly could. For special processing purposes, this may be all right; but when it comes to making steam, so many times we have seen a really good coal, with maybe a percent or two higher Sulphur than its competitor, be absolutely cast aside, and a higher price paid for some other fuel, when in reality the coal with the higher Sulphur would have produced just as good, if not better, a steam cost in the plant. The steam cost of course does not take into consideration any deterioration to equipment caused by Sulphur, and this naturally must be considered, and facilities at the plant be of such a nature that deposits can be removed with as little cost and trouble as possible.

To show the stress that has been placed upon the Sulphur content in coal, we cite an incident where only last week a very large shipper who was furnishing coal to a steel plant was quite concerned regarding the percentage of Sulphur in his coal. After the analysis was out it showed

.78% Dry Sulphur, this being an Eastern coal. He was quite put out because the buyer for this plant wanted a coal that would run not over .60% Dry Sulphur. So no doubt a contract was at stake where from .1% to .2% Sulphur would probably determine the awarding of a contract of about 100,000 tons of coal. I might mention that the percentage of Ash in this coal was only a trifle over 3%, and the Dry B.t.u. was better than 15,000.

It is my prediction that as developments progress in the manufacture of stokers, very little attention will be paid to the percentage of Sulphur, and even to the formation of clinkers, as these problems will be taken care of to such an extent that Sulphur, Ash and Fusion temperature will be of little importance. For instance, take for example the Taylor stokers that are being made. They are quite versatile with reference to type and kind of coal which can be burned on them, and with the addition of control of air distribution over each small grate area, it will help most materially to get around some of the difficulties which have been encountered in the past in the amount of coal which can be burned per square foot of grate surface. More recent development is the water cooling of grates, which promises to further assist the elimination of heavy clinkers.

With the advent of sizing and cleaning, and the tempering of coal, it is making the burning of coal easier and better as time goes on. So to us who are following the economics of the burning of coal, the use of Illinois coal, regardless of its percentage of Sulphur, will probably have an easier road to travel than has been the case in the past. There will always be present, however, a certain percentage of plants that have old equipment and whose efficiency will be below new installations, and it is in these plants where more care will have to be exercised in the kind and type of coal to be used.

With further regard to Sulphur and any deleterious effect upon heating equipment, I am reminded of an incident some few years ago when a plant on the South side of Chicago was experiencing in their overhead steel coal bunkers what they thought was excessive corrosion. They laid this to the percentage of Sulphur in the coal, and placed a serious complaint with the coal company. It so happened that the coal was being wet previous to its being delivered into the bunkers, and they thought that the addition of the water, with the percentage of Sulphur in the coal, was forming sulphuric acid, and that this was playing its part in eating away the steel. Some of the drippings which were coming through the gate which controlled the flow of the coal from the hopper into the spouts were caught and analyzed to find out whether or not there was the presence of sulphuric acid. It was found that these drippings were absolutely alkaline, so that any corrosion which was taking place was not due to the presence of Sulphur in the coal, but attributable to the additional water put on the coal to temper it.

Investigations carried on in certain Eastern fields have shown that the mine water from old workings which had been sealed against air circulation was much less corrosive in character than the water from the same mine when air was permitted to circulate. This would indicate that oxidation of various elements in the coal results in corrosive compounds being formed when air is present.

In order to find out what the makeup is of some of the deposits which are to be found through the passages from the combustion chamber to the breeching of some hand-fired and stoker-fired plants, samples were obtained in Chicago covering smokeless coals and coals from both Indiana and Illinois.

The percentage of Dry Ash and Dry Sulphur was determined on each sample. The Sulphur found in these deposits was then split up into the percentages of Sulphate, Residual and Sulphide. However, no attempt was made to investigate the character of the residual Sulphur. The Sulphide Sulphur is combined with a base such as iron or lime; while the Sulphate Sulphur is combined with a base such as iron or lime, and oxygen, so that it has already been oxidized beyond the sulphide state. This is brought about under these conditions by the presence of water vapor and air.

In order to explain what these three determinations are, namely, Sulphate, Residual and Sulphide, the Sulphate Sulphur was determined by extracting the sample with dilute hydrochloric acid. The Sulphur determination was also made on the extracted residue in order to determine the residual Sulphur. The sum of these two percentages of Sulphur was then subtracted from the total Sulphur in the original sample, the difference being considered Sulphide Sulphur, which had been eliminated as Hydrogen Sulphide during the process of extracting the soluble Sulphur with hydrochloric acid.

The source of the Sulphate Sulphur was considered to be both hydrogen sulphide and sulphur dioxide which had been absorbed by soot, and in the presence of water vapor had been oxidized to Sulphuric acid. This Sulphuric acid then reacted with lime and iron compounds to form the corresponding sulphates.

The source of the Sulphide Sulphur was probably Hydrogen Sulphide which had remained adsorbed in the soot as H_2S; or Ferrous Sulphide, FeS, which had been carried over in the fly ash and had not been oxidized to the sulphate state.

It will be noted from the following table that in practically all cases the amounts of residual and Sulphide Sulphur were very small as compared with the Sulphate Sulphur and the total Sulphur.

Summarizing the above, the conclusion is that all deposits from the combustion chamber through the passes of the boiler and breeching into the stack are sources of danger so far as corrosion and the eating out of metal parts is concerned; therefore, it is quite essential that in order to increase the life of boilers, breechings, steel stacks, etc., care should be exercised to see that these deposits are eliminated just as soon as possible.

The reason for including in this investigation some of the deposits from smokeless coals was to find out whether or not the actual amount of Sulphur in the coal had much bearing upon the amount contained in the deposit; and it was found that deposits from the smokeless coals were just as detrimental from a corrosion standpoint as coals from Indiana and Illinois carrying a much higher percentage of Sulphur.

When a plant is kept absolutely clean, there is practically no danger from corrosion, regardless of the percentage of Sulphur in the coal burned. With this as a basis, it then puts every coal produced in the state of Illinois, regardless of whether it has less than 1% Sulphur or 6% Sulphur, on exactly the same basis. Corrosion really then

Analyses of Deposits

Kind of Coal — Location of Sampling — Equipment	Dry Ash	Dry Sulphur	Sulphate Sulphur	Residual Sulphur	Sulphide Sulphur
Ind. & Ill. Segs..... Tubes ..... Stoker, F-M	62.32	3.26	2.60	.39	.27
Ind. & Ill. Segs..... Ashpit ..... Stoker, F-M	90.81	.94	.76	.06	.12
Ind. & Ill. Segs..... Breeching ..... Stoker, F-M	60.94	3.06	2.48	.42	.16
Ind. & Ill. Segs..... Combus. Chamber... Stoker, Modern	70.66	1.69	1.07	.53	.09
Ind. & Ill. Segs..... Flue cap ..... Stoker, Modern	57.79	2.68	2.04	.63	.01
Ind. & Ill. Segs..... Breeching ..... Stoker, Modern	77.55	2.58	2.33	.18	.07
Illinois Segs..... Tubes ..... Stoker, Auburn	68.98	2.22	1.86	.29	.07
Illinois Segs..... Ashpit ..... Stoker, Auburn	76.77	1.24	.44	.24	.56
Illinois Segs..... Breeching ..... Stoker, Auburn	61.01	2.10	1.39	.57	.14
S. Ill. 2″ Segs..... Top of 2nd pass.... Burke Furnace	81.16	2.58	2.03	.20	.35
S. Ill. Segs..... Breeching ..... Stoker, Modern	96.37	2.40	2.32	.08	.00
S. Ill. Segs..... Combus. Chamber... Stoker, Modern	82.68	1.11	1.10	.00	.01
S. Ill. Segs..... Flue cap ..... Stoker, Modern	80.07	1.27	1.05	.12	.10
Indiana Segs..... Tubes ..... Stoker, Combus	58.25	1.62	1.14	.36	.12
Indiana Segs..... Ashpit ..... Stoker, Combus	65.19	1.10	.63	.20	.27
Indiana Segs..... Breeching ..... Stoker, Combus	56.89	3.74	2.74	.68	.32
Smokeless M.R..... Ashpit ..... Hand fired	79.53	.36	.16	.19	.01
Smokeless M.R..... Tubes ..... Hand fired	32.42	1.74	.89	.77	.08
Smokeless M.R..... Breeching ..... Hand fired	13.56	1.82	1.09	.73	.00
Smokeless M.R..... Tubes ..... Hand fired	85.01	6.18	5.95	.14	.09
Smokeless M.R..... Ashpit ..... Hand fired	84.72	.64	.43	.14	.07
Smokeless M.R..... Rear pass ..... Hand fired	37.70	3.58	2.96	.37	.25
Smokeless M.R..... Ashpit ..... Hand fired	77.93	.88	.52	.20	.16
Smokeless M.R..... Tubes, 1st pass..... Hand fired	41.64	2.62	1.89	.56	.17
Smokeless M.R..... Rear breeching..... Hand fired	61.12	1.56	1.18	.38	.00
Semi-Bit. M.R..... Tubes ..... Hand fired	20.24	2.28	1.66	.56	.06
Semi-Bit. M.R..... Ashpit ..... Hand fired	83.55	.90	.76	.14	.00
Semi-Bit. M.R..... Combus. Chamber... Hand fired	70.25	3.62	2.90	.10	.62
Semi-Bit. M.R..... Tubes ..... Hand fired	65.71	6.24	5.65	.59	.00
Semi-Bit. M.R..... Ashpit ..... Hand fired	85.28	1.00	.38	.01	.61
Semi-Bit. M.R..... Combus. Chamber... Hand fired	54.25	2.24	1.83	.22	.19
Semi-Bit. M.R..... Tubes ..... Hand fired	73.14	1.94	1.44	.26	.24
Semi-Bit. M.R..... Ashpit ..... Hand fired	71.72	.46	.12	.19	.15
Semi-Bit. M.R..... Combus. Chamber... Hand fired	48.26	2.96	2.11	.53	.32
Semi-Bit. M.R..... Combus. Chamber... Hand fired	82.46	2.24	1.99	.01	.24
Semi-Bit. M.R..... Ashpit ..... Hand fired	91.00	.66	.29	.09	.28
Semi-Bit. M.R..... Flue space ..... Hand fired	77.08	1.42	1.03	.01	.38
Semi-Bit. M.R..... Settling chamber.... Hand fired	66.58	2.54	2.28	.24	.02
Semi-Bit. M.R..... Tubes ..... Hand fired	46.22	2.52	1.74	.78	.00
Semi-Bit. M.R..... Ashpit ..... Hand fired	77.89	1.38	.99	.10	.29
Semi-Bit. M.R..... Combus. Chamber... Hand fired	23.76	3.68	2.55	.58	.55
Semi-Bit. M.R..... Ashpit ..... Hand fired	96.01	.17	.08	.09	.00
Semi-Bit. M.R..... Tubes ..... Hand fired	62.87	2.76	2.37	.34	.05
Semi-Bit. M.R..... Combus. Chamber... Hand fired	43.30	3.06	2.39	.56	.11
Semi-Bit. M.R..... Tubes ..... Hand fired	53.94	4.81	4.59	.23	.00
Semi-Bit. M.R..... Ashpit ..... Hand fired	80.78	.88	.16	.11	.61
Semi-Bit. M.R..... Hand fired	44.72	3.52	2.61	.49	.42

amounts to a plant problem rather than a coal problem. This is shown by the fact that the deposits from the semi-bituminous coals, which had very low Sulphur contents, contained large amounts of Sulphate Sulphur.

From a purchasing standpoint, everything else being equal, a coal containing a high percentage of Sulphur should not automatically be ruled out for this reason, because there can be just as much damage from a low Sulphur coal as there can from one with a high percentage of Sulphur, because, as stated above, corrosion is primarily a problem of plant cleanliness.

* * *

Chairman Taylor: Thank you, Mr. Langtry. We would like to hear some discussion on this very interesting paper of Mr. Langtry. One thing you said that was interesting to me, Mr. Langtry, in particular, was your reference to the effect of sulphur upon the disintegration of coal. I am thinking of a storage pile. Could you tell us something about that a little more in detail?

Mr. Langtry: With regard to sulphur in coal and it acting as a detriment to the storage of coal, the effect is this, that the sulphur will oxidize, break the lumps apart, make fines, and in that way increase the number of surfaces upon which the action of the oxygen may work. So that if the larger lumps of coal, egg coal and so on, mine run, are put in storage, there may be some danger from the high sulphur content in that these larger pieces are broken up and thus increase the amount of fines. Spontaneous combustion will nearly always be found where the fine coal is. Some of these coals will have a tendency to disintegrate and go to pieces, and that is caused by the oxidation of sulphur.

Chairman Taylor: Any further discussion on this question?

O. R. Steffens: Speaking of spontaneous combustion in storage piles of coal, I was interested this summer or last summer in making a trip through some coal mines in Southern Illinois, where we were considering stripping screenings. I noticed some of these screenings piles, piled up at some of the southern Illinois mines, were fired on the bottom and outside, and we were told that is where the fires generally started. I wonder if the gentleman could offer any light upon that?

Mr. Langtry: There is no set rule as to where spontaneous combustion will start in a pile of coal. I have seen it start right at the top, I have seen it in the middle, right inside the pile, on the side, and in fact almost any place.

You will find if you start to investigate the source of the fire, it will invariably be where the fine coal is. That is, if it is true spontaneous combustion of coal. If it has been set on fire by some outside agency, that is an entirely different thing. But your fire will start where your fine particles are, and it is because—if you just stop and think, if you have a lot of coal—if you have a lump the size of this glass, you have so many square inches of surface. If you crush this up to go through a twenty mesh screen, you will see how you increase the number of surfaces, which makes possible a great amount of increase in the amount of surface the oxygen can work on. You will find it is the fine coal that usually starts the trouble.

In this plant you speak of, with the fire at the bottom, there might have been some outside agency that started that. There might have been some oily waste or wood or something more combustible than the coal itself. There is no set rule that will determine where spontaneous combustion will start in a pile. Does that answer your question?

Mr. Steffens: Yes, sir.

Vice-President Thomas: Have you discovered if there is any way in which coal may be stored to prevent the possibility of spontaneous combustion?

Mr. Langtry: Yes, put it under water.

Vice-President Thomas: I mean on the outside.

Mr. Langtry: Yes. There is nothing that is absolutely foolproof, I would say, outside of submerging it under water. But one of the surest ways is to build the pile up in a layer method. In other words, scatter the coal so that you can take your fine coal and use that as a filler-in between the larger pieces. By filling in with the smaller particles, you crowd out the air.

You may be interested in knowing that a plant in Michigan had been putting in Eastern coal and had been experiencing a lot of trouble by spontaneous combustion. The coal was delivered by boat and unloaded on the dock, and their loss amounted to quite a little. I went over the proposition with them, and suggested the next year in unloading the coal they pile it on the available space in layers, and then I said "It will cost you some money, but I believe it will pay you to spend it, to get out and get some sort of a machine that will roll it down and pack it."

They did. They not only got that, but got a pusher in front of it to level off those layers and pack it tight. Then they put the next layer on and packed it tight. I went up there the next year, and they said they had cut down the hazard ninety-five per cent. They had just a little trouble which had been on the outside of the pile in different spots, but they could very easily get to it. The main body of the pile had come through successfully, and they were very much elated. It cost them about $6,000 to get equipment that first year, and that — they have followed that ever since.

Vice-President Thomas: About how thick are those layers?

Mr. Langtry: The thickness of the pile makes no difference. You can pile it as high as your crane will reach. The thickness means nothing as to spontaneous combustion. It is merely a convenience in reclearing in case you get in trouble as to the height you want to go and the available space. A very good plan is to take the available space and pile your layers just as thin as you can, considering of course the cost of reclaiming the pile.

Mr. E. W. Brandenberger: I would like to ask a question. What relation has sulphur to the fusing temperature of the ash?

Mr. Langtry: There is a gentleman here whom I brought down and whom I think has run more fusions than anybody in this section of the country, and as he is wrestling with that all day, and I will ask Mr. Cahote to answer that question.

(Here a discussion ensued between Mr. Cahote and Mr. Brandenberger which the reporter could not hear.)

This concludes our meeting, gentlemen. Remember, dinner starts at 6:30 tonight in this room.

(Whereupon an adjournment was taken until after the banquet on the evening of the same day.)

The following advertisers in the 1934 Yearbook displayed merchandise of their manufacture in the Exhibit Hall. The exhibits were very well attended and created a great deal of interest.

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University of Illinois	Urbana, Illinois
Bureau of Mines	Vincennes, Indiana

EVENING SESSION
7:45 O'clock P. M.

Meeting reconvened.

President Sandoe: We have a toastmaster and a speaker who want to handle the meeting, and I will not ask for any assistance from the floor. I will tell you about a young fellow who has gained international repute. I expect he can tell a lot of things that are not true, but he is still a fine chap. When he grows up, some day he will make a good toastmaster. It gives me great pleasure to introduce Mr. George B. Harrington.

Toastmaster George B. Harrington (President, Chicago, Wilmington & Franklin Coal Company, Chicago): I would like to say "Gentlemen," but if I start now I will have to say "Ladies and Gentlemen," and that is a great handicap.

Sandy is a fine chap, and I know you will not take him seriously. You must not expect too much from the toastmaster. He is a necessary evil. There are a lot of people who like to have a lot of statistics about their speakers. They want to know where they were born and why, and if not for that you could get rid of the toastmaster. It is a real job. If you have ever gone to a friend and asked him to tell you a nice, clean, little story you can use at a dinner, he sits there grinning and you know you cannot even start with it. But I had a break this morning, for I asked Paul Weir and he said "Well, I cannot help you now, but if you get this job two years from now I will clean up some of Sandy's stories for you in my new 'Genuine' Super Washer,—if I ever get it going." So I am leaving the story-telling to the speakers who are here for that purpose.

I have to look down here, for I have so much data I do not want to overlook anybody. They tell me Sandy is really a fine singer. He is on the Apollo Quartette of St. Louis, or Trio, you know what I mean, but the trouble is he always wants to start singing about three o'clock in the morning. He is a hard fellow to find sometimes after office hours. They tell me that last night there was a fellow named Fay who paged him all evening, but later had to transfer the call to next year's president, Mr. Jenkins. I don't know if that is true or not, for I wasn't here.

This Mining Institute is really a splendid crew. Secretary Schonthal is a fine stroke-oar. And while Sandy looks a little heavy for a coxswain, they tell me he is doing a fine job at it.

Of course, I am supposed to say, and do say it with a great deal of sincerity, this is a wonderful meeting. You always have dandy meetings down here. I have attended the last several, as far back as I can remember.

Now we get down to my stuff, and it becomes my pleasure, or privilege, I should say, to introduce, or at least to present, for he needs no introduction, our new President, "T. J.", or better known as "Tommy," Thomas. Before I let him up, I have got to tell you these statistics. That is the reason I am here.

He was born in Collinsville, Illinois, and when approaching the state of manhood, started in the mines, which means that he had just exactly the kind of a start we want for these Illinois coal operators, of which he is now one of our leading ones. One very prominent man today told me he was the best, which I question, because there are a good many of us, but still—he is pretty good. Twenty-five years ago he switched to railroading, which has become his major love or whatever it is, and has risen to be the Assistant to President Budd of the Burlington Railroad, who you remember addressed us here two years ago. He is also President of the Valier Coal Company and now President of the Illinois Mining Institute.

Mr. Thomas is a musician, which I was pleased and surprised to learn, a violinist, and also a great lover of art, and I happen to know he has a lovely family with at least one fine boy and girl I have met. I think the Institute is very fortunate, and I am sure happy, to have Mr. Thomas as its President, and I now present him and give him the "mike."

President-Elect Thomas: Mr. Toastmaster, gentlemen of the Illinois Mining Institute, I want to thank you for the honor you have conferred upon me in selecting me as your President for the coming year. This is a great organization, aggressive and active. I want to pledge to you I will do my utmost in upholding the traditions of the Illinois Mining Institute during the year.

I thank you.

Toastmaster Harrington: Now, the Vice-President, and, if tradition is followed, next year's President. He will be allowed to make a speech next year. Whoever is toastmaster will have the pleasure of telling you his pedigree. However, I will have to say he is one of our best known elder statesmen, and I will let you have a look at him in a moment. He follows the tradition of our late lamented retiring President by being somewhat of a Beau Brummel.

I have got to say something that has been bothering me a great deal about this election, because today, when Sandy retires, being a wellknown wet, you have put in our friend Tommy Thomas who I forgot to say is a wellknown dry. Someone told me this morning you could not even get him to smell a cork. And then you taper off by putting in a vice president who is also dry but not quite so dry. Does it take two years to get back to normal after Sandy?

I will ask Mr. Jenkins if he will get up and smile at the audience.

Our Secretary, heretofore referred to, has been Secretary for about six years, and it would be foolish to try to tell you anything about him. However, he has been known to give a fellow a match.

I hate to have to refer to these notes and printed matter, but we have a number of our directors and guests, and one or two other people not here who have sent you messages, and I will ask those present if they will please rise when I introduce them, but keep their speeches until they become president.

Way over here, on my extreme right, is my little friend Wardie Argust.

Down the other way, Mr. W. J. Austin, of the Hercules Power Company, and we want him to make a speech some time.

Charlie Hamilton, a former president, and, on the other side again, "Rock Dust" Johnny Jones.

I cannot read this, but it seems to be Chief Leighton, of the Geological Survey. Somebody says he does not like to be called Doctor so I will not call him Doctor. He does not look like a Doctor.

Herbie Taylor—if he had an old hat he could take this job and get away with it better than I will.

Another ex-president, Harry Treadwell.

And the aforesaid wise virgin who is building a washer,—Paul Weir.

From Indiana, Harvey Cartwright.

And Dean Thompson of the School of Commerce, University of Illinois.

Mr. Erskine Ramsey, well-known consulting engineer.

Denny Lewis, formerly one of us and now Ambassador-at-Large in Washington.

We have several directors who are absent. And I will follow the suggestion of a friend and introduce a newcomer to the Illinois coal ranks,—a convert from metal mining,—the new President of the United Electric Coal Company,—Louis Ware.

Mr. Schonthal has an extremely nice but somewhat long letter from the Governor, in which he says he intended to be with us, but owing to an unexpected call to Chicago, which I happen to know was a funeral, he could not come. He writes us a very nice letter.

And Mr. George Riggs, President of the Coal Mining Institute of America.

Mr. George Riggs (President, Coal Mining Institute of America): In the early days, back in 1911, I went to work for the United States Bureau of Mines, and put in five years and seven months with them. It has been my duty—duty, now get that, to attend more mine fires and explosions than any man in America and wear breathing apparatus, and I am not standing up and bragging to you but telling the facts.

Today, and for the last three or four years, I want to say we have made headway. We have not been called on to wear breathing apparatus and fight fires and explosions and bring out dead and search for the living that might be in the mine. We are making progress.

This year I happen to be President of the Coal Mining Congress of America, and I want to bring out this: In Pittsburgh, in December, on the 12th and 13th, we are holding our session as you have been today. We are putting over our program. A few months ago one of the members in Pennsylvania said to me, "George Riggs, I think it would be a fine thing if we put over a program this year showing the progress of mining coal from 1910 to 1935, twenty-five years of progress." I said, "That is exactly the kind of program we will put on."

Now, on the 12th and 13th of December, in Pittsburgh, in putting on this program, we assigned three men from various firms to take up the matters of mining, three more men to take transportation, three more ventilation and three safety, and then we have three for a general resume of the whole thing.

I invite you fellows, each and every one of you, if you can, to come to Pittsburgh and hear that program of the Coal Mining Institute of America on the 12th and 13th of December.

That subject is a big subject, the methods of mining that have been tried out since 1910, some discarded and some carrying on. There has been quite a change in the method of mining bituminous coal in twenty-five years, quite a change in transportation of this country in twenty-five years; quite a change in the ventilation; quite a change in the duties of mine inspectors, for there have been many changes in the mining laws of the various States; and Oh, what a wonderful going-forward in the safety means! In 1910 we had very little safety in the mines, and with all these fast methods of mining safety has had to come in.

Dean Holbrook of the University of Pittsburgh said, "George, you are not going far enough. You should take up the preparation of coal and the selling of coal and new uses for coal, and so on." I said, "No, it is too big a program. We will have to stop with the mining of coal this year." And like the toastmaster said about the fellow who was president last year, if he sees fit he can take up where we left off this year and go on with the preparation and selling and that end of it, and it will make a good program, I believe, for two years.

I am very much interested, was very much interested, in your program here today. Yesterday evening, when I left Pittsburgh, Jack Ryan, my boss—you know, something funny is that Jack Ryan and I worked together in the Bureau of Mines many years ago. Now I have worked for Jack twenty years. He would not want to work for me, but I like to work for him. That is the difference in men. He would not want to work for me, but I like to work for him. There is a whale of a difference there. But Jack said to me, "I want you to take my regards and best wishes out to the Coal Institute in Springfield and convey my trust and respect to those men out there," and that is what I am doing.

Last July, I believe it was, somewhere in there, or in June, they had a Coal Mining Institute, a very fine one, in Terre Haute. Mrs. Riggs and some of the children and I drove to the meeting, and I met your Secretary. He wanted to know what he would have to do to get me to come to your Institute. The program was something similar to tonight. I said, "All you have to do is to get in touch with Mr. Ryan, and if he says I can come I will be there." He said, "You are just as good as out in Illinois now."

I must leave tonight. I did intend to see the Pittsburgh game, but before I left Pittsburgh I got a telephone call, and my oldest brother lost his wife. She had typhoid fever and rheumatism set in, and he lost her. The funeral will be in the afternoon. I go to Chicago tonight and get to Pittsburgh tomorrow evening at 8:25.

It has been a pleasure to be here. I have met a lot of old and new friends, and am more than pleased to have been with you. I thank you very much for this opportunity.

Toastmaster Harrington: I thought that was a diplomat that Denny Lewis brought from Washington, but he turns out to be just another guy from Pittsburgh. They have big ones and little ones here tonight.

I will now introduce our speaker of the evening, and, joking aside, we are, I think, a most fortunate group to have Mr. Morrow as our speaker. This Program Committee seems to lean toward the Four Horsemen. We had Ralph Taggart last year, the Four Horseman of the South, and this year we have a Four Horseman from the North. But as I said earlier, I think it does add very much to the interest of hearing a speaker to know what his background is.

Mr. Morrow was born and educated in Ohio, and today is probably the largest thorn in the side of the Ohio coal operators, with his 52,000 tons of coal per day moving out of Pittsburgh. After growing up, as we all do, he first became acquainted with coal by working, about 1910, on the Coal Census, or the Census on Coal Mining. A little later, about 1913, he was either drafted or taken into or maybe got in business with the Federal Trade Commission under Chairman Hurley, who apparently was a discerning individual because he talked Mr. Morrow into getting the Federal Trade Commission, which was then quite young, organized. You will note that from then on this chap has organized everything or nearly everything he has touched,—as an organizing job,—down to the present when he seems to be bent on disorganizing the Guffey Bill. I do not know just where the change came in, but we will see.

On this Federal Trade Commission job, Mr. Morrow had a lot to do with the passage of the Webb-Pomeroy Act, which was the first exemption from the Anti-Trust Laws, and exempted foreign shipments, foreign commerce, from the Anti-Trust Laws, so that, for instance, the copper fellows could get together on exports and protect themselves against such combinations as the foreign cartels.

But as far back as 1913, John Morrow was monkeying with the Anti-Trust Laws. After he fixed up the Federal Trade Commission—and if I speak in jest you will know that I am speaking in jest, and I would not mention it if he did not do a good job—he went to Pittsburgh and organized the Pittsburgh Coal Producers Association over which he presided for a time, until he was taken to Washington to organize and become the first head of the National Coal Association. About that time Mr. Garfield was Coal Administrator, or something like that, and he took John Morrow over to organize the distribution of coal during the war.

After a short time with the National Coal Association, that already being organized, he did not feel there was anything to do there, so he went back to Pittsburgh and went into the coal selling business in a wholesale way,—for a while. He became impressed with the Joy Loading Machine and became associated with that Company, of which he is still Vice-President, and in that capacity went to see the Chairman of the Pittsburgh Coal Company, to see if he could unload on them some of his coal loading machines, and instead he loaded himself on them by selling himself and became Vice President in Charge of Sales of the Pittsburgh Coal Co. At that time the Company was producing about 6,000 tons a day, and in six months our hero was President of the Pittsburgh Coal Company, which was by then producing 20,000 tons per day, and today he is still President and they are producing 52,000 or 53,000 tons a day. I hope he retires by becoming Chairman of the Board before he gets out much more coal.

Now, the subject tonight,—I cannot tell you anything about it. It says "The Spiral in Coal." We out here know about the "Spiralizer," an invention, I believe, that went back to—where is that Museum in Washington where they put things? —The Smithsonian Institute, those things that come in for awhile and then go out,—like coal washers. I expect maybe it is a monkey wrench John is throwing into the Guffey Act, for he is the large if not the largest proponent of the holdouts, not having yet come under Mr. Guffey's Bill, and probably not having sent forward his tax,—and I do not know whether he has made up his mind. That is probably what this spiral is. He is going to tell us about it.

At any rate, I think it will be safe for me to say that Mr. Morrow, in addition to being a well-rounded operator and well-rounded organizer, is the littlest big coal operator in the United States, and is rightfully known as the "Mighty Atom." I would like to introduce Mr. John D. A. Morrow, of Pittsburgh.

THE SPIRAL IN COAL

By J. D. A. MORROW
President, Pittsburgh Coal Company, Pittsburgh, Pa.

Mr. Toastmaster and Gentlemen of the Illinois Mining Institute: I was careful to note the opening remark of your retiring President that he hoped to get this over with just as soon as possible. So do I.

A few years ago it was my good fortune to go on one of your boat trips. I still remember it with pleasure. So when you invited me to address you this evening I looked forward to renewing some pleasant friendships, seeing men I have not seen in the years between, and having an enjoyable visit with the Institute.

This "Spiral in Coal" has agitated George Harrington a great deal. All the way down from Chicago this morning, every time George waked up he would say, "What is that darned spiral, anyway?"

Let me explain briefly. Some of you have been fortunate enough to see an eagle rise into the sky and you will recall that he went upward in ascending circles that took him higher and higher in a great spiral.

And so it was with Bituminous Coal. For years production swung upward in a swiftly rising spiral that lifted the industry to wealth and prosperity. In twenty yearly swings of that rising spiral, Bituminous Coal production soared from 200,000,000 tons to nearly 600,000,000 tons per year.

Then the rising circles faltered, swung lower and yet lower until in fifteen yearly swings of that downward spiral, production plunged to little more than half its peak total. That downward spiral brought financial disaster to scores of coal companies, idleness and want to hundreds of villages and communities, poverty and despair to thousands of families throughout the coal fields.

Across the last thirty-five years the history of Coal parallels the fairy story of Hadj the Arab. In the dim light of dawn he wakes from sleep in the dust of the roadside, a beggar in rags at the gate to the palace of the Prince. As the sun rises throughout the morning he seizes one opportunity after another, and thanks to a kind Fate, he rises swiftly from one post to another until at midday he has become the Prince on the throne in that same palace, his person garbed in gorgeous robes, his turban flashing with precious jewels, his state exalted in pomp and power. But as afternoon wanes, while he feasts and enjoys himself, other men swiftly seize his power, misfortune overwhelms him and when night falls he lays himself down to sleep, a beggar again, in his old rags in the dust of the road at the palace gate.

Almost it is the story of Coal. In the years from 1918 to 1934, competitive fuels, petroleum and natural gas, seized their opportunities to rise to economic pre-eminence by more than doubling their production and sale in America. But in those same years, sunk in its own ineptitude, Coal, like Hadj the Arab, was returning to beggardom in the cobwebs and rust of its idle plants, until coal men, like Hadj in the hour of misfortune, filled the air with their wails and lamentations, and some even proclaimed that coal is a dying industry and petitioned Washington to provide economic and legal burial for the unattractive remains.

We who are in the coal business ask ourselves tonight, "Is this the end of the story?" Has Coal had its one great day and is it either to sit forever a beggar before the splendid palace of American industry, or become forever a mummy, laid away in wrappings of official regulations and red tape? In all the long years ahead is there no possibility of another upward spiral in Coal?

To the question of such possibility unhesitatingly I answer "Yes," but it rests largely with us ourselves how far that possibility translates itself into reality.

Think for a moment what made that ascending spiral in Coal. A tremendous expansion of the use of power and machinery in the United States demanded more and more coal as the source of energy for that power and machinery.

Now, what are the possibilities of another great expansion of industrial activity here and of another consequent increasing demand for coal? Several factors enter into the answer to that question. The first, of course, is the cost of coal itself. One of my reasons for affirming the possibility is the record of what you production men have done in Illinois and Indiana in the last decade.

Ten years ago your best mines were producing 6½ to 7 tons of coal per man on the payroll per 8-hour shift. Today your best mines are producing 14 to 15 tons in 7 hours. In ten years, therefore, you have more than doubled the productive capacity of your men, with significant reduction in costs.

What are you going to do in the next ten years? Will you stand still where you are, at 15 tons per man, or will you multiply the productive efficiency of your organization to produce 25 or 50 tons per man per shift? I have sufficient confidence in the men in this room to believe that through greater use of machinery, the development of new inventions and the adaptation of new processes and instrumentalities to the extraction of coal from the ground, you will make such further gains.

True, there are physical difficulties in the way, but physical difficulties never stopped anybody determined to go through them. They have not stopped you in the last ten years! They will not stop you in the next ten, nor will they stop us in Pennsylvania, West Virginia or Kentucky. We are grateful to you for what you teach us. We do not have to begin where you began ten years ago. Your accomplishments have lighted the road for us far into the future.

Thus when we consider coal as the source from which to supply a possible increasing demand for energy in the United States, so far as mine costs are concerned, we can look forward with reasonable assurance to decreasing costs without reducing wages.

But Mine cost is not all. The transportation cost from mine to user may be the deciding factor between coal and some competing fuel. I shall not discuss freight rates here, but it is necessary to mention them to make my argument complete. Most coal men believe that lower freight rates on coal are necessary to the recovery of the industry. Some authorities assert that our whole transportation system must be reorganized and put under more direct Governmental control, even to Government ownership. I hold a contrary opinion. In my view the railroads need less regulation and control instead of more, and Government ownership, management and operation would be a limitless calamity. The way to better transportation service and lower rates on coal is to let our capable and able railroad men build up the railroads as we and other business men expect to build up our enterprises. And I believe that we can rely upon the ultimate common sense of the American people presently to adopt this policy.

Therefore, when we consider future coal costs, either at the mines or at consuming points, we have reason to anticipate costs that will foster and not prevent the increased use of coal.

Remember we are talking about a rising spiral in coal and not a descending one. This implies greater consumption of coal, but can the United States consume increasing outputs of coal? Here we are confronted with two exactly opposite theories of production and consumption in this nation over the years 1920 to 1929 as causes of the depression and as indicators of the future.

One theory is that through those years we were over-producing, that we produced more of everything—boots, shoes, hats, clothing, automobiles, refrigerators, iron, steel, copper, coal, cotton, corn, wheat, hogs and all the other thousand and one things that this nation uses—than we needed or could use, that producers of these commodities increased their efficiency and productivity so much and forced upon the market such an over-abundance of goods of all kinds that the accumulating undigested surplus finally swamped the nation's production machinery, until it had to slow down—and down—into the depression.

The other theory is that we were over-consuming, that as a nation we lost our heads and went on a wild orgy of buying and using and enjoying more than we needed, really wanted, could pay for or ought to have, that we ran prices up, stuffed ourselves with the surplus of production thus called into being until we bankrupted ourselves, and thus caused the depression.

You will recognize that the mere statement of these two theories implies a startling confusion of mind on the part of one or the other or perhaps both advocates. Nevertheless, some branches of our Federal Government are acting on the theory of cutting down production, for example, by paying the producers of cotton, corn and wheat not to produce these commodities, by shortening hours of labor and limiting production in manufacturing and mining industries. On the other hand, we have other branches of the Federal Government industriously, enthusiastically borrowing trainloads of money, giving it away, spending it on huge public works programs, good, bad and indifferent, for the purpose of increasing purchasing power—in other words, to stimulate consumption.

Some professorial reforming economists and politicians may think such conflicting policies are marvelous, but from the point of view of a plain business man, they just don't make sense. Now, as plain business men, let us ask ourselves—what are the facts that can be brought to bear on these economic theories, if that is what they are, and the political actions that grow out of their acceptance.

First, was the industrial machine of the United States, its mines, its farms, it factories, forests, transportation lines, etc., in the boom years of 1928 and 1929, producing at or beyond the peak of capacity? The answer is "no"! Every one of us knows of mines and plants that were idle or not running to capacity. We have all seen hundreds of thousands of acres of farm lands not utilized at all. As nearly as competent observers can estimate, our total industrial machine was used in those peak years only to about 80% of actual capacity. Thus, even at the top of our boom years, we had 20% of our productive organization as a nation idle, unused and uncalled for.

Now as to consumption, were we as a nation of people consuming all that we needed or more in those same years? Your own knowledge and experience emphatically answers "No" to that question. We all know that millions of people in America did not have as much coal to burn in winter as they could comfortably have used. Millions of people did not have the clothing, the food, vacuum cleaners and washing machines, electric irons and radios, motor cars, shoes, education for their children, travel for themselves, and all the thousands of other things that people need or can use and enjoy.

Therefore, as a nation, even in 1928 and 1929, we were consuming nowhere near the quantity or variety of products and services that we might have consumed and used and enjoyed. In short, even in the most shining days of the glowing 20's, both production and consumption were far below the possibilities of this nation.

Civilization in its progress, gentlemen, is nothing more than the process on the one hand of creating new wants, new pleasures, new needs for the human animal, and on the other hand providing new ways in which those wants and desires can be satisfied. The method by which they have been expanded and the way in which they have been satisfied from the beginning has been through man's increasing utilization of power and machinery.

When man first picked up a club and swung it in his hand he multiplied the strength of his arm to reach out farther and hit harder to defend himself or to kill his game, in other words, to satisfy his needs and wants. When he learned to use the power of a sapling bent into a bow to shoot an arrow, when he learned to tame and use the horse and dog, he began to use power outside of himself. Since those far distant days, man has learned to make himself a thousand tools of wood, stone, metal and even of flaming gases, and to build himself armies of machines to do his work. He has learned to get power for his machines from the wind, the rivers and oceans, the lightning of the air, and from the sunlight of countless ages stored within the earth in pools of oil, fields of gas and seams of coal. We forget that all this is a daily miracle over the wide earth because it is the commonplace fabric of our everyday life.

The other day I stood beside a small machine making an intricate little fixture at the rate of 2,000 per day, each exactly like every other. One man could look after a half dozen of those machines. Twelve thousand of those little fixtures every day! That man could never make that little shape of metal with his bare hands, and if he used hand tools, how long would it take him to make the twelve thousand? Not with the accuracy of the machine in all his lifetime! He had multiplied his productive capacity hundreds of thousands of times with the modern machine.

In that manner, in the last twenty years, we multiplied our productive capacity. That multiplication of human productive capacity made possible the discovery and satisfaction of new wants, desires and pleasures. In other words, it multiplied human happiness and at the same time created more leisure for its enjoyment.

Do you think that we are through with that process, that we shall make no more new scientific discoveries, invent no more new machines, make no further additions to the sum and substance of man's enlightenment and enjoyment? All your intelligence rebels at such an idea. Not yet have we started the clock of human progress running backward in America!

Hence we have every reason to believe that ahead of us there is still opportunity for increasing consumption of commodities of all kinds, coal included, with the continuation of the same industrial development that has added so much to life in the span of our own years.

The economists will tell you, however, and many of the bright young men of the New Deal at Washington have shouted the idea from the housetops, that we must have greater purchasing power in the United States, that it is not enough to produce or be able to produce all of these commodities and enjoyments unless people are able to buy them. I agree with the truth of the statement, but I disagree with many of the means they would use to increase consumption. Let us ask ourselves, as business men, how can consumption of motor cars, or refrigerators, or hats, or shoes, or clothes, or foods be increased?

Dr. Townsend proposes that the Federal Government pay everybody 65 years of age and over $200 per month and require him to spend it, that this would produce a vast increase in purchasing power, stimulate industry and restore prosperity. Where he would get the $200 for everybody, year in and year out, does not seem to worry him any.

Let us indulge our fancy for a moment with some of these ideas. If you would take all the families in the United States whose income, as a family, totals less than $2,500 per year, and if you would raise their family incomes all up to $2,500 per year, that additional purchasing power would create a demand for commodities and services in the United States approximately 20% greater than the peak demands of 1928 and 1929. In other words, the satisfaction of that increased demand would run all our factories, mines, saw mills, farms, forests, fisheries, etc. to their capacity. Unemployment would vanish and prosperity would return.

Let us try another one. If you could arbitrarily add $1,000 per year to the income of every family whose annual income is less than $10,000, that increase in purchasing power would probably create such a demand in the United States for commodities and services of all kinds as would require the building of new factories, the opening of additional mines, and would create another cycle of expansion.

Well, then, why not go ahead and do some of these things? Why not adopt Dr. Townsend's proposal? Or the still more effective one of just giving every family in the United States a minimum income of $2,500 per year?

Now for a moment let us simplify our thinking by eliminating money from the proceedings. After all, money is only a medium of exchange. It is a common measure of value and a handy device which you can also use to trade your commodities or your labor or your skilled services for the commodities produced by someone else, or for his services or his labor. But if we would think straight on some of these subjects, we must eliminate that confusing medium by which we effect the exchange of commodities. When we do that, our own income, then, instead of dollars, becomes whatever we ourselves can produce in the way of commodities, food supplies, goods of all kinds, services that we render or labor that we perform. If we barter those commodities that we produce, or the labor that we perform, or the services that we render, for other commodities, other services, or other labor, then our income is transformed into food supplies, clothing, shelter, a motor car, a dining room table, a rug, or whatever we choose to convert it into.

Let us then talk for a moment not about income in dollars, but about income in bread, meat, eggs, potatoes, shoes, socks, hats, clothes, refrigerators, radios, motor cars, tickets on railroad trains, the right to use a telephone, to send a telegram, in short, in terms of the commodities and services that we all need and have for the enjoyment of life in the United States today.

Then our bank account becomes, not so many dollars, but so much of all these various things that you have saved up out of your own earnings and stored in the hands of the bank. You have a call on that bank for so much food, for so much clothing, for so much shelter, for so much of these other commodities and services as you have stored there, and the total of all these commodities that are produced in the United States and of the services that are rendered in a year, constitutes the nation's income for that year. That is our real income and that income does not change, although the dollar by which you measure its value yesterday was worth 100 cents, today is worth 59 cents and tomorrow possibly 10 cents. Changing the legal value of the dollar, our measure of value and our medium of exchange, does not produce one more bale of cotton, one more bushel of wheat, one more suit of clothes, or one new machine of any kind. It does not alter the quantity or character of the real income of the nation.

Now, thinking again in terms of real income, why don't you just go ahead and write a check on the bank for the new motor car you want, for the new clothes, the new house, the winter vacation in Florida, the summer trip to Europe, or whatever else your fancy may dictate? Because your own common sense tells you that whenever you have exhausted the motor cars, the clothes, the trips that you have earned and laid up for yourself in the bank, you are through. The bank won't give you any more. Gentlemen, a nation is not different from the individual. It cannot write its check for any more bread, meat, clothing, shelter, motor cars, etc. than it produces.

How, then, do you go about increasing the purchasing power of a nation? If I wish to increase my own purchasing power, I myself must create more of the commodities that other people want, or I must furnish more or better services that they desire in order that I may command more of what they have than at present. And so with a nation. Before it can increase its purchasing power at all, it collectively must produce more of the things it wants to enjoy. Now, how that production is to be distributed among the people who produce it is another problem, but the letter "A" in the alphabet of increasing purchasing power is to increase production. The letter "B" is to produce it more cheaply, and if that is to be done while purchasing power increases, then it can be done only by reducing the cost of production through multiplying the efficiency of the producer, not by cutting his wages. As we have seen from time immemorial, this has been accomplished by the addition of more power, the development of new inventions and new machines and the use of that power and those machines more effectively.

In short, our common sense tells us that we cannot reach up into the air of some fairyland and pull down $200 per month income for every family in America, so that they can buy and use more of everything and thus increase purchasing power and start our idle wheels turning again. But if we pull the cost of more and more commodities down to levels where more and more people can buy with their present incomes, the net result is an increase of national purchasing power and of national income, measured not in dollars but in what dollars will buy. On that principle, by constantly lowering the price of his car, Henry Ford vastly increased the power of the American people to purchase his motor cars. This is the only way a nation can write its check for an increase of income—real income—for all its people. Furthermore, this is something we can do and not by political sleight-of-hand but by the hard work and inventive genius that has always done it.

I stress the necessity of not cutting the wages of the operator of the machine. This is only another way of saying that the better worker, the worker with the skill, intelligence and adaptability to multiply his productive efficiency with the machine is entitled to a reasonable share of the greater output he then produces. That means more purchasing power, more income for him, measured either in money or in commodities and services. This is what has taken place throughout this nation's industrial development. Here in Illinois and Indiana, for example, you pay the operators of your loading machines and your cutting machines more money than you pay hand loaders or pick miners. Both you and they have gained from the use of the machines.

That is true in industry generally in the United States. The United States Census Bureau every ten years obtains complete information about the number of employees in mining and manufacturing enterprises and what they are paid. From that source we know that in 1909, out of the total of everything produced from mines, farms factories, etc. in the United States, 54% went to employees in salaries and wages. From 1909 to 1929 there was a great extension of the use of mechanical equipment, power and machinery in all industries throughout this country.

At the end of those twenty years, the population of the United States had increased 33%, but the total product of the nation had increased by 65%, and again I am talking, not in dollars, but in quantities of goods and commodities produced. The nation's total product in 1929, if valued in dollars, was three times the product of 1909, but because of different price levels the use of dollar figures is not accurate for comparing the total quantities of commodities produced. Now, how did the share of employees in the 1929 output compare with their share in 1909? At the end of those twenty years, their share of the National output had risen from 54% to 65%.

Furthermore, employees, those to whom industry paid salaries and wages, were the chief beneficiaries of the twenty years' increase in productive output. The return to capital between 1909 and 1929 was approximately stationary between 13% and 15%, whereas the share of employees in the greater total National output ran up from 54% to 65%. We need not fear the more extended use of machinery. What we must fear is restriction upon its introduction and use.

A moment ago I said that our minds revolt from the idea that we are through with mechanical and industrial progress in this country and that we confidently expect new inventions and new industrial developments. Is there any real foundation for that expectation or is it only a hope, what the psychologist calls "mere wishful thinking"? There is a real basis for our belief.

The other day a celebrated English scientist, perhaps the greatest physicist in the world today, said that before long man would create for his use in art and science and industry, new elements not known before in earth or sun or stars. They have discovered isotopes of nearly all the elements, even for the hydrogen atom, but recently thought to be the elemental building block of the universe. That hydrogen atom they have identified in two forms, one heavier than the other. Water, the old familiar H_2O, is either light or heavy, and the heavy water is quite a different thing, chemically and physically, from our everyday beverage.

I shall not go into any abstruse discussion of atoms, protons, electrons, neutrons and the new physics. It is enough to say here that men are now doing astounding things with the atom. For example, the transmutation of one metal into another, the dream miracle of the alchemist, is a fact in the laboratories of today. Television will be a commonplace tomorrow because scientists have learned to use electrons to create a mechanical eye more nearly perfect than the human eye. Certainly new industries will rise in the United States and in the world.

And what does this new knowledge mean to coal? We think of coal for heat and power, but in the next thirty-five years other uses may be of greater importance. Today the United States requires the equivalent of more than 300,000,000 tons of coal in the form of gas and oil. What will it do for motor fuel and lubricants when the gas and oil wells begin to run dry? The United States Geological Survey in a recent inventory of the nation's oil reserves estimated that the oil in the pools and fields known on January 1, 1934, if used at the 1933 rate of production, would last not quite fifteen years, but it could not be taken out at that rate and production would be diminishing seriously before that date unless new supplies were found. Of course, some new oil pools will doubtless be discovered, but demand is also increasing and even now we import from 50 to 100 million barrels of oil per year. Nations are becoming oil-conscious. The nationalistic policies now being applied to export and import trade over the world may cut off or curtail our imported oil supply at any time. The American people will not readily give up their motor cars, their farm tractors, their Diesels. Too much of our modern life is absolutely dependent upon the internal combustion engine. How then shall we satisfy the ever mounting demand for gasoline and lubricants?

This country then will inevitably turn to coal, of which it has the greatest known supplies in the world. Nearly a hundred years ago, Charles Dickinson tells me, they made lubricating oil out of coal in the Kanawha Valley. Even today, one coal company is experimenting with a process to manufacture low volatile coal out of high volatile screenings. It is making an entirely smokeless, sootless solid fuel, obtaining sufficient gas to process the coal and to refine the 18 or 20 gallons of tar it obtains per ton of coal. This tar is different from the familiar tar of the high temperature coke plants. It is much richer, with a different range of chemical products, and with ordinary petroleum cracking stills, about half of it can be turned into fine knockless motor fuel at little above the present price of gasoline.

There is another process by which coal today can be liquified completely, the ash and sulphur precipitated, the solvent driven off and the coal recovered pure. That process is not commercially practicable as a means of cleaning coal for sale at current prices, but if coal is considered as a raw material for some branch of a great new chemical industry in which pure coal is desired, or if that liquified coal by hydrogenation or other atomic change is to be turned into crude oil and refined into motor fuel and lubricants, that process may be entirely practicable, and immensely significant.

Coal men have been criticized for years because they did not attempt to discover new uses and new markets for coal. They are now beginning to make progress in such efforts that may contribute materially toward another expansion of the coal business in the United States.

Thus we can say with reasonable assurance that there is a definite possibility of another rising spiral in coal. In the beginning I said the question of whether that possibility was translated into reality rests largely with the coal men themselves. As already pointed out, a part of that responsibility is for reduction in production costs. Another part is for the application of new chemical discoveries to the coal industry. A further responsibility is political.

Your President has asked me to comment on the Bituminous Coal Conservation Act. It is because I believe that the coal industry of the coming generation, in which some of us are not too old to hope to have some share, requires, in part at least, new development scientifically, industrially and commercially, that I cannot join with enthusiasm in turning over this industry to a Commission in Washington to manage. Government bureaus do not create and develop new industries. Public officials are too much interested in holding their jobs to run the risks that must be taken to pioneer new industries. And when I envision the kind of work, management and risks that are involved in the coal industry that is possible, I would rather trust its development to a dozen courageous and able men I see here in this room than to any set of politicians that ever shined the seats of their trousers on office chairs in Washington.

There is a sharp distinction in my mind between detailed regulation of the coal industry in all its aspects by a centralized authority in Washington and the sound management of the coal industry by coal men themselves, with intelligent and sympathetic help from the Government. I would like to see the latter policy adopted as a part of the foundation for a new rising spiral in coal.

There are only two kinds of Government possible for a nation. One is the strongly centralized, the other the decentralized. The centralized form of Government may be an absolute monarchy, like Russia before the War; it may be a Communistic Government like the Russia of today; it may be a Fascist state, like Italy, or it may take some other form. But in all these various manifestations, such a government is characterized by one single autocratic central personage or group, that imposes its authority upon all the citizens of the state in manifold detail.

In Russia the amount and kind of food that you may eat, even the way your children shall be educated, is determined by Moscow. In Italy, Mussolini seemingly exercises unlimited authority over industry, finance and social conditions. In Germany, you cannot buy a carload of copper without the permission of the German Finance Minister. Your business may perish without that metal, but if the Finance Minister decides that Germany can do without your product, even without your business, you do not get the copper, no matter what the loss and suffering to you may be.

Always that kind of government aggregates to itself more and more power, always controls more and more the freedom of action of its citizens and from time immemorial it always leads to unbearable tyranny until the state explodes in revolution, bloodshed and destruction. Revolution is the only cure for that form of government. It is the only way a people ever rids itself of the slavery it imposes.

We have started here in America to change our free and democratic government to that strongly centralized type. Washington is extending its power into the homes of millions of farmers, hiring them not to grow cotton, wheat, potatoes, corn and hogs. Next, Washington will order them to produce so much cotton, wheat, potatoes, corn, hogs, etc., without paying them for what they do not grow or raise.

This is no idle prediction. In the coal industry the Government is now, by legislative enactment, claiming the right to determine the way we shall mine our coal, the way we shall prepare it, the sizes in which we shall screen it, the prices we shall get for it and even the people to whom we shall sell it. The framers of that legislation, before it is yet in effect, are already saying that Washington must also fix the annual output of each and every mine and control the opening of new mines. If they can tell a farmer how much coal he can dig from the hill behind his barn they can also tell him how much corn he can raise on the surface of that hill. And that is Russia as it is today.

I am opposed to all such fundamental change in the form, purpose and conception of our government. This nation was the product of exactly one of those explosions of popular resentment against long years of autocratic imposition of central authority upon a people. After that long and bitter experience the founders of this nation wanted no more autocracies on this continent. They deliberately and purposefully went about the business of forming a decentralized government. All the development of this nation, all the industrial expansion that has lifted it to preeminence in the world and given its citizens the highest standard of life attained by any people on this globe, has taken place in the freedom assured by that decentralized government. I don't want that Government fundamentally changed, I don't want any elected or self-appointed dictator and I don't want America revolutionized into the likeness of the miserable, planned industrial states of Europe, on the pretext of stabilizing the bituminous coal industry. I am the more vigorously opposed to it because I think it will not provide a sound and prosperous coal business, but will disappoint even its authors by failing completely to cure our basic ills, and afflicting us with others worse than those we now have.

I do want the coal business to be sound financially, to pay decent wages to its employees and to earn reasonable profits for its investors. You have a right to ask how we shall get such an industry if not by the detailed control provided in the Bituminous Coal Conservation Act. By the same kind of law that was passed for American export trade twenty years ago, known as the Webb-Pomerene Act.

Prior to its passage, when American copper producers undertook to sell copper to Germany, they found the users of metal in Germany united into one single powerful buyer in the Metallgesellschafft, that played one American copper producer off against another. Other foreign combinations played the same game on the exporters of other American products. To meet that situation, the restrictions of the Sherman Anti-Trust Act were lifted from American exporters. Then whenever it was practical as a business proposition for exporters to get together in export combinations, they did so, and so were able to deal with foreign buyers on a footing of equal effectiveness. The American public were safeguarded against the improper use of such export combinations to control prices in the domestic market by subjecting them to the oversight of the Federal Trade Commission. American export trade has prospered for twenty years under that Act. The central government does not regulate it nor impose its authority upon the details of the exporters' business.

Gentlemen, I would like to see the same thing done for the coal industry, with the same kind of safeguards. Let coal operators, in whatever way they want, organize themselves into such groups as they choose, make such agreements as they desire with respect to the tonnage of coal they will produce, its preparation, its sale and price, and make those contracts legal, binding and enforceable in the light of day in our Courts. Require the coal operators to report all such agreements to the Federal Trade Commission or the new National Bituminous Coal Commission with all pertinent information and give that Commission the right to veto these agreements when they transgress sound principles of public interest. If that were done, I think Pennsylvania would deal with Illinois when we come in competition with each other. We would find some reasonable means by which we could both make some money instead of both losing money.

This program is simple, it has been tried successfully in other business in the United States even more complicated and difficult in the variety of conditions to be met than the coal industry, and it requires no revolutionary change in our Government or in its relation to our business.

From the standpoint of the framers and the advocates of the new Bituminous Coal Conservation Act, this proposal has one fault. They will say that various operators will always stay outside these coal associations or sales agencies or groups of operators who are attempting by agreement with each other to improve conditions, and that these outsiders will prey on those who make such attempts. Maybe they would prey and maybe they would find themselves preyed upon until they would prefer to come inside the fold, but in any event, even if few or many should stay outside, that, gentlemen, is the price of freedom. That is exactly what this Government was founded to assure to each and every one of us, and personally, I am not willing to exchange it for an arbitrary personal mandate from any politician in Washington.

This evening we have been considering the coal industry, not in its own narrow field and not merely in the restricted limits of what it is today. We have been looking at it in its relation to other industries and to Government in America. We have been considering what it may become tomorrow and what it may need in its relations with other industries and with Government. Looking at it that way, I regard the Conservation Act as a passing incident in its history. Either by action of the Courts or by sad experience under it, we will live it down like a bad disease, recover from it and go on, and presently it will be forgotten in the new rising spiral in coal.

I like to think that spiral will mark a wider range of uses for coal than we have had before and that our economic foundation will therefore be on firmer ground. I like also to hope that when the

Conservation Act is a forgotten incident, we will no longer be prohibited from working together as business men, but will be allowed to cooperate with each other to assure the new spiral in coal a greater share in a more permanent prosperity than we have known before.

I thank you.

* * *

Toastmaster Harrington: Gentlemen, all I have to do now is to thank Mr. Morrow in your behalf, and Mr. Riggs. I can say to you I am delighted to meet the Optimist from Pittsburgh, for a number of you remember Mr. Eavenson, also of Pittsburgh, who spoke on "The Future of the Coal Industry" not so long ago, was not quite so positive. I personally agree with Mr. Morrow. I think we are at the bottom of something, and I am glad to find out what that darned spiral was.

I will now turn the meeting back to our new President, Mr. Thomas.

President-Elect Thomas: Mr. Morrow, I am glad to find out about this spiral, and I hope you are right that we are on the upgrade. I was a little fearful about your getting here today, for I met a friend of mine this morning and asked how you were coming down and he said you were driving down with George Harrington, leaving Chicago about nine o'clock. I said then you ought to be here about two o'clock. Someone else spoke up and said "Thomas, do you know whether there is a golf course along the route between Chicago and Springfield?" I said, "No, I do not." Someone else said, "Yes, there are two or three of them." He said, "If George Harrington sees a golf course, he will not get here until seven or eight o'clock tonight."

Gentlemen, is there anything further to come before this meeting? If not, we will stand adjourned, subject to the call of the Chairman.

(Whereupon the Forty-Third Annual Meeting of the Illinois Mining Institute was declared to stand adjourned.)

CONSTITUTION AND BY-LAWS

Adopted June 24, 1913
Amended Nov. 12, 1926
Amended Nov. 8, 1929
Amended Nov. 8, 1935

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 honarary 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 officers and executive board members shall be elected by ballot, annually, at the regular November meeting and shall hold office for the ensuing year.

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.

ILLINOIS MINING INSTITUTE

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BROOKS, C. W.................Brooks & Stewart, Inc., 53 W. Jackson Blvd., Chicago, Ill.
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CONLEY, V..........Troy Fuel Co., Troy, Ill.
CONWAY, C. C., Chief Elect..........Consolidated Coal Co., Herrin, Ill.
CONWAY, LEE, M. E..........Consolidated Coal Co. of St. Louis, Staunton, Ill.

COOK, WALTER, Sec.....Central Mine Equipment Co., Webster Groves, Mo.
COOLEY, H. B.....Allen & Garcia Co., 332 S. Michigan Ave., Chicago, Ill.
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COX, R. L., Sls. Mgr.....Jeffrey Mfg. Co., Columbus, Ohio
CRAGGS, W. C.....Peabody Mine No. 8, Taylorville, Ill.
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CURL, JOHN.....Franklin County Coal Co., Freeman Spur, Ill.
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JONES, JOHN Z.....U. S. Fuel Co., 306 Chandler St., Danville, Ill.
JONES, WALTER M.....Joy Manufacturing Co., Centralia, Ill.
JORGENSON, F. F., G. M.....Consolidation Coal Co., Fairmont, W. Va.
JOY, DEWEY E., Sls. Dept.....
Sullivan Machinery Co., 307 N. Michigan Ave., Chicago, Ill.
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KISS, LAWRENCE.....Superior Coal Co., Gillespie, Ill.
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O'ROURKE, PETE..William Hales Co., West Frankfort, Ill.
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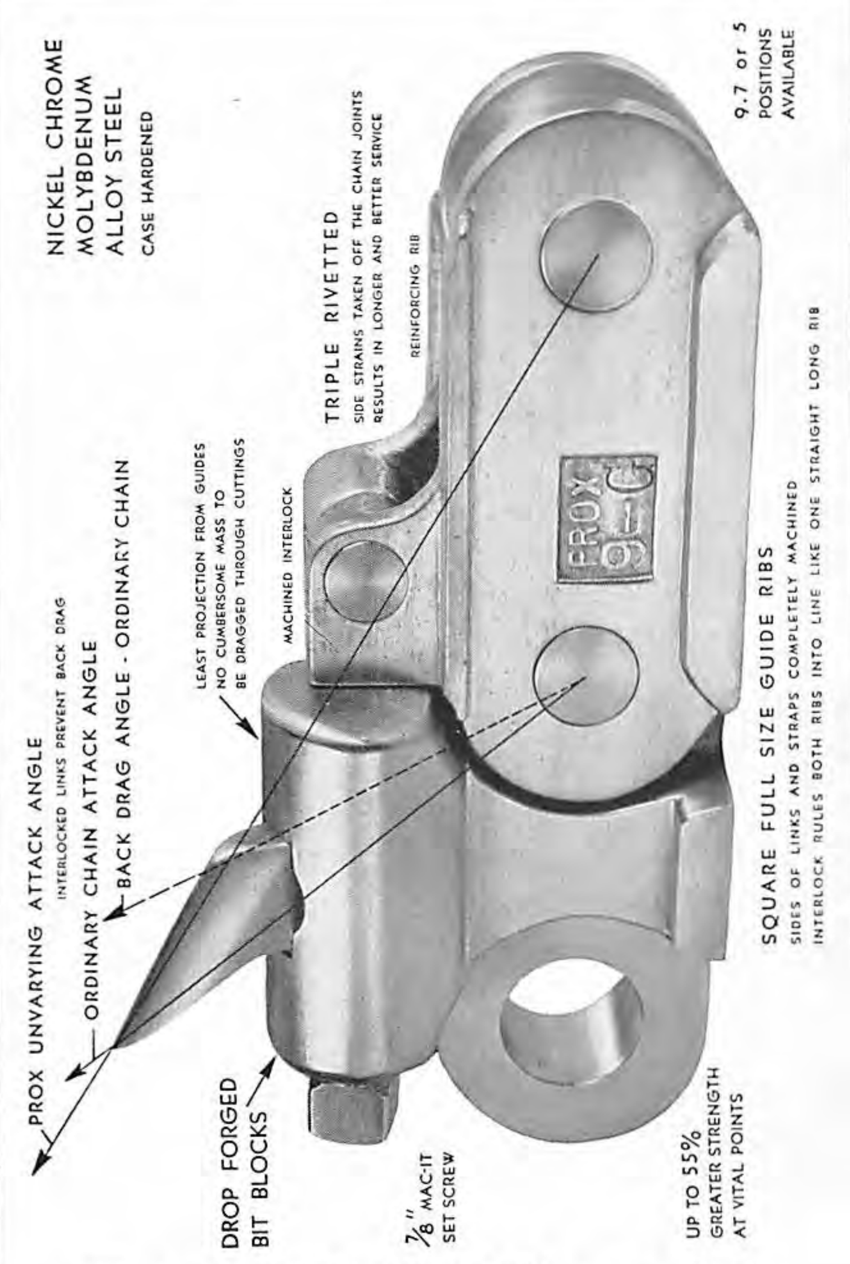

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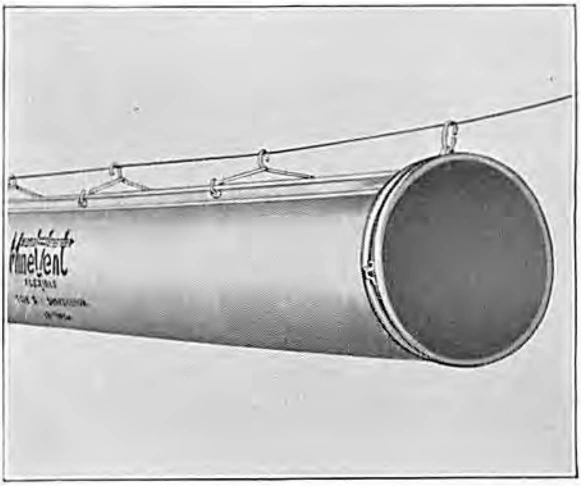

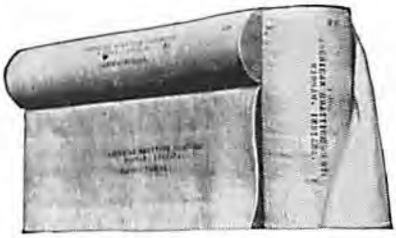

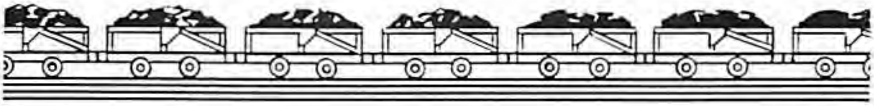

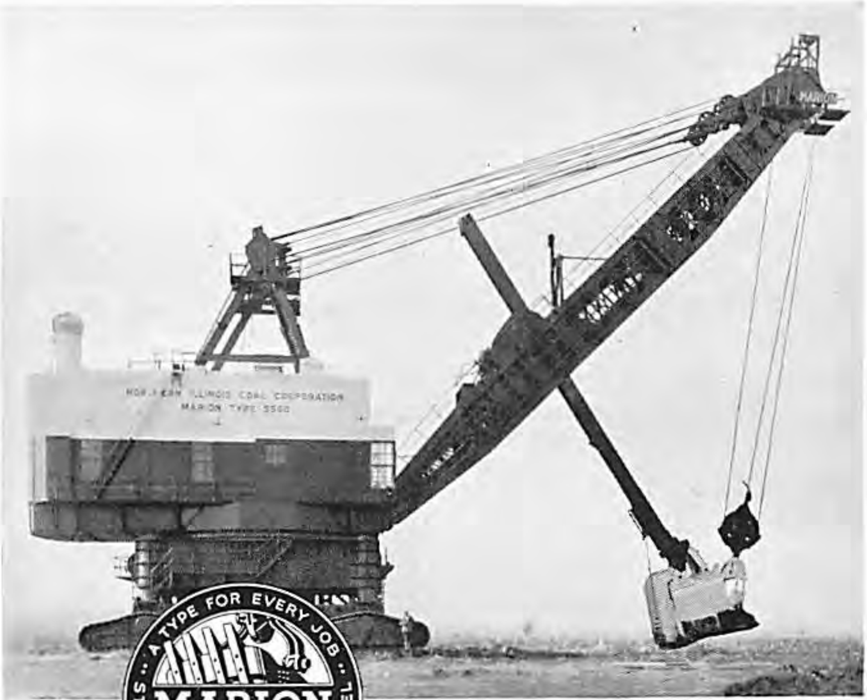

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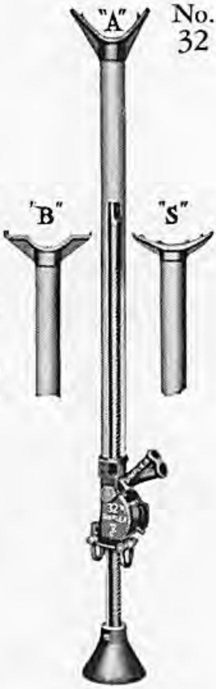

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Twenty-five years have passed; yet this battery, with the active material of its positive plates practically sealed in tubes of slotted rubber, continues to hold the position of leadership in the storage battery industry which it assumed a quarter century ago.

This is not difficult to understand. The Exide Ironclad was a battery of exceptional value when it was introduced. It was the first to combine all four of the essential battery characteristics — high power ability, high electrical efficiency, extreme ruggedness and long life. With the passing years, refinements have marked its consistent progress. Today, this battery offers greater freedom from trouble, and requires less time and attention than ever before in its long successful history.

For wholly gratifying locomotive service, use Exide Ironclad Batteries.

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When you use Lay-Set Preformed you use a rope that has no internal stress. You use a rope that resists kinking; that may be cut without seizing; that is easy to handle or splice; that spools on the drum better; that resists twisting in the sheaves.

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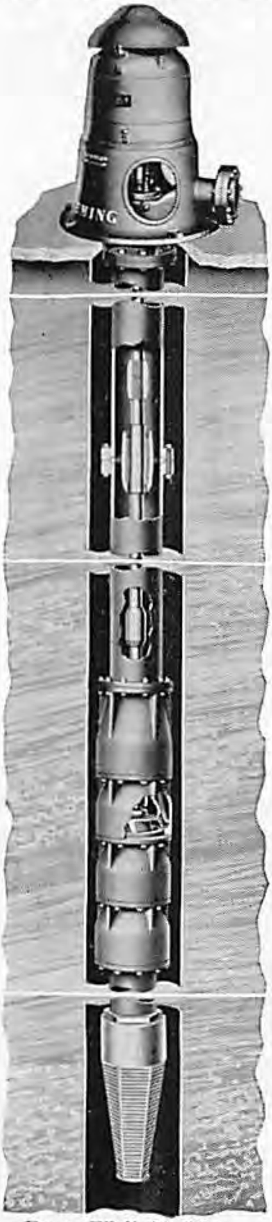

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This type of pump is becoming increasingly popular for mine dewatering.

Whether it is a series of small gathering pumps, a large centrifugal or any size or type between—you can be sure Deming has the equipment to fit the job.

Today, Deming offers so complete a line of pumps that many mine owners are standardizing on this equipment—dealing with one competent organization which can fill every pump requirement. And, at the same time these users are getting the most for every dollar invested in pumps.

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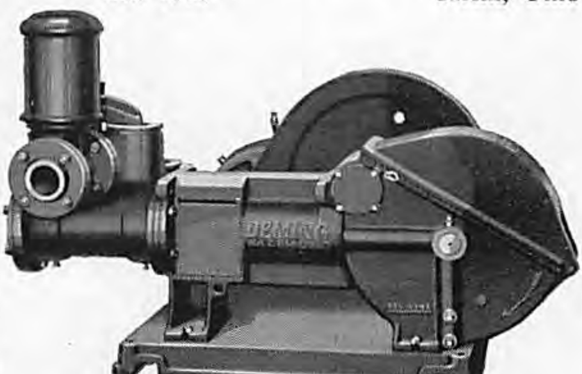

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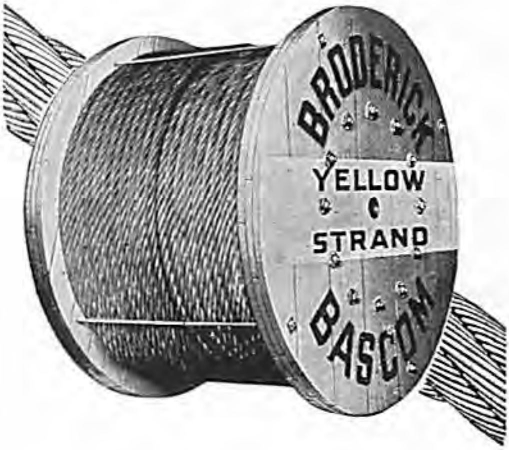
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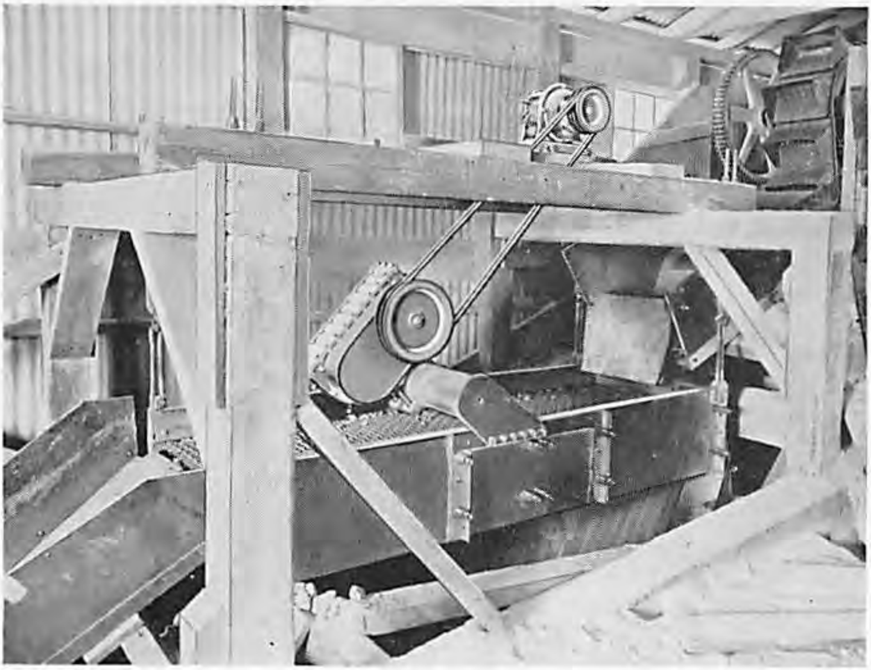

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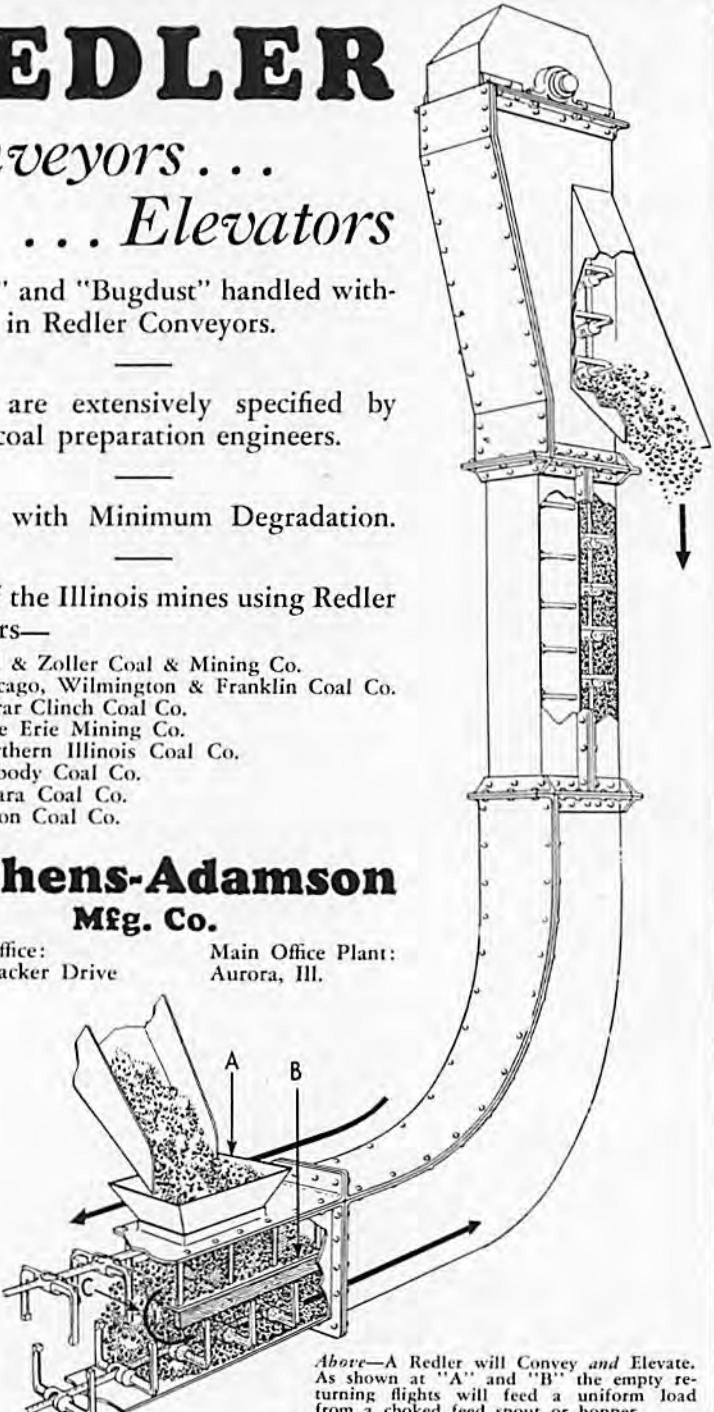

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