PROCEEDINGS OF THE ILLINOIS MINING INSTITUTE

Founded February 1892

1931

HAWKINS & LOOMIS CO.
162 W. Monroe Street
CHICAGO, ILL.

PROCEEDINGS

of the

ILLINOIS MINING INSTITUTE

Founded February 1892

1931

Summer Meeting
on board S. S. Cape Girardeau
June 5-6-7

and

Annual Meeting
SPRINGFIELD, ILLINOIS
November 6

Jos. D. Zook
President 1931

OFFICERS 1931

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Jos. D. Zook

Chicago, Ill.

VICE-PRESIDENT

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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 S. 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' Association, Chicago, Ill.

CONTENTS.

SUMMER MEETING AND BOAT TRIP

June 5, 1931

Annual Summer Meeting and Boat Trip of the Illinois Mining Institute held on S. S. Cape Girardeau, leaving St. Louis Friday June 5, 1931, at 10:30 P. M., and returning to St. Louis Sunday June 7, 1931, at 8:30 A. M.

The meeting was called to order on Saturday morning June 6th, by President Jos. D. Zook. There was a total of ninety-eight members and guests on board, as follows:

ATTENDANCE

ABRELL, JOHN	Peabody Coal Co., Kincaid, Ill.
ARGUST, W. C., Div. Supt.	Peabody Coal Co., Taylorville, Ill.
BARNES, N.	West Virginia Coal Co., St. Louis, Mo.
BARTLETT, A. G.	Burton Explosives Co., West Frankfort, Ill.
BEAN, F. M.	Egyptian Iron Works, Murphysboro, Ill.
BIGGER, I. T.	Vacuum Oil Co., Cape Girardeau, Mo.
BLAKE, ARTHUR	Peabody Coal Co., Marion, Ill.
BOLT, W. W.	West Virginia Coal Co., O'Fallon, Ill.
BREWSTER, B. B.	Sullivan Machinery Co., Mt. Vernon, Ill.
CADY, GILBERT	State Geological Survey, Urbana, Ill.
CAHILL, EDW.	Operators' Commissioner, Duquoin, Ill.
CALLEN, A. C.	University of Illinois, Urbana, Ill.
CHAMBERLAIN, WM.	Jeffrey Mfg. Co., Springfield, Ill.
CLARK, FRED K.	Hulburt Oil & Grease Co., Webster Groves, Mo.
CONWAY, LEE	Consolidated Coal Co. of St. Louis, Mt. Olive, Ill.
DAKE, WALTER	Joy Mfg. Co., Franklin, Pa.
DAVIS, A. J.	Osborn & Lange, Chicago, Ill.
DAVIS, WM.	Simplex Wire & Cable Co., Evansville, Ind.
EDWARDS, J. H.	"Coal Age," Huntington, W. Va.
ENGLISH, THOS.	Dept. of Mines & Minerals, Springfield, Ill.
GARCIA, JOHN A.	Allen & Garcia Co., Chicago, Ill.
HALBERSLEBEN, PAUL	O'Gara Coal Co., Harrisburg, Ill.
HALLER, EMIL	Consolidated Coal Co. of St. Louis, Mt. Olive, Ill.
HAMILTON, CHAS. F., V.-P.	Pyramid Coal Corp., Chicago, Ill.
HARVEY, HADLEY	Ohio Brass Co., Evansville, Ind.
HASKINS, LEE	Bell & Zoller Coal & Mining Co., Zeigler, Ill.
HAYDEN, CARL T., G. M.	O'Gara Coal Co., Chicago, Ill.
HEFFERNAN, JACK	DuPont Powder Co., St. Louis, Mo.
HELM, GUIDO	Consolidated Coal Co. of St. Louis, Mt. Olive, Ill.
HELSON, J. R.	Joyce-Watkins Co., Metropolis, Ill.
HUFF, GEO.	Dearborn Chemical Co., St. Louis, Mo.
HUTTON, WM.	Operators' Commissioner, Springfield, Ill.
JOHNSON, ED. H.	Safety Mining Co., Chicago, Ill.
JEFFERIS, J. A.	Illinois Terminal R. R. System, St. Louis, Mo.
JENKINS, G. S.	Consolidated Coal Co. of St. Louis, St. Louis, Mo.
JENKINS, S. T.	Goodman Mfg. Co., St. Louis, Mo.

JENKINS, W. J., Pres. .... Consolidated Coal Co. of St. Louis, St. Louis, Mo.
JONES, A. M. .... John A. Roebling's Sons Co., St. Louis, Mo.
JONES, JOHN E., Safety Engineer .... Old Ben Coal Corp., West Frankfort, Ill.
JOYCE, A. R. .... Joyce-Watkins Co., Chicago, Ill.
KLEIN, GEO. .... Klein Armature Works, Centralia, Ill.
KNOIZEN, A. S. .... Joy Mfg. Co., Franklin, Pa.
LA MERTHA, E. E. .... John A. Roebling's Sons Co., St. Louis, Mo.
LEE, CARL .... Peabody Coal Co., Chicago, Ill.
LEIGHTON, M. M. .... State Geological Survey, Urbana, Ill.
MAHLSBERGER, A. H. .... DuPont Powder Co., Springfield, Ill.
MANCHA, RAY .... Mancha Storage Battery Locomotive Co., St. Louis, Mo.
MARBLE, G. E. .... General Electric Co., Chicago, Ill.
MARSHALL, HARRY, State Mine Inspector .... Springfield, Ill.
MILLER, FRED .... Franklin County Coal Co., Royalton, Ill.
MILLER, J. B. .... Mines Equipment Co., St. Louis, Mo.
MILLHOUSE, JOHN G. .... Director of Mines & Minerals, Springfield, Ill.
MITCHELL, A. G. .... Sullivan Machinery Co., Mt. Vernon, Ill.
McCULLOUGH, F. R. .... C. I. P. S. Co., Marion, Ill.
McFADDEN, GEO., Asst. Vice-Pres. .... Peabody Coal Co., Chicago, Ill.
McFADDEN, NAT .... Peabody Coal Co., Taylorville, Ill.
McORTER, GEO., Operators' Commissioner .... Herrin, Ill.
NEAL, DAVE .... Consolidated Coal Co. of St. Louis, Mt. Olive, Ill.
O'BRIEN, FRANK .... American Cable Co., Harrisburg, Ill.
OLDHAM, R. J. .... Centralia Coal Co. Centralia, Ill.
PFAHLER, FRED, Pres. .... Superior Coal Co., Gillespie, Ill.
PICKARD, A. E. .... Mt. Vernon Car & Mfg. Co., Mt. Vernon, Ill.
POWERS, F. A. .... Dooley Bros., Peoria, Ill.
REES, EDW. .... Central Illinois Coal Mining Co., Springfield, Ill.
RICHARDS, JAS. .... Belleville, Ill.
ROTH, A. W. .... Vacuum Oil Co., St. Louis, Mo.
SANDOE, C. J., V.-P. .... West Virginia Coal Co., St. Louis, Mo.
SCHONTHAL, B. E. .... B. E. Schonthal & Co., Inc., Chicago, Ill.
SCHULL, BEN .... Binkley Mining Co., Clinton, Ind.
SCHULL, FRANK .... Binkley Mining Co., Clinton, Ind.
SINCLAIR, ROBT. .... DuPont Powder Co., St. Louis, Mo.
SMITH, C. M. .... University of Illinois, Urbana, Ill.
SMITH, HARRY .... Consolidated Coal Co. of St. Louis, Mt. Olive, Ill.
SPICER, C. J. .... Hercules Powder Co., St. Louis, Mo.
STARKS, J. W. .... Peabody Coal Co., Langleyville, Ill.
STEDELIN, JOHN .... Marion County Coal Co., Centralia, Ill.
STEIGER, A. E. .... Pyramid Coal Corp., Pinckneyville, Ill.
STUTSMAN, B. D. .... Mine Rescue Station, Johnston City, Ill.
SYERS, J. .... Western Powder Co. Peoria, Ill.
TARRACH, A. C. .... Consolidated Coal Co. of St. Louis, Mt. Olive, Ill.
TAYLOR, F. E. .... Chicago Pneumatic Tool Co., Decatur, Ill.
TAYLOR, H. H., JR. .... Franklin County Coal Co., Chicago, Ill.
THOMAS, T. J., Pres. .... Valier Coal Co., Chicago, Ill.
TIRRE, FRANK F. .... Better Business Bureau, St. Louis, Mo.
TREADWELL, H. A., G. S. ... Chicago, Wilmington & Franklin Coal Co., Benton, Ill.

TROEGER, L. H. .... Consolidated Coal Co. of St. Louis, Mt. Olive, Ill.
VEATCH, F. M. .... Consolidated Coal Co. of St. Louis, Mt. Olive, Ill.
VLASACK, JOS. .... St. Louis & O'Fallon Coal Co., East St. Louis, Ill.
VOELKEL, E. .... Utility Conveyor Co., St. Louis, Mo.
WEART, A. T. .... John A. Roebling's Sons Co., Chicago, Ill.
WEIR, PAUL, V.-P. .... Bell & Zoller Coal & Mining Co., Centralia, Ill.
WEISSENBORN, F. J., Operators' Commissioner .... St. Louis, Mo.
WILKIE, F. S., Secy., ... Illinois Coal Operators' Assn., Chicago, Ill.
WILSON, J. C. .... Ohio Brass Co., Mansfield, Ohio
WHITE, JOHN, State Mine Inspector .... Collinsville, Ill.
WRIGHT, D. D. .... C. I. P. S. Co., Marion, Ill.
YOUNG, W. P. .... Crescent Mining Co., Peoria, Ill.
ZOOK, JOS. D., Pres. .... Illinois Coal Operators' Assn., Chicago, Ill.

After an address of welcome by the President, the Secretary was requested to report as to the membership of the Institute, at which time he reported as follows:

Total regular membership	349
Total life membership	22
Total honorary membership	4
Total membership	375

The meeting was then turned over to Mr. W. J. Jenkins, President of the Consolidated Coal Company of St. Louis, who acted as Chairman of the morning session.

During the morning session a landing was made at Cape Girardeau, Mo., for recess of one hour, after which the business meeting was resumed.

The morning program consisted of the following papers:

"Increasing the Life of Cutting Machine Bits" by Mr. H. H. Taylor, Jr., General Manager of the Franklin County Coal Co., Chicago.

"Practices Relating to Mechanized Operation," by Mr. Lee Haskins, Supt. of Bell & Zoller Coal & Mining Co., Zeigler.

Discussions were entered into freely after each paper was presented.

Immediately after lunch, the meeting was re-opened and turned over to Mr. Geo. McFadden, Asst. Vice President of Peabody Coal Company, Chicago, who acted as Chairman of the afternoon session. The following papers were presented:

"How can our miners and underground officials be educated in Safety", by Mr. John E. Jones, Safety Engineer of the Old Ben Coal Corporation, West Frankfort.

"The Use of and Saving Effected by Acetylene and Electric Arc Welding," by Mr. Carl Lee, Electrical Engineer of Peabody Coal Company, Chicago.

These papers were also very liberally discussed.

After the evening dinner a most interesting paper was presented by Mr. E. T. Weart of John A. Roebling's Sons Co., Chicago, entitled "Safe Practices with and increasing the Life of Hoisting Rope." This paper was supplemented by a most interesting three-reel film of the construction and building of the Hudson River Bridge, recently completed by John A. Roebling's Sons Co.

Mr. G. E. Marble of the General Electric Co., also showed some interesting pictures of the recent developments in electric welding.

The business session held in the middle of the afternoon took up routine matters. The question of the Fall meeting was discussed, and upon motion duly made by Mr. John A. Garcia, properly seconded and carried, it was voted that the Institute would hold its Fall meeting in Springfield, Ill.

On motion made by Mr. Frank Tirre, properly seconded and carried, the decision as to the length of the session, being one or two days, was left with the Executive Board. The date of this meeting also to be decided by the Executive Board.

The President then presented to the members a matter that has been up for discussion for some time, regarding the Institute affiliating or joining up with other mineral industries of this state; and a committee of three was appointed to draft an amendment to the By-Laws, to be presented at the Fall meeting for final disposition or rejection. The proposed change in the By-Laws is as follows:

"Art. 1, Name and Purpose. The Illinois Mineral (Minerals) Institute has for its objects the advancement of minerals and the mining industry, by encouraging and promoting the study and investigation of mining and mineral properties, by encouraging education in practical and scientific methods, and by diffusing information in regard to minerals and mining that would be of benefit to its members and the people of Illinois.

Art. 2, Membership.

Section 1. Any person directly engaged or interested in any branch of minerals, mining, mining supplies, mining appliances, or equipment utilized in the mineral or mining industry, may become an active member of the Institute. (No change in balance of this section.)

Section 2. Any person of distinction interested in the mineral industries or in mining may be elected an honorary member of the Institute by a 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, may become an honorary member."

Mr. T. J. Thomas reported activity in connection with the Vocational Education Movement, of which he is Chairman of the Committee representing this Institute.

Communications were read by the Secretary including telegrams of regret from Mr. F. F. Jorgenson, Mr. Geo. B. Herder and Mr. J. Milton Duff; also letters were read from Mr. Geo. Ellstrom who has been transferred to the West Virginia field, and from Mr. James S. Anderson, our past president, who is taking a trip around the world. All communications were well received.

It was generally conceded that taking everything into consideration the meeting was well attended, and we were all very grateful to have had as many representative attendants as we did have on the boat this year.

There being no further business, on motion the meeting adjourned.

B. E. Schonthal
Secretary and Treasurer.

INCREASING THE LIFE OF CUTTING MACHINE BITS

By H. H. TAYLOR, JR.
General Manager Franklin County Coal Co., Chicago

Mr. Taylor: I imagine that Roy Adams in test which he made for the Old Ben Coal Corporation on cutting machine bits has additional information to what I will give you.

About three months ago we became interested in improving our cutting machine bits. We made several studies and made some experiments preparing bits and after some time we prepared this information in a paper which was read at Cincinnati. I will mention nothing more than the important parts. We have reduced the cost of undercutting by the use of improved machine bits, more than enough to pay for the extra cost of the bits.

We found from experience with the stellited bit that it cost us less to deliver these bits to the face, as we found we were able to reduce our labor. Since that time we have decided to go a little further, and we made two more tests at the mine which were similar to the tests which we described in the paper read at Cincinnati. At that time the machine was rather new but by now it has had time to work in, and does not offer as much resistance.

When using the ordinary bit we averaged about one ton of coal per bit sent below. On the basis of the tests made last week with the new material, we have increased this figure to about four or five tons per bit sent below. In fact on one test we have obtained thirteen tons per bit used. But taking the mine as a whole we will not be able to do that well.

It might be stated that the new material is about twice as hard as stellite.

We are just starting to learn something about this proposition, and it is our hope to be able to get one machine to run a whole day without changing bits.

Discussion

Mr. Argust: I might say that we tried the stellited bits, and we found that they did not stand up any better than the ordinary bit steel. However we are still interested in these tests.

Mr. Starks: In the Kincaid field I think that we have the hardest cutting in the State of Illinois. We have lots of boulders, and if a bit costs a dollar it will go, if it hits a boulder.

Now in tipping a bit with stellite you get another bad feature as you get a crystallization and our bits have to bend or they will break when they hit a hard object.

We have places that we will probably use 150 bits before we get them cut.

There has been many concerns that have come in and talked to us about tempering, but for our particular work we find that the ordinary steel bit gives us the best results.

Mr. Argust: I would like to ask Mr. Taylor where they apply the stellite on the bit? And if they have ever tried grooving the bit in two places so that you would have the benefit of the stellite all through the bit. I believe that by grooving the bit in two places you will get better results. You simply cut two grooves from the point down to the shank. You can cut this with a die, or with a shaper or an emery wheel.

Mr. Taylor: We apply our stellite on the tip of the bit. We have never tried the groove process.

Mr. Starks: Has anyone found out if you stellite bits that you do not crystalize your metal. We had some drill bits that we ground off and tried stelliting, and it was a sad experience.

Mr. Treadwell: I do not have much to say, except after the bit comes back up out of the mine, what do you do with it?

Mr. Taylor: We figure you can use a new piece of bit steel 25 or 30 times.

Mr. Treadwell: About three years ago when we put in the McKinley entry drivers, we tried stellited bits and we had a hard time to keep the stellite from chipping off, and our bits bent and we gave it up and started buying high speed steel for those machines.

About two months ago we started stelliting again, but we tried it different. So far we have been averaging about 1.2 tons to the bit, and we sent these stellited bits into the mine and on the rooms we run about 7.4 tons per bit. We are now averaging about 6 tons on our bits. Now we figure that those bits will come out and be shaped twice, and after they have been ground twice we bring them out and give them another dose of stellite. So far we have not developed any more broken bits than with any other bit. Like everyone else we have used stellited bits to try to eliminate the delays on track cutting machines.

Another thing we found out was that we could speed up our deliveries a lot by using stellited bits.

Mr. Knoizen: What experience we have had with stellited bits was very similar to the experiences described by Mr. Starks. Usually about fifty per cent. of our bits break off. Our experience has been confined to Pennsylvania.

We grind our bits about two times, and that's about as far as we have gone.

Mr. Thomas: All I can say is that our experience has been about the same as Mr. Taylor's, and we are getting about the same results as they are, and we are now getting about four or five tons per bit.

Mr. Garcia: I would like to insert an entirely new idea into this discussion, and I am convinced that the problem is a mechanical one. Ever since the machine was invented we have been adding to or improving the quality of material used. And we know that no matter what kind of a bit we may have, if we hit a "Nigger Head" or a boulder the bit is gone. Why not have two, three or four bits on a lug? Make a lug on which there will be four bits, so that the thing can be controlled to cut down changing bits, and I am convinced that good results will be obtained.

Mr. Thomas: It seems to me that anything we could do, so that we could avoid the delays in changing bits, and if we could get a bit that would stand up for one full day's operation it would save us $100.00 per day.

Mr. Starks: We have one machine at our No. 7 mine that cut an average of 1,150 tons per day last month. We have another type machine that averaged 1,080 tons per day. We are running about two tons per bit. So you see we are changing between 500 and 600 bits a day, which our machine men do in about 30 minutes.

Mr. Zook: I presume that any increase in the dullness of the bits also increases the wear and tear on the machine.

Mr. Thomas: On this question of changing bits, I would just like to know if anyone else can change 500 or 600 bits in 30 minutes time.

Mr. Taylor: I made the statement somewhere that we had reduced the cost of our machine repairs about half within the last 6 months over what it used to run. However these figures covering machine repairs involve loading under the mechanical loading system. And I really feel that we have made a better showing than these figures indicate, for under the hand loading system we were only getting about 140 tons per machine, and we are now obtaining an average of 250 or more tons per machine per day.

Mr. Treadwell: Now I know we have not been setting the world on fire with our track cutting machines, and are not doing it now. But before using the improved bit we were having considerable trouble to keep up the cutting on two loading machines. But since putting in the improved bits we have been able to keep up our cutting for two machines regularly, although we are not cutting any tonnage like Mr. Starks over here.

There has been the direct question asked as to whether stellited bits have effected any saving. From our experience I would say they have.

Mr. Starks: After using the bits some time we were losing 180 bits a day, which is quite an item. This was caused by the tempering in the bits. When the machine comes up against these case hardened bits in cutting it throws out bits from the chain. We tried buying bit steel from several concerns, and that is where we run up against a sorry proposition. Now there is where you get a big loss in bits.

Paper referred to as having been read at Cincinnati will be found in the reprint of papers presented at the Mining Congress, elsewhere in this book.

MECHANICAL PRACTICES

By LEE HASKINS

Superintendent, Bell & Zoller Coal & Mining Co., Ziegler, Illinois

Illinois has extensive areas of high grade Bituminous coal and the mines in this field produce a high percentage of domestic fuel. Coal mining in Illinois is gradually passing from hand to mechanical methods.

The one principal reason for this change is the high wage scale paid in Illinois which makes it necessary to produce more tons per man employed so that the cost per ton will more nearly equal the mining costs in other fields which pays lower wage scales, and the change to mechanical loading is necessary if the production of coal in this field is to be put on a profitable basis; and, as I see the problem today, we are now in a mechanical age. Nevertheless, it is a recognized fact that the details of mechanical loading at each mine is an individual problem and must be solved at that particular mine as to the detail of operation and the choice of proper equipment.

One of the major difficulties to be overcome in the installation of loading equipment was the impression that the entire mining method would have to be changed. Many operators and mining men were slow to make these imaginary changes at a large expense to new methods with loading equipment, also the labor relations between the operators and the miners has made the change more difficult and has greatly retarded its progress. However, with these difficulties to combat, mechanical loading has made progress, as the report of the Illinois Operators Association for the month of April this year shows that 1,526,379 tons were mined by mechanical methods which was 57% of the coal mined in the State; 28% was hand loaded and 15% by stripping operations.

And, when you stop to think that what were considered record daily tonnages a couple of years ago are average tonnages today and I believe that our record tonnages of today will be average tonnages in the near future, because we all know that we have plenty of room for improvement as our time study on our machines show that they are only loading coal about half of the time, which goes to show that transportation is more than half of the problem, and it is up to us fellows who are in the game today to work these matters out. Some operators have put in larger pit cars, laid heavier rails and put in more switches for quicker car change which have all helped, however, it is rather difficult to deal with the sources of haulage delays in general terms and their effect on the productive capacity of any particular mine, as all mines differ in grades and other conditions so that one system that might be successful in one mine might be a failure in another so it is up to each and every one to work out his own problem along this line.

Preparation

Preparation of coal in my opinion starts at the face, for if you don't properly under-cut, snub, drill or shoot the coal so as to make large sizes at the coal face, it is a sure thing there won't be any lumps by the time it reaches the railroad car. All seams of coal in Illinois have more or less impurities that must be removed at the working face or in the tipple. Under the old hand loading method, the loader was required to load clean coal at the face, and the impurities that the loader missed or failed to throw out were picked out in the tipple. Now, under mechanical loading, these impurities all come to the top where they must be removed, and in mechanical loading the impurities in the sizes that are above two inch are somewhat increased and must be cleaned on top. If the coal under two inch did not need cleaning under hand loading, it will not need it under mechanical loading. The cleaning of coal above two inch mechanically loaded has been solved in this field by splitting the load on the 6 x 3 and 3 x 2 sizes and increasing the number of pickers on the picking tables. The method to be used depends on the amount and character of the impurities in the seam.

Maintenance of Joy Loaders

Often the maintenance of such equipment is not given the attention and consideration which it is due. The maintenance department is relied upon to keep the loaders at work and the results they obtain are not always measured in tons per lost time repair hours, but in up-keep cost per ton. With this in mind, we have a rigid inspection of each Joy machine every six days. An inspection form is used which covers the motor, controller, circuit breaker, clutches, hydraulic system, its pressure, chains, transmission cases, oil and grease leaks.

Our night Joy maintenance men are organized into crews of two men each, a leader and helper. The leader is paid $7.00 per shift and is held responsible for the work while the helper is paid $6.10. Each crew of two men have six Joys to grease, oil and repair, and the complete inspection of one Joy each shift.

The inspection reports made out by the crew leader are turned in to the Head Electrician. Each crew is furnished a daily repair order which is made out at the end of the day shift by a mechanic who receives the location of the machine and the nature of any repair work which should be done that night by the repair crews. This information is obtained from the

Joy operator. By obtaining this information from the operator himself, a man who knows the machine, a detailed repair order can be left for the night crews which is clear to them and much time is saved in locating and repairing the machine as well as blocking the alibis by the operator and Joy gang foreman in the failure to correctly report such work orders. Each crew is provided with a locomotive repair truck which is equipped with a tool box, mounted vice, necessary tools, spare hoses, spare pump and other smaller parts which are most often used; while the larger parts or units which are not often needed are kept at a central station to which any of the crews have access. The repair crew, after locating the machine from the repair slip, proceeded with the work reported. The helper fills the machine with hydraulic oil, a road engine oil being used, making a note on the repair order the amount used and then greases the parts of the machine fitted with ball and spring oilers. The leader fills all clutches and cases with Joy loader grease and notes on repair order the amount used. The repair work is then performed and we have found that the repair being of minor nature for the first year, after which the machine is brought out to the shop and carefully overhauled for another year's service. Of course, there are exceptions where occasionally major repair work is required before the end of the year, which is taken care of by extra men when required to have machine ready for the next shift. But our experience has proven that a Joy loader properly serviced and operated is dependable with only minor repairs for at least one year. And, at the end of that time, it should be taken to a properly equipped shop and gone into thoroughly.

After finishing the shift the leader of each repair crew O. K.'s each repair order leaving same and any parts changed, such as pump hose and other smaller parts, at the surface where he received his work order. The O. K.'d orders are filed away for reference, while the changed parts are required or replaced and left for the crew that evening. Summaries of the work orders and the inspection reports made from time to time brings to light many interesting and worth while facts. It has been found some operators have very little trouble with their machine and are tonnage leaders while others have considerable more trouble and low tonnage. Often an operator having considerable trouble with a particular part of the machine is coached in the proper operation and his trouble is overcome.

It happens also sometimes a machine, after being inspected and reported in good condition, breaks down next day. For example, a machine after being inspected and the controller fingers and segments were reported in good condition, and some of its segments and fingers come loose and fall out of place after the first hour's run the following day, the leader of that repair crew is called in and informed of his neglect to properly servicing of this machine. In this way the repair man is brought to realize his responsibility in the dependable operation of the machine in his charge.

While the system discussed may sound complicated and uninviting to many maintenance department heads, we have found it to carry on with little difficulty and to be of major importance to the man held responsible for the maintenance cost.

Gentlemen I thank you.

AFTERNOON SESSION

Mr. Jenkins: The first paper on the program this afternoon will be "Practices Relating to Mechanized Operation" by Lee Haskins.

Discussion on Mr. Haskins' Paper

Mr. Steddlin: I have listened very carefully to Lee's paper and I think as Lee said for that case to work out our own problems. Our aim should always be to increase our tonnage. We either go forward or backward.

Lee talked about his inspection, and his method of inspection. We started a report in each section each morning on any particular thing that a machine might need. The night repair man picks this up and does whatever is necessary. That system has just recently been started. On that same report we take the number of cars and figure the tonnage from that.

Another thing is the carelessness of weighing coal in the tipple. Our weighman now gives in a change on the average for each day. We were getting a difference of 12% in our tipple and track scale weights. Now we have only about 6.2% difference in our weights.

When we first started in mechanical loading, we were all more enthusiastic. It is hard to keep it up. I was told today about a fellow who was getting 400 tons of coal per day per loading machine with a 1½ ton car.

Mr. Sandoe: Speaking of mechanical mining, in the past few years we have tried out almost everything. Just as Steddlin said, we are finding out some things that we did not know of.

We have had some experience with small pit cars, as we have a mine that uses a one ton car, and we have loaded as high as 415 tons in an 8-hour day. We have only had the large loaders in for about a year, but have had good success with them.

Mr. Pfahler: Now that some of you fellows that have large loaders have spoken, I will mention our mine that is equipped entirely with conveyors. While on a hand loading basis we were not so much interested in delays. Now when we are paying on an hourly basis we are very much interested in eliminating delays. Every delay that you can now cut out or reduce has a direct bearing on cutting your costs. In arriving at a solution in properly reducing your delays a thorough study of your conditions must be taken into consideration. The eliminating of delays in mechanical loading determines whether or not we are successful.

But I might say that we are only scratching the surface in mechanical loading. Our records are open to any legitimate operator.

Haulage to me is one of the most important things in mechanical loading.

Mr. Starks: A number of us fellows have been making these trips on the river and to Cincinnati. Most of these fellows have considered mechanical loading as being just around the corner, which has been demonstrated in the State of Illinois. We have learned a great many things from these different fellows.

We see some good operations in travelling. I had the pleasure of visiting No. 15 mine at Mt. Olive.

We have advanced in mechanical loading so much faster, then in mechanical cleaning. And we will never be successful until we perfect that. And the ash content must be brought down if we expect to furnish coal to the railroads. I am informed that the screens in the mechanical mines are much better than in the hand loading mines. Of course some do not have the equipment to clean the coal, and they expect the men at the face to clean it.

Mr. Sandoe: I think that meetings of this type brings all operators in this field together and creates a feeling of friendliness.

I want to say that I believe the cleaning proposition is a very important one. We must take this coal from the face and prepare it after we get it out. But I believe that we have a long way to go in the preparation of coal. I want to say that I have been to several universities and they are all working on the coal cleaning proposition.

Mr. Garcia: I don't agree with Mr. Starks as to the quality of coal in a mechanical mine. It has been our experience all over the United States that the percentage of ash increases. In a number of mechanically operated mines a lot of the coal will come out stuck to pieces of rock, and then you must send this coal through some cleaning apparatus.

You will find in Europe practically all wet cleaning plants. Our experience in dry cleaning indicates that it is a matter of the adjustment of the equipment.

So you find in England they have gone almost entirely to the wet process. The big problem in the wet process is the handling of the 1/16" on down. It is now being thrown away in a creek. That is the practice that is going on now.

As to the question of loading coal with conveyors, we have made a study of conveyors in several mines. We have made a material reduction in the cost of coal in all the entries and narrow work.

Now our biggest problem today is the switching of cars. We should install large pit cars, 4 or 5 tons and 8 tons, to eliminate important delays in switching. Of course some times larger cars would involve practically building the mine over again and is not practical in a lot of cases. We have up the problems of loading coal in conveyors that run continuous and load the coal in pit cars continuously. I hope some one will work this matter out if we do not.

Mr. Taylor: May I ask Mr. Garcia if he advocates dry cleaning all together?

Mr. Garcia: No, there are some coals you can not clean successfully with dry cleaning. I have seen dry cleaning tables installed at mines that did not need cleaning at all. We found that they were cleaning coal from 3" to 0" and only the coal from 3/8" to 1/2" needed cleaning.

HOW CAN OUR MINERS AND UNDERGROUND OFFICIALS BE EDUCATED IN SAFETY?

By JOHN E. JONES

Safety Engineer, Old Ben Coal Corp.

Paper submitted at meeting of Illinois Mining Institute, June 6, 1931

The subject assigned to me by your program committee evidently presupposes that education in safety lies somewhere ahead of us rather than behind. By inference the subject indicates that either the education has not yet begun, or that it has not been successful. I will, therefore, endeavor to analyze the results of recent safety education in an effort to present data and to establish our status.

More or less intensive efforts in safety education began about twenty years ago, following the Cherry disaster of November 13, 1909, in our state. Important factors beginning at about the same time were, the act creating the Bureau of Mines (1910) and the Illinois Compensation Act (1911). There have been in force safety educational methods of various types and kinds resulting in the creation and organization of associations, departments, classes, contests, periodicals, experts, devices, legislative bodies, bulletin and picture advertising, and others; wholly concerned in the progression of safety. We have had at least one decade, probably two, of rather intensive safety education.

I know of no means to measure the amount of attempted safety education through these various agencies. I cannot even estimate the added cost, during the two decades, that has been expended through added laws, devices, propaganda and jobs in the name of safety. All I can do is to say that it is an enormous amount. Were I stationed at the other end of this time period and looking ahead through the twenty years, and knowing that such a great deal of effort towards safety was going to be expended, I would naturally expect results, not 100% of course, but a decided improvement, and so would you. There are many of us here today who were at that time actively engaged in coal mining and we can recall that we did expect results. Well, here we are at this end and we can look backward through the twenty years and check up on what we have done.

"A"

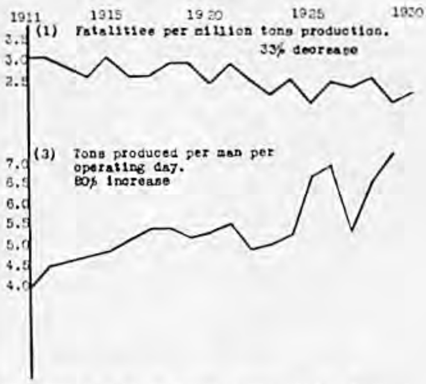
Coal Mine Fatality Rates—Illinois

(1)	(2)	(3)	(4)	(5)	(6)
	Tons per man		Fatalities per 1000 employed		
Year	Per year	Per day	From annual report	Calculated to 1000 tons per man, per year	Fatalities per Million tons produced
1910	653	3.8	5.4	8.27	8.3
1911	650	3.9	2.0	3.08	3.1
1912	722	4.5	2.3	3.19	3.1
1913	774	4.6	2.2	2.84	2.8
1914	758	4.7	2.0	2.63	2.6
1915	762	4.8	2.4	3.15	3.1
1916	838	5.1	2.2	2.62	2.6
1917	987	5.4	2.6	2.60	2.6
1918	985	5.4	2.8	2.80	2.9
1919	833	5.2	2.3	2.76	2.8
1920	838	5.3	2.05	2.44	2.4
1921	836	5.5	2.3	2.75	2.8
1922	645	4.8	1.6	2.48	2.5
1923	730	5.0	1.6	2.2	2.1
1924	725	5.2	1.8	2.5	2.5
1925	712	6.6	1.3	1.8	1.8
1926	900	6.9	2.1	2.33	2.4
1927	597	5.3	1.3	2.18	2.3
1928	858	6.5	2.1	2.43	2.5
1929	1043	7.3	1.9	1.9	1.8

I wish first to call your attention to the tabulation which is lettered "A". The data for this tabulation are taken from the annual coal reports of the State of Illinois. This table is self-explanatory, showing for each year and each day, the average production per man, and the fatal accident rates. These tabulations are also shown in the graph Plate, "B". You will note that the tonnage per man per day has gradually increased and the fatality rate per million tons of production has gradually decreased. That in which we are chiefly interested in this discussion is why these fatalities have been reduced. We want to know if safety education is wholly or in part responsible.

"B"

Coal Mine Fatality Rates—Illinois



Fatalities per million tons—rate decrease 33%

Production per man per day—rate increase 80%

Time of exposure for equal tonnage—rate decrease 44%

Fatality rate based on exposure—rate increase 11%

Graph No. 1, Plate B, is made from column No. 6 of Table "A". It shows a fairly gradual decrease, arriving at 33% improvement at present as compared with the beginning. Had the average production per man per day been constant over the twenty-year period, the average exposure would also have been constant, and the 33% decrease would show 33% improvement. Had the average exposure per man been reduced 33%, the 33% reduction in the fatality rate would just balance this decrease in exposure indicating that we had just held our own in so far as time of exposure were concerned. However, the records show that the tonnage per man per day has increased 80% in the 20-year period. Where he was formerly exposed for 8 hours for a certain tonnage, he is now exposed for only 4½ hours for the same tonnage. Strip mines are largely responsible for this reduction. His exposure has decreased 44%. The chances for a man to be fatally injured while at work are therefore the difference between the 44% and the 33%, or 11% greater now than at the beginning of the 20-year period. The greater tonnage per man per day accounts for more change than the improvement in the fatality rate.

We will not spend much time with the ratings relative to the non-fatal injuries in Illinois mines, simply showing tabulations and their Graphs, Nos. 1 and 2, on Plate C. There is no need to go into discussion since the increase is so big and so obvious.

Let us study briefly the fatality rating of the coal mines of the United States. The data are taken from Bureau of Mines reports. The tabulations and graphs on Plate D show the

Plate C.

Coal Mine Non-Fatality Rates—Illinois

Injuries involving a loss of 30 or more days.

Year	Per million tons	Per thousand employees
1911	14.2	9.2
1912	13.9	10.7
1913	16.2	12.9
1914	17.6	13.4
1915	17.6	13.4
1916	20.5	17.2
1917	20.7	20.2
1918	24.0	23.7
1919	34.9	28.8
1920	48.3	40.5
1921	54.0	45.2
1922	61.3	39.5
1923	47.9	34.9
1924	53.9	39.0
1925	46.0	
1926	44.2	39.7
1927	29.8	18.0
1928	38.7	33.2
1929	39.1	40.8
1930		

Plate D.

Coal Mine Fatality Rates—United States.

Year	Per 1000 300-day workers	Per million tons
1911	3.59	4.82
1912	4.11	4.04
1913	4.54	4.53
1914	4.90	4.40
1915	4.47	3.80
1916	3.88	3.33
1917	4.31	3.83
1918	3.97	3.50
1919	4.16	3.62
1920	3.79	3.13
1921	4.38	3.48
1922	5.16	3.99
1923	4.65	3.46
1924	5.39	3.94
1925	4.79	3.53
1926	4.86	3.60
1927	4.60	3.36
1928	4.90	3.45
1929		3.19
1930		3.41

fatal injuries per 1,000,000 tons production, and per 1000 300-day workers. Graph No. 1 shows that there has been a little improvement from the beginning to the end of the 20-year period, approximately 10%. Graph No. 2 is based upon the exposure of the workers. It shows approximately 25% increase in fatalities. Compared with the nation our rate in Illinois is less than one-half and our increase in fatalities based upon exposure approximately one-fourth.

From the foregoing, however, it is certainly evident that we have not accomplished in coal mine safety that which we expected, twenty years ago. The average coal mine worker is either subjected to a greater total of hazards during the shorter time he is at work, or he is less educated in safety than formerly. One ponders upon whether the present results would have been materially different had tons of the safety literature and thousands of the safety meetings been omitted. A timely expression nowadays is that production exceeds consumption, or that supply exceeds the demand. The supply of safety material produced during the past two decades evidently is largely unconsumed.

It would be easy to jump at conclusions and to find fault either with the proponents or the recipients of the safety efforts, or both. We must avoid condemnation and apply our energy to make a thorough study of the efforts and the results, and to choose that which has proven worth while, eliminating that which has proven to be of no value.

It is difficult to give "Safety" an impartial hearing, and an impartial verdict. Probably no other propaganda surpasses safety propaganda. It is next to impossible to eliminate our emotions and to compel cold reasoning to govern. The stereotyped argument of the safety enthusiast, "If only one life can be saved, then it is worth more than all it costs," is an emotional conclusion cloaked in would-be logic. It is likely to sway us as individuals and as groups, blinding us from rational thinking and logical conclusions. To give "Safety" the proper study with the hope of accomplishment we must omit the emotions and apply true reasoning.

As long as there are any injuries in our industry there is work to be done to prevent those injuries. Perhaps, however, we have in our earnestness and safety enthusiasm oversold those of us employed in the industry, the public, and our law makers, upon the degree of our hazards. It is the general opinion that our coal mines are extremely hazardous and unhealthful. Our industry is in a measure handicapped because of this false opinion. It seems to be the purpose of each one of us, the press, and our would-be reformers to foster this idea. We seem to delight in posing as martyrs in fueling our nation, in increasing insurance rates, and in developing a belittling attitude from the general public because we labor under such conditions. It is not my purpose to underrate the idea of safety, but I do think we herald the hazards of coal mining far more loudly than the conditions warrant. We seem to forget that the age is one of recklessness as compared with a decade or two ago. When one considers that the fatal accident rate of the nation is mounting higher and higher, year by year, than the growth in population, perhaps we are doing well in holding the coal mining fatal accident rate to where it is. In the United States during 1930 there were approximately 32,500 automobile fatalities, 30,000 home fatalities, 30,000 industrial fatalities, and 2,014 coal mine fatalities.

Let us concentrate upon coal mining, finding if possible where we have succeeded and where we have failed.

There are two general methods of procedure in lowering the accident rate. One is to make the mine safer and the other is to make the man a safer workman. I am sure that a vote here would be unanimous that the mines are safer than they were twenty years ago. But we want to keep away from opinions. In so far as possible we want the results of the last two decades to tell the story.

We have learned a lot about the natural hazards, especially those over which the majority of the individuals exposed would have little or no control. The hazards over which the individual does have control dovetail into those in which he does not have control, so it is difficult to draw a hard and fast dividing line between the two. We do know, however, that explosions and fires are an index of the natural hazards and are more remote from the individual care of the workmen than other causes of injury. Considering all such accidents in Illinois in the last 20 years in which two or more men lost their lives, and not counting the Cherry disaster, we find that there were 31 such accidents causing a total of 274 fatalities. 157 of these fatalities occurred in the first decade and 117 in the second decade; an improvement of 40 lives saved. The tonnage was practically equal for these two decades. Calculating and correcting for equal exposure there were the equivalent of 31 lives saved. This indicates that there has been improvement in the disaster hazards. The whole failure at progress then resolves itself into the individual hazard. We have, therefore, in general failed to make the man a safer workman.

There must be a cause or set of causes as to why he is not a safer workman. There certainly can be no question that he has been afforded safety education. The failure seems to be in his acceptance of it, and our problem further resolves itself into the question, why?

The safety education that was adopted for the individual consisted of four general parts, as follows:

(1) To teach the miner how to take care of himself.
(2) To create in him a greater desire to take better care of himself.
(3) To surround him with safeguards for protection.
(4) To supervise and discipline him to see that he did take care of himself.

We started with the assumption that the miner needed to learn a lot about safe workmanship. As a matter of fact he already knew far more than the average instructor could teach him. Picture yourself back twenty years ago, or your dad; a full-fledged miner proud of your working place, the sets of timber you were putting in, or the switch you were laying. Then picture some safety first fellow coming up and telling you how to take care of yourself. It would have been dangerous in those days, and in the days preceding, to try such educational methods on those men who knew their work only as experienced workmen can know the hazards of their jobs. Our procedure indicated that we thought safety to be something separate from the job, a study apart in itself. We have learned since that we were wrong. Safety is wholly and fundamentally the proper and efficient procedure of work. To teach a man safety mining is to teach him correct mining.

Then we wanted him to want to be safer. Here we were poor psychologists. We started (and are still trying) to scare him into being safe. We worked on his emotions, reminding him how his family could not get along without him. We frightened him by picturing him with an empty sleeve, or a peg-leg, or a dog leading him around. We actually did instil fear into him in our effort to instil caution. Fortunately human nature is a pretty stable thing or we would have scared nearly everybody out of the mines by this time.

There is no criticism to the third part, but it does seem that that old fundamental precept, "To every action there is an equal and opposite reaction", functions even here. Just in the proportion that the miner is guarded there seems to be that much relaxation on his part resulting, in the course of time, in a corresponding lack in his safety sense. One may consider a family of boys as being guarded closely from all harm and contamination. It does not take much stretch of imagination to conclude that the chances for them to amount to much are negligible. There are some who lament that we don't have the master picksmen we formerly had. That this is true is not due to a lessening of ability. It is the result of taking the pick away from the miner in lessening the laborious task of loosening the coal. Someone has said, "All things carry within themselves the seed of their own destruction." Even an organization, created for united effort, must expect that individualism will be stifled and that compensation will be lessened for the man who has initiative. The tendency is to elevate the inferior and lower the superior man. Likewise, protection other than the man himself tends to unmake the capable man who has been able to take care of himself. From a study of thousands of injury causes I am convinced that it is not inexperience, not a lack of knowledge of any particular hazard, not a lack of safety education that is the chief cause of individual injuries. The chief cause is the calloused mental development that results from apparent hazard after hazard being encountered successfully. The hazard that results in injury is not the whole cause. The thousand similar hazards that were successfully chanced combine into an important factor as to the cause of that injury. If every hazard were certain injury we probably would have fewer injuries.

What is said in the last paragraph belongs also in answer to part No. 4. From authoritative sources we hear and read a lot upon the need of more supervision and stricter discipline. One hesitates to state just what he thinks when that thinking is in such opposition to opinions of authorities. We learn, however, from exchange of ideas. In my opinion we have already overdone supervision and discipline. Picture again your dad, a full-fledged miner, being supervised and disciplined. Discipline is primarily for the youngster until he can take care of himself, for the inefficient and inferior, and for concerted action. Cooperative action is necessary and a certain amount of supervision is essential. The tendency now is to super-supervise. Individuality is being crushed, and we are unsuccessfully attempting to make robots out of men. It is plainly evident that we are not succeeding in the top-heavy supervision that is general, and it is difficult to appreciate why there is contention for more.

There are those who will contend that the ability of the present average miner is less than that of the miner of twenty years ago. There is a general tendency, and always has been, to regard the past as the "good old days." We even regard ourselves as having been more stable and obedient children than the children of today. Have you ever heard a high school senior tell of the inequality of hardships and inferiority of personalities of the present freshmen as compared with only four years ago? This will give you a good picture of the psychology concerning the myth we develop about the good old past. The human family now acts and reacts to the same stimuli as for many thousands of years. We are just beginning to appreciate this. When we can couple our present knowledge of things to a true knowledge of human nature we are going to make a lot of progress in safety as well as in other desired accomplishments.

Compensation costs may be factors for or against safety. It is quite right for an industry to pay for its injuries. When compensation payments are such that it pays a worker to lay off then the incentive for safety is discouraged and the effort is transferred to a fight between adjusters.

There are bright spots here and there in the remarkable records that are achieved by many companies. We can learn from them the causes for their continued success in their safety campaigns and their procedure. I venture to suggest that no small part of their success is due to the enthusiastic effort of those officials who have inspired their men with the pride of accomplishment in achieving such safety records. This success I ascribe more to the pride and individuality of the careful workman than to the repetition of the hackneyed slogan of "Safety First". There are readily available the elements and fundamentals of success. Success does not consist of a deluge of safety propaganda. It consists wholly of common sense that can be written in a very small space.

I will now briefly summarize my talk into a few short paragraphs, as follows:

(1) Statistics for state and nation show no general successful results from the immense safety effort of the last two decades. The success that has been accomplished is the result of increased production per man.

(2) Safety propaganda has flooded the public in general, and the coal mining industry in particular, with the *hope* of its success rather than the *knowledge* of its success.

(3) It is doubtful if as much as one-hundredth part of the safety literature published is even read by the worker, much less adopted.

(4) The true educator, or psychologist, would view with alarm the amateurish methods of such education.

(5) Safety educational propaganda is young and probably must complete its cycle of development before it will become efficient.

(6) We are likely to be led astray by theories that we believe to be unsound, because of our unwillingness to appear antagonistic to safety. When a safety recommendation, however futile, is made; who dares openly to oppose it?

(7) It is time that we become awakened as an industry and make a true inventory of efforts and results, and were governed accordingly.

(8) We rushed into this accident prevention with a great deal of enthusiasm and a fair knowledge of what we wanted to do. We also were well informed upon how to do things except that we ignored, largely, the human equation.

(9) We are learning, as the outside world is learning, that it is not rules and regulations, supervision and discipline, laws and statutes, that make for progress. These must follow a majority desire to round up the minority lack of desire, rather than lead with an immature emotional frenzy. Good laws and regulations are the results of progress rather than the cause. They are for the weak, the unwilling minority.

And from this talk and summary I would formulate my answer to include:

(1) the development of individualism is more to be desired to promote safety than further supervision and discipline.

(2) Adoption of true psychological principles and omission of the uses of fear, morbidness and dread.

(3) Adoption of true educational principles and avoidance of repetitions that become boresome and then unnoticed. The multiplication table is not repeated every day in the grades, then in high school and on through college. It's a wonder that some workman somewhere hasn't done something desperate to the boss who morning after morning, day after day, has warned him to "be careful."

(4) Quit the pretension that we are martyrs and get away from that foolish and childish pride in calling ourselves such as "underground savages", belittling ourselves in the public mind. Outside opinion of us is largely what we make it. We have almost made ourselves believe we are martyrs.

(5) Let's consider our work in the mines as wholesome, healthful work;—not a germ in a million tons,—and constant temperature the year around.

(6) You can't surround a man with enough devices, regulations and talk to keep him safe any more than you can give him religion that way. Safety must come from within. If the boss hasn't made a convert of an unbeliever in a week or two there is need of a new boss or a new man, perhaps both.

(7) We need a different mental attitude regarding our work. We have harped upon our hazards so much and listened to such extent to outsiders who pose as safety experts that we are more than undoing the good of coal mine improvements.

(8) Probably we should make a fresh start, fortified with the experience of failure and success of the last 20 years but with a psychologist and an educator on the staff so that we may take into account the human equation which after all is the greatest part of our problem.

And in conclusion—

(9) A further development in each man, each examiner, each boss, to earnestly ascertain to his own satisfaction, to his own conscience, that the job is well done. Such a principle makes it best for the individual and the group as was so aptly expressed by the poet 300 years ago, "To thine own self be true, and it must follow, as the night the day, thou canst not then be false to any man."

DISCUSSION

Mr. McFadden: We are all deeply interested in the health and welfare of the men who are doing all this work we have been talking about this morning.

The next paper on the program will be "How Can Our Miners and Underground Officials be educated in Safety" by John E. Jones.

Mr. McFadden: We thank you Mr. Jones for your interesting paper and the large size graphs which have enabled us to follow you in your treatment of the subject. I appreciate that you have given this subject much thought and study. It is rather in opposition to the general accepted procedure of safety instruction. There is no question but that you will have adherents and opponents in the discussion to follow.

Mr. Argust: I have been working a great many years in a coal mine. I maintain that we must continue to educate the workman in the prevention of accidents. I think almost all of you will agree that in machine mines there are more hazards. Therefore we must have closer supervision. And in all with increased hazards we have had a reduction of accidents which must be due to closer supervision.

I can not agree that our fathers twenty years ago knew all there was to know about safety. And that was the kind of education that was taught to me at that time. If we are to accept the theory that the men of twenty years ago had the proper method of mining then we are not making any progress. There must be a right and a wrong way to do anything. Therefore I believe the right way to be found is in the line of education and closer supervision, and I believe statistics, contrary to what has been said by Mr. Jones, will prove there has been a lot accomplished by education in the coal mine.

Mr. Millhouse: This accident prevention subject has been butted around very thoroughly all over mining communities. It seems that everybody has a special remedy to prevent accidents. Many honest and sincere men believe that only by education can you accomplish it.

It seems when you talk to a miner about this he does not fall for your line. I do not know of anything more ridiculous than to go to a practical miner, thoroughly familiar with all the dangers and try to show him how to prevent an accident. That man who has spent his time at the face has forgotten more about how accidents happen than any teacher can tell him. What you have got to do is interest that man in his safety.

You approach a man and you tell him "you are responsible for your safety, you are under sacred obligation to your wife and family, surely you should safeguard these loved ones." I have never failed nor been refused attention when approaching a man in this way. I have found men working in dangerous places, and spoken to them as above, and when you talk to men in that way they realize their sacred obligations. There is nothing more pitiful than to see a practical miner laid away for an untimely death in a coal mine.

You can talk about education and discipline, but they won't get you anywhere. You have got to approach the subject from another angle, and that is by the way I have spoken, and embody methods used years ago. We had accidents in those days just as much as we have now, but our mines are in better condition today than forty years ago. I can remember when a man got injured in a mine, he was taken home in a wagon and lay in his home until he got well.

Modernization has taken hold of our mines through the kind application of first aid, and many of our injuries that would have resulted seriously now turn out very favorably, and I believe that the chance of a man getting back to work has improved at least 50%. I am very much sold on the purpose of first aid, and as long as you have mines you will have accidents.

Stories have been brought to me that mine operators preach safety, but do not practice it. I have found men in the mine under dangerous conditions and told them to get out of there. Accidents do not pay anybody. The cost of accidents come high, whether they are fatal or non-fatal. We need a little bit more co-operation than we now have. As the old saying is, "Good air and good roads and coal will come out itself." I like to talk about it. How are you going to do it?

You need co-operation between the miners and operators.

Mr. Starks: I have had twenty-five years' experience as a foreman, but I am going to disagree with Mr. Millhouse and Mr. Jones. The ordinary miner won't do the things necessary to protect himself, unless he is forced to do them. We often hear that in these days of machinery we are killing men just the same as we did way back in the hand-mining days. The miners in this State at that time were men from other countries. Many of these men had no education whatever. What did we do with them? We supervised and educated them. And we are now mining five times as much coal per man per day as then.

In my 25 years' experience as a foreman I am very much of the opinion that you cannot have too much supervision. For 99 out of 100 do not do any more than they are forced to do. We have many more hazards now than formerly.

Now I am not sentimental about this subject at all. Your coal is costing you what it costs to operate plus about 3c to 13c per ton for accidents. I believe the average runs about 6c per ton. How are we going to prevent that? I believe the answer is supervision. I believe that anyone will find that supervision will pay.

Mr. Brewster: I dislike to intrude myself in this discussion. But I believe that I have been in more mines than any other man in this boat. I have had a chance to study every class of labor, and I believe that Mr. Jones is right and that his experiences will hold true anywhere. I believe that if you will take your workman and tell him of his obligations you will get farther than in any other way.

Mr. Argust: To those of us who believe that we have overdone the educational work for safety, I want to repeat that the work of education for safety in coal mines has only begun. I do not believe that you can do this with everyone, but in a lot of cases you must do something.

In any class meeting most of us will agree with most that is said by the various speakers. But I find that I am able to impart some knowledge to those men that work under my jurisdiction. We find a lot of men in the mines that are able to make suggestions, and we take these ideas and pass them on to their fellow workmen.

Mr. Halbersleben: The O'Gara Coal Company had a mine that had been on a hand-loading basis, but during 1930 it was 100% pit car loaders. And this mine had the lowest accident rate to any mine we were operating. We attribute this to the fact that the mules were displaced and motors put in the mine; also under the pit car loader system, we used about one-third more face bosses, than we had under hand-loading. We have also adopted a bonus system and are getting much closer supervision.

Mr. McFadden: We have all obtained a great deal of food for thought from this interesting paper presented by Mr. Jones and the discussion which we must now conclude.

The next paper on the program will be "The Use of and Saving Effected by Acetylene and Electric Arc Welding" by Mr. Carl Lee. Mr. Lee is one of the first to realize the benefits of this prcoess to the mining industry.

THE USE OF AND SAVING EFFECTED BY ACETYLENE AND ELECTRIC ARC WELDING

By CARL LEE
Chief Electrical Engineer, Peabody Coal Co., Chicago, Illinois

It may be interesting to note that the village blacksmith was able to weld iron, but with plain steel he was able to get only 20% to 50% strength in the weld and with alloy steels and other metals he was totally lost.

The history of industrial use of both oxy-acetylene and electric arc welding is quite recent. Both have been known in laboratories for many years, but only in the last few years have they been used extensively in a practical commercial way.

The oxy-acetylene torch uses the same kind of gas as is used in miner's carbide lamps plus pure oxygen mixed in varying preparations. The cutting torch had limited use 20 years or more ago in manufacturing plants to cut slabs of steel to complex shapes such as locomotive side frames. Mechanical guide devices enabled smooth cuts to be made through four inches or more of steel.

Acetylene welding developed more slowly and required the development of special alloy metal, fluxes, coatings, etc., for the filling metal, to make this work successful.

The electric arc itself has been known for 50 years or more. Later it was found that cutting could be done by using carbon rods or electrodes and very heavy current. This has met with only limited application.

Still later it was found that by using a metallic electrode that the metal from the electrode itself could be deposited on the work. However, in welding with the metallic electrode a very short arc has to be maintained and to do this requires skill. Also to maintain this work for hours is very trying on the nerves, therefore on large jobs the operator tires and becomes less proficient.

To overcome this trouble automatic welding heads to hold the electrode and feed it into the work at the proper rate have been developed.

With the brief outline above, let us come right down to modern applications to our own field of work. Inasmuch as we are not manufacturers of metal products we will omit that portion and limit our references to repair work.

Mining machines, locomotives, mechanical loaders, tipple machinery, etc., are made up of a large number of various sized castings, forgings, shafts, gears, clutches and so on. Some of these are very complicated in design and have a large amount of machine work done on them, hence are very expensive.

In years gone by when these parts were worn or broken they were replaced by new parts and the old ones thrown in the junk pile. Often the wear or break affected only a small portion of the part. Such part being essential in all details, and not usable if not complete and of full size, necessitated replacement.

Just for example, an armature shaft may have several sizes of machining keyways and a short threaded portion. The threads may become damaged, and the part is useless unless those threads can be replaced. With either of the two types of welding available it is possible to build new metal on the shaft and then cut new threads.

Another example is simple. In many machines we have gears with jaw clutches on the same part. The jaws become worn to a wrong angle. The defective jaws make the gear unusable because they are one and the same piece. Now it is possible to build up the jaws with very hard alloy, regrind to the proper angle, reuse the part with almost as good life as a new part.

In rebuilding cylindrical work the automatic electric welding head is very applicable. The metal can be deposited more uniformly, rapidly and perfectly than by hand.

Recently several mines have installed full automatic welding equipment for filling in or building up worn threads and flanges of locomotive tires and wheels. The trucks are supported in a lathe which has a special back gearing to run it at a very slow speed giving about 7 to 9 inches per minute travel of the tire. The automatic head is mounted on the carriage and the bed feed used while operating. This places the welding on the tire in one continuous spiral. The beads are ⅛ to ¼ inch pitch. About five pounds of metal can be deposited per hour. The tires require from 20 to 50 pounds of metal to bring them back to full size.

The tires may or may not be turned in a lathe after welding. It seems quite essential to turn the flanges, and is desirable to take a very light cut on the treads.

Now it is not in the scope of this paper to go into all the details or technique of the work. That is a study in itself. However for you to know that the savings are possible, and for you to encourage this work and promote the application to your equipment should bring good returns.

It is impossible to define the limits of this sort of work. The more use is made of these tools, the more additional applications will be found.

We have a standing rule that all parts removed from equipment shall be returned to the shop. There the electrician or master mechanic and the welder inspect it and decide if it can be repaired at a saving.

A record is kept of repairs made, showing cost of labor and material required, the cost of the item new, and the saving effected and the ratio of the repair cost to new part cost. The repaired parts may not be 100% as good as new, and good judgment has to be used in analyzing results. However for sake of comparison we use the above reports to see what is accomplished.

On the basis mentioned we saved over $100,000 on supplies at all of our mines in 1930. The average cost to repair was about 10% of the new cost. The total number of pieces repaired or total of different parts was not added up but certainly run into a large number. For example, on one type of equipment alone in a four months' period 87 catalogued parts totaling 528 pieces were repaired.

From the above you may be able to draw some conclusions as to the possibility of applying or expanding this type of maintenance work to your mine repairs.

DISCUSSION.

By G. E. MARBLE.

A somewhat recent improvement in metal cutting over the oxy-acetylene process consists in the use of illuminating gas instead of acetylene.

Where illuminating gas is available from pipes, there are many advantages to be obtained by its use, for nearly all classes of work.

These advantages seem to be as follows:

1. Low cost of the gas.
2. High factor of safety.
3. Its chemical and physical properties, which permit of its being used in a torch employing superheat, thereby effecting marked

economy in the amount of oxygen required.

4. Elimination of delays and handling of tanks.
5. Cuts are smoother, there being no slag to be ground off in preparation for future arc-welding.

Reverting to electric welding, the automatic welding head does make the work easier for the operator, as pointed out by Mr. Lee, but it has other advantages for standardized work of considerable importance.

By its use, the rate of deposition has been increased three to five times over manual welding.

There is also a considerable saving in the cost of the welding wire, which is cheaper when made in long lengths for winding on reels, again, no stub ends of wire have to be thrown away. In hand-welding, this wastage is sometimes as high as 25%.

In these days when it behooves us to watch our costs very closely, it would appear timely to call attention to the marked economy in the motor-generator welder, over the resistor-type, in cases where there is a fair amount of work to be done. To make this clearer, let us work out an average case.

Assume 5 hours steady work per day.

Assume 200 working days per year.

Assume cost of power=1 cent per KWH.

Assume 175 amperes as average welding current.

Assume 20 volts as average welding voltage.

Then in the case of the motor-generator type welder, we have—

175 amps. x 20 volts	=	3.5 KW
3.5 KW ÷ 50% eff.	=	7 KW
7 KW x 5 Hrs.	=	35 KWH
35 KWH x 200 days	=	7000 KWH
7000 KWH x 1c	=	$70.00

In the case of the resistor type welder we have—

175 amps. x 275 volts	=	48 KW
48 KW x 5 Hrs.	=	240 KWH
240 KWH x 200 days	=	48000 KWH
48000 KWH x 1c	=	$480.00
$480.00 less $70.00	=	$410.00 savings per year.

I have used 1c per KWH merely as an arbitrary figure. Where power costs more or less than this figure, the saving will vary accordingly.

Attention is also invited to the difference in primary charges, where purchased power is used, 7 KW for the motor-generator welder as against 48 KW for the resistor welder.

G. E. MARBLE,
Sales Engineer General Electric Co.,
Chicago.

SAFE PRACTICES WITH AND INCREASING THE LIFE OF HOISTING ROPE

By E. T. WEART
John A. Roebling's Sons Co.

Safe practice in connection with the use of wire rope is the most certain manner of securing maximum rope economy. In order to use wire rope safely and economically, it is essential that it be regarded as a machine and not as just so many wires twisted together. Wire rope is a powerful machine designed as a flexible medium of power transmission and although rugged in character may be considered a delicate mechanism in many respects. Its safe use and ultimate service are dependent entirely upon its treatment during installation and throughout its period of service.

Demands of modern industry have called for increased production in all branches of manufacture and operation, and at the same time an exacting maintenance of quality. To keep pace with this progress, the size of machinery is being constantly increased. In the cases of most industrial machines, their physical proportions are increased in keeping with their increased capacities. However, this is not the case with wire rope, for to increase the size of a wire rope proportioned to strength would mean costly and impractical sizes of sheave and drum equipment. Wire rope manufacturers have been confronted with the problem of producing desired physical properties in their products with strict limitations and size, and this has been accomplished by refinements in steel manufacture, wire drawing and rope fabrication. In order to understand something of the difference between the grades of steel commonly used and those used in wire ropes, it is interesting to compare the tensile strength of ordinary structural steel, which runs about 60,000 pounds per square inch, with the tensile strength of the steel used in improved grades of Plow Steel Wire Rope, which averages about 230,000 pounds per square inch.

Like any other machine, wire rope has a definite capacity for performing work. If worked beyond its capacity, some hazard usually attends its use and most certainly the rope life is greatly reduced. Wire ropes operated beyond safe and economical limits invariably render erratic service. In the Illinois coal mining fields most of the shafts are relatively shallow, and a safety factor of eight is recommended. This recommendation is supported by the Department of the Interior, Bureau of Mines, in their technical paper No. 237, and you may feel assured that the recommendations given in that paper are based on a sane appraisal of the value of safety, coupled with reasonable rope economy.

In connection with the figuring of wire rope safety factors, it must be borne in mind that acceleration stresses and the efficiency of wire rope attachments play just as important a part as the weight of the cage, car and coal.

The properly designed, properly attached wire rope socket is the only 100% efficient attachment and any other method used does not develop the full breaking strength of the rope. If a standard clip and thimble attachment is used, an efficiency of only 75% to 85% may be safely relied upon, due to unpreventable distortion of the rope at the clips and thimble. Sometimes there is an objection to the use of wire rope sockets due to the fact that the rope must be frequently taken up. In such cases it is desirable to use a special thimble and clamp arrangement instead of the usual clip and thimble method of attachment. By the use of this special thimble and clamp arrangement an efficiency in excess of 90% can be regularly obtained for the attachment.

When a wire rope manufacturer is asked to recommend a suitable rope for a given set of conditions, he gives serious consideration toward recommending a rope that will maintain the highest safety factor throughout its period of service. In some instances, it is possible to use wire ropes of constructions other than those recommended which will give greater service, but it must be remembered that such substitutions are usually made at a sacrifice of safety. The design of wire rope and its relation to safety and service is too lengthy a subject for discussion in this paper. Most wire rope manufacturers maintain a highly specialized corps of engineers for the purpose, and the user will find it profitable to submit his wire rope problems to them.

In the Illinois coal fields where hoisting cycles are rapid and rope speeds are high, the fatiguing action on rope wires is a serious factor. This fatiguing action does not cause any change in the outward appearance of the wires, the only visible evidence being the development of broken wires at the points of fatigue concentration. On shaft hoists the points of maximum fatigue are usually located in three places—first, in the section of the rope wound in the pick-up grooves of the hoist, second, in the section of the rope which passes over the head sheave during the acceleration cycle and third where the wire rope is attached to the cage. Of these points, the closest inspection should be given to the section of the rope located at the attachment. There is but a short length of rope between the head sheave and the attachment when the cage is in the dump and a good deal of vibration is developed in a short section of rope, all of which is concentrated at the attachment. If it be found that one or more broken wires has developed in that section of rope, the attachment should be cut off and re-attached. Sufficient rope should be stored in the drum to permit cutting off several feet of rope from the cage end at intervals during the rope life, the frequency of these intervals being dependent upon individual cases. In the section of rope wound in the pick-up grooves on the drum and in the section which passes over the head sheave during the acceleration cycle, fatigue breaks seldom appear before some degree of abrasive wear is noted.

The appearance of broken wires in a wire rope and the reduction of cross section area of the outer wires provides a very reliable gauge with which to determine the time of removal from service. Barring internal corrosion and assuming that the rope is of high quality and proper construction as to reserve strength, it will be found that the inner wires are usually intact when the rope is taken out of service. The reserve strength of a wire rope is that portion of the wire rope's total strength represented by the inner layers of wires and in the case of high quality shaft hoist ropes usually represents about 44% of the total rope strength.

No hard and fast rule can be made for the removal of ropes from service. Tests made on discarded ropes of standard constructions indicate that shaft hoist ropes should be removed from service under the following conditions:

1. If six broken wires develop in one rope lay.
2. If more than three broken wires develop that are reduced by wear more than 30% in cross section.
3. If the crown wires are worn to 65% of their original diameter.
4. When marked corrosion appears.

Under existing conditions in the Illinois coal fields much can be done toward increasing rope life. It is seldom realized that the installation of a new rope plays so important a part. Under no circumstances should the rope reel be placed close to the drum and the rope then reeled directly onto the drum. The reel should be located as far as possible on the opposite side of the head frame away from the hoist and the rope pulled up over the head sheave and then wound onto the drum. A suitable mounting for the wire rope reel should be a part of the rope equipment at every mine and this reel mounting should be provided with a powerful brake so as to keep the rope under tension during installation. Before attaching the rope to the cage it should be allowed to hang freely in the shaft and twist or untwist under its own weight. During the installation of a wire rope extreme caution should be used to prevent the rope from becoming kinked. It is just as important that no loops, either large or small, be allowed to form in the rope. Such a condition if not properly handled will eventually cause a wavy appearance in the rope and in extreme cases so-called "tight" or "loose" strands develop.

Head sheave and drum grooves provide the most frequent source of short rope life. As a rope wears in service it is constantly being reduced in diameter due to stretch and abrasion, with the result that the grooves in the equipment are gradually worn undersize. A new rope installed in undersize grooves cannot be expected to render economical service and the only remedy is to replace the drum shells and head sheaves. The head sheave problem is best solved by the installation of one of the new type sheaves equipped with removable steel liners. Some of this equipment is already in service in the Illinois coal fields.

The use of undersize ropes on worn hoisting equipment will in many cases increase the rope life, but this practice should be condemned because it eventually leads to a much worse condition than if standard diameter ropes are continued in use. The best practice is to use standard diameter ropes, anticipating that the rope life will be lessened as the equipment wears. In addition to performing useful work, the ropes used on worn equipment have to do a certain amount of machine work to free themselves in the tight grooves which accounts for lessened service.

Electrolysis is not an unheard of cause for rope deterioration. Where this condition is suspected the installation should be checked over and the condition corrected.

In rope manufacture one of the important considerations is lubrication. It is impossible to store up sufficient lubricant in a wire rope to last throughout its life and frequent applications of suitable lubricants are necessary to maintain the rope in proper condition. Contrary to popular opinion, the Hemp Center does not aid materially in lubricating a rope. It is important that the applications of lubricant penetrate the rope to the Hemp Center in order to prevent the center from drying up and to lessen the internal friction between the wires. Before applying lubricants, the ropes should be thoroughly cleaned by means of air or steam jets or by the use of wire brushes and thoroughly inspected at the same time. Lubricants should be applied hot so as to insure penetration to the Hemp core. It is important that lubricants of the proper grade be used and it is recommended that these lubricants be procured from the wire rope manufacturers. It is realized that it costs money to properly lubricate a wire rope but there is nothing that will pay greater dividends in the form of increased wire rope life.

COAL VERSUS OIL

Covering Service Tests at the St. Clair and Eastgate Hotels, Chicago, Illinois

By GEORGE I. METHE, President
Chicago Coal Merchants' Association, Chicago

Presented at Second Midwest Bituminous Coal Conference
University of Illinois, May 21 and 22, 1931

[*The following article should be of very great interest to all connected with Coal Mining and we are very grateful to the author for his permission to present it as a part of our proceedings.*]

The Chicago Coal Merchants Association during the past year conducted an extensive advertising campaign to prove that coal heat costs less—supporting these statements with data supplied from various sources.

The firm of Oman & Lilienthal, Architects and Engineers, who control several large hotels—all of which were built and designed to use oil as fuel—challenged our statements, claiming that the over-all cost of heating with oil was less than the over-all cost of coal, all things being taken into consideration and they were frank to state that in designing the various buildings in which they were interested they recommended and installed oil burning equipment, and did not even provide coal storage space for emergency.

All of the data submitted by the coal merchants to support their advertisements, and to prove that coal heat costs less, did not convince Oman & Lilienthal that it was a fact. The only method that could be employed to prove conclusively to them that coal heat does cost less was to conduct a coal and oil test in their plants in accordance with A. S. M. E. code—the test to be conducted by disinterested engineers of high standing. Then, if coal heat proved to cost less—taking into consideration the cost of fuel, ash removal, labor and upkeep, they would be convinced and in the future recommend coal in place of oil.

The Chicago coal merchants readily agreed to cause the test to be conducted in the manner prescribed. The Commercial Testing & Engineering Company of Chicago was mutually agreed upon as the testing engineers—the Eastgate and St. Clair Hotels were named by Oman and Lilienthal as the plants in which the tests were to be made.

All plant changes necessary were made under the supervision of the Commercial Testing & Engineering Company and the chief engineer of Oman & Lilienthal. All instruments used were furnished by the Commercial Testing & Engineering Company and were standardized before being put into use. All readings and records were made by the Commercial Testing & Engineering Company and checked by the Chicago Coal Merchants Association. When conducting the oil tests the Hardinge and Johnson Oil Burner people were invited to be present and were present for short periods—in each case they were afforded the privilege of adjusting the burners to their satisfaction.

Description of Eastgate Hotel Plant

The Eastgate Hotel is a 15-story brick building, located at 162 E. Ontario Street, Chicago, erected in 1926.

The heating plant consists of two No. 416 Fire Box Bros boilers, rated at 80 h. p. or 8,000 sq. ft. of radiation. The boilers furnish steam for the heating system, a 12,600 sq. ft. Illinois

Gravity System, and heat to a Bell & Gossett hot water system. The two boilers are connected into a common header for the heating system, each boiler being supplied with a separate Bell & Gossett hot water heater. The boilers have been fired by two Hardinge Oil Burners with No. 5 atomizers, using 18-20 pre-heated oil.

Description of St. Clair Hotel Plant

The St. Clair Hotel is a 21-story brick building, located at 162 East Ohio Street, Chicago, erected in 1928.

The heating plant consists of two No. 823 Special Oil City Boilers rated at 209 H. P. or 29,300 sq. ft. of radiation, fired by Johnson Oil Burners using 18-20 pre-heated oil. The boilers furnish steam for the heating system—a 27,842 sq. ft. Dunham Vacuum System, and domestic hot water heated in a Patterson & Kelly hot water heater. The two boilers are connected into a common header leading to the heating system and hot water heater.

Procedure of Test

Oil was tested first at the Eastgate Hotel on a 24 hour basis. After the test was completed the oil burner was removed and a Modern Stoker was installed. Preliminary tests were conducted over eight hour periods to adjust conditions, then a 24 hour test was made, using a mid-western 2″ screenings which retails at $5.15 per ton.

At the St. Clair Hotel test was made first on oil then an Iron Fireman Stoker was installed and a 24 hour test was run on the same coal as used at the Eastgate. The results obtained were as follows:

Data—Results

EASTGATE HOTEL

	Oil	Coal
Date of Test	11/28/29-30	12/15/30 12/16/30
Stoker or Burner	Hardinge	Modern
Kind of Fuel	Oil	Coal
Price Delivered	4¾c	$5.15
Duration of Test	24 hours	24 hours
Average Pressures		
Steam	1.92	1.60
Draft over fire	.07	.10
" under boiler damper	.20	.25
Average Temperatures		
Feed Water	40°F	38°F
Flue Gas	506°F	412°F
Outside	22°F	22°F
Flue Gas Analysis		
CO_2%	8.95%	11.1%
O %	9.70%	8.6%
Coal Analysis (As Received)		
Moisture		7.37%
Ash		9.34%
Volatile		35.13%
Fixed Carbon		48.16%
B. T. U.		12,133
Sulphur		4.01%
Fusion Temperature of Ash		1991°F
Oil Analysis		
B. T. U.	18,776	
Sulphur	.82%	
Combustible in Ash		17.82%

	Oil	Coal
Ash Removed from Furnace		612#
Water Evaporated (Actual)	47,310#	47,286#
Equivalent into Pounds of Dry Steam	55,778#	55,844#
Pounds of Water per Pound of Fuel from and at 212°	14.19#	9.76#
Efficiency—Boiler, Stoker or Burner	73.3%	78.0#
Percent of Rating Developed	94.0%	99.0#
Fuel Cost per 1,000 lbs. Steam (In cents)	43.5	26.4
Power Cost	.2	1.4
Ash Removal		.6
Total Cost per 1,000# Steam (In cents)	43.7	28.4
Percent Saving	35%	

Data—Results

ST. CLAIR HOTEL

	Oil	Coal
Date of Test	12/22-23	1/5-6
Stoker or Burner	Johnson	Iron Fireman
Kind of Fuel	Oil	Coal
Price of Fuel	4¾c	$5.15
Duration of Test	24 Hours	24 Hours
Average Pressures		
Steam	1.07	1.00
Draft Over Fire	.23	.26
Draft Under Boiler Damper	.33	.36
Average Temperatures		
Feed Water	36°F	36°F
Flue Gas	375°F	383°F
Outside	24.5°F	34.0°F
Flue Gas Analysis		
CO_2%	9.5%	11.6%
Coal Analysis (As Received)		
Moisture		6.26%
Ash		7.72%
Volatile		36.90%
Fixed Carbon		49.12%
B. T. U.		12,574
Sulphur		3.65%
Fusion Temperature of Ash		1991°F
Oil Analysis		
B. T. U.	18,781	
Sulphur	.54%	
Combustible in Ash		15.19%
Ash Removed from Furnace		876#
Water Evaporated		
Actual	92,407#	102,053#
Equivalent Pound Dry Steam	107,839#	119,095#
Pounds of Water per Pound of Fuel from and at 212°	15.17#	10.36#
Efficiency—Boiler, Stoker or Burner	78.4%	79.8%
Percentage of Rating Developed	75. %	83. %
Cost per 1,000# Steam (in cents)		
Fuel	40.6	24.9
Power	.6	1.0
Ash Removal		.6
Total Cost per 1,000# Steam	41.2	26.5
Percent of Saving with Coal	35.7%	

COMPARATIVE HEATING COSTS OF OIL AND COAL

	Eastgate	St. Clair	Both
Price of Oil per Gallon (in cents)	4.75	4.75	4.75
Price of Coal, Truck Load Delivery (ton)	5.15	5.15	5.15
Per Cent Saving with Coal Based on 24-hour Tests	35.0	35.7	35.4
Heating Costs Using Oil, May 1929 to May 1930	4,832.32	9,379.02	14,211.34
Annual Saving in Fuel Cost	1,691.32	3,348.31	5,039.63
Estimated Additional Labor Required	623.34	1,246.66	1,870.00
1 man 12 mo. @ $110.00 per mo.			
1 man 5 mo. @ $110.00 per mo.			
Net Saving	1,067.98	2,101.65	3,169.63
Percent Net Saving	22.1%	22.4%	22.3%

The results of these tests, together with the cost of the stoker, and estimated cost of providing coal bins, was submitted to Oman & Lilienthal and they decided to order the necessary building changes to accommodate coal.

After making the necessary changes, the Eastgate Hotel started in February and used the stoker to date, with the exception of a few days when it was necessary to make some changes—during which time they used some oil.

At the St. Clair the stoker was put in regular operation on March 1st, and has been in continuous use up to date. At this plant, while using oil, it was necessary to use a gas-fired boiler to supply steam to the kitchen for cooking purposes, but it was found that this load could also be carried on a coal-fired boiler. This created an additional saving.

At both plants accurate records were kept of all coal costs and compared with the oil costs for the same period last year * * * and the records show the following:

EASTGATE HOTEL

February

	1930	1931		
Average Outside Temperature	36.5°	35.8°		
Oil Cost	$516.55	$ 54.00		
Coal Cost		272.77		
Labor		35.00		
Ash Removal		10.80		
Total	$516.55	$372 57		
Saving (Coal over Oil)			$143.98	
Percent of Saving				27.8%

March

	1930	1931		
Average Outside Temperature	38.0°	35.0°		
Oil Cost	$588.51	$ 27.00		
Coal Cost		280.90		
Labor		35.00		
Ash Removal		10.00		
Total	$588.51	$352.90		
Saving (Coal over Oil)			$235.61	
Percent of Saving				40.3%

April

	1930	1931		
Average Outside Temperature	49.0°	48.0°		
Oil Cost	$459.90			
Coal Cost		$219.91		
Labor		35.00		
Ash Removal		10.00		
Total	$459 90	$264.91		
Saving (Coal over Oil)			$194.99	
Percent of Saving				42.4%

Total cost for February, March and April, 1930, using Oil vs. Coal for February, March and April, 1931, is as follows:

	1930	1931		
Average Outside Temperature	41.2°	39.6°		
Oil Cost	$1,564.96	$ 81.00		
Coal Cost		773.58		
Extra Labor		105.00		
Ash Removal		30.80		
Total	$1,564.96	$990.38		
Saving (Coal over Oil)			$565.58	
Percent of Saving				36.1%

ST. CLAIR HOTEL

March

	1930	1931		
Average Outside Temperature	38°	35°		
Oil Cost	$987.45			
Coal Cost		$764.81		
Gas Cost (Kitchen)	278.13			
Extra Labor		65.00		
Ash Removal		13.20		
Total	$1,265.58	$843.01		
Saving (Coal Operation)			$422.57	
Percent of Saving				33.4%

April

	1930	1931		
Average Outside Temperature	49°	48°		
Oil Cost	$919.80			
Coal Cost		$501.35		
Gas Cost (Kitchen)	319.41			
Extra Labor		65.00		
Ash Removal		14.00		
Total	$1,239.21	$580.35		
Saving (Coal Operation)			$658.86	
Percent of Saving				53.2%

Total cost for March and April, 1930, using Oil and Gas, vs. Coal for 1931, is as follows:

	1930	1931		
Average Outside Temperature	43.5°	41.5°		
Oil Cost	$1,907.25			
Coal Cost		$1,266.16		
Gas Cost (Kitchen)	597.54			
Extra Labor		130.00		
Ash Removal		27.20		
Total	$2,504.79	$1,423.36		
Saving (Coal Operation)			$1,081.43	
Percent of Saving				43.3%

The estimated cost of stoker and building changes to accommodate coal for both hotels was $5,385.00.

Their figures show a saving of $1,647.00—or 30% of the investment—in less than three months' time.

SAFETY AND MECHANICAL MINING

By W. J. JENKINS

[The following papers by W. J. Jenkins, I. D. Marsh, H. H. Taylor, Jr., R. M. Lambie, C. J. Sandoe and G. C. McFadden, all members of our Institute, were presented at the 1931 meeting of American Mining Congress, and reprinted by Mining Congress Journal. We are grateful to both these organizations for their full permission to give them to you herewith.]

In dealing with the subject assigned to me, it is not my intention to discuss it from a strictly technical or engineering standpoint. Rather, I am going to present it from the viewpoint of an executive, who, in the last analysis, must stand the brunt as to cost, as well as answer the criticism of the injured employe and those dependent upon him.

The introduction and use of mechanical equipment, whether it consists of trolley and storage battery locomotives, chain or punching coal cutters, coal loading devices, power drills, etc., in and of itself, does not entirely remove the hazards of the occupation or insure absolute safety to our employes. It may be that additional safeguards are required. If and when guards and shields are provided, it then becomes necessary to intelligently direct all those utilizing mechanical appliances to avail themselves of these protective features.

It is the duty of the management to insist upon the use of the safety features supplied. Employes disregarding the laid down rules for safety should be cautioned, and if necessary, disciplined.

The introduction of any mechanical appliance with which the employes are unfamiliar usually carries along with it the idea that we must anticipate an increase in the number of accidents, by reason of the user of the equipment being unfamiliar with its operation. To this thought I do not subscribe. I do agree, however, that the efficiency or results secured in the operation of the appliance during its introduction, in many instances, is very disappointing. During such period the management should be patient, and not until the operator feels at home or has familiarized himself thoroughly with the equipment should he stress the point of increased efficiency and better results. Pressing the employe for maximum results too early in his experience will cause him to become careless as to his own safety or the safety of those working with him.

It may be said that this is "old stuff." Granted, yet it is the essence of satisfaction in operating coal mines.

At our Mt. Olive mine, practically every item of its operation utilizes mechanical aids, undercutting, drilling, loading, transportation, etc. Power is supplied from our own power house. Motor generator stations are located in close proximity to the face. The A.C., delivered to the stations at 2,300 volts, is transformed into D.C. and reaches the working places with the maximum voltage permitted under our state laws. The usual precautions prevail as to having locks on the motor generator stations, explosive boxes, etc.

In the loading of coal mechanically at this mine all employes working with a loading unit are confined to a range averaging 14 rooms and 2 entries and 7 to 8 crosscuts. In other words, the loading machine and its crew, on operating days, move about in only 6 or 7 working places. The cutting machine crew of 2 men is, of course, working just ahead of the loading unit.

The supervising unit consists of one foreman to each two loading machines and cutting crews. The operation of the two loading units is in closely connected territory, so that it is not uncommon for him to visit every working place several times a day.

Before the machine cutting crews go into a room an inspection has been made to determine its safety, first, as to roof conditions, and, second, as to safety at the coal face, and particularly as to the possibility of a fall due to a possible coal overhang attributable to sticky top, etc.

Supervision also carries with it more frequent visits from the mine superintendent, the mine manager and such assistants as may be deemed advisable.

Compare these practices with those of previous years, under the hand-loading or individual contract system. This mine then had more than 700 working places and six supervising officers, as against 197 working places today and ten supervisors. With hand loading the miner many times took an unnecessary risk. He would continue to finish loading his car, rather than stop temporarily, set a prop or take down an apparently dangerous piece of rock. This temporizing in making the working place safe does not exist while he is employed on the mechanical loading units.

With each loading machine crew there is employed two certified miners as face men. The duty of these men, primarily, is to provide a safe working place by the setting of timbers, taking down loose or hanging coal, slate or rock. During the period of loading they continually sound the roof, break down coal that might possibly "hang," whether due to poorly placed shots or for any other reason.

In loading coal mechanically there is the additional supervision exercised by the operator, of the loader and his helper.

The adoption by the Consolidated Coal Company of the mechanical principle of loading dates as of May, 1928. Several types of mechanical loaders, as well as conveyor type have been installed. An analysis of accidents by years, starting with the year 1927, at which time we were hand loading exclusively, shows conclusively that the introduction of additional mechanical appliances has not increased the number of accidents; on the other hand, the number has actually decreased, with a corresponding increase in tonnage produced.

At this mine every accident, no matter how trivial, is and has been made a matter of record. As an illustration, the mine produced 112,704 tons during the month of March, 1931, with 19 accidents reported. Of these 19 accidents, no time was lost on 9, 3 lost one day each. The remaining 7 were of a more serious nature, however. Six of the 7 had returned to work before the middle of April, and only one of those injured during March had not recovered and returned to take up his usual duties.

It might be of interest at this time to note that only 4 employes injured prior to April have not recovered sufficiently to return to work. Only one of these injuries can be definitely attributed to mechanical loading. The injuries sustained by these 4 men cover: No. 1, sprained ankle, due to falling over coal; No. 2, a double rupture, suffered by a main line trackman; No. 3, fractured ankle, occurred while wedging down coal, a piece of which struck the injured employe's ankle; No. 4, while pushing cars the employe was caught between cars at a time when empties were being placed on switch by storage battery locomotive.

During the year 1930 there was reported a total of 379 accidents; 333 of these occurred underground and 46 on the surface. Of the underground accidents 218 were non-compensable. Of the 46 surface accidents 38 were of minor importance and did not call for compensation.

Of the 42 classified segregations or lists governing this operation: 15 classes suffered no compensable accidents; 14 classes suffered one employe accident each; one class suffered two employes accident; two classes suffered four employes accident.

The following table of comparisons for the last four calendar years is enlightening on the subject under discussion, since during the entire year of 1927 hand loading prevailed. In 1928, beginning with May, the greater part of the tonnage was secured by hand shoveling onto conveyors. In 1929 the greater portion of the tonnage was loaded by mechanical loaders. The year 1930 represents a year's operations, using only mechanical loaders.

A study of these figures is convincing. As employers using mechanical loaders, we furnished safer working places to all employes, as compared to the conditions during the year 1927, at which time hand loading methods prevailed.

We are firmly of the opinion that the improvement would not have been possible were it not for the introduction of the mechanical loader, with the more intensive supervision possible under that plan of mining.

In closing, I want to simply state that we believe the men are happier since the danger ratio has been bettered, while, on the other hand, as an executive, I can join with the men, in that "our treasury" also reflects a decided improvement.

MINE NO. 15, THE CONSOLIDATED COAL COMPANY

Year	Tonnage Produced	No. of Accidents	No. of Compensable Accidents	Tons per Accident	Tons per Compensable Accident
1927	598,704	467	146	1,282	4,101
1928	693,604	495	177	1,401	3,919
1929	708,899	423	146	1,676	4,855
1930	975,391	379	123	2,574	7,930

MINING SYSTEMS IN INDIANA AND ILLINOIS ADAPTED TO MECHANICAL LOADING

By I. D. MARSH

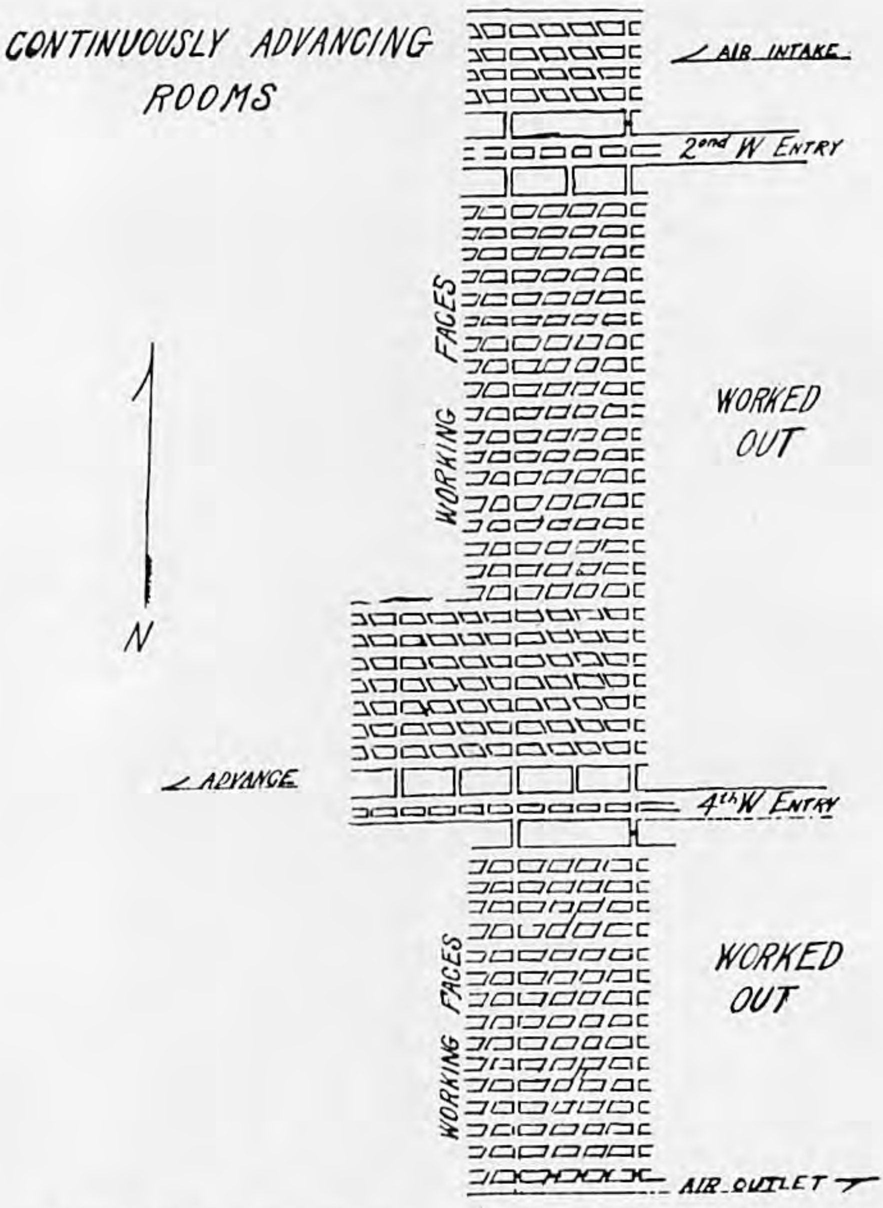
Alcoa Ore Company

Mining systems in Indiana and Illinois as a subject for presentation and discussion takes in entirely too much territory. It was not intended, as I take it, that review of all the many systems used in these two large coal-producing states be attempted. Probably nearly every operation today is working out some changes, great or small, in their methods of mining. The progress made is a real tribute to the organizations at work in these mines.

Mechanical loading has forced everyone to consider and experiment with new mining methods. One of the most successful operations in this district is now, after two years of mechanical loading, changing their entire mining methods. Because I have been for more than three years considering only the problems of a mechanical loading mine, this paper is forced to consider mining methods which apply most peculiarly to mechanization. Rather than take your time explaining in great detail methods which are common knowledge, I am, in the following paragraphs, giving briefly the basic ideas behind two, to my knowledge, new systems. However, I would not be surprised to be informed that several of you here are working along similar lines. I am not making any sales talk for these systems. Your understanding of mining methods will enable you to apply these ideas to your conditions where they may or may not fit.

Before confining myself to specific methods, let me devote to those who might be entirely unfamiliar with Indiana and Illinois a short paragraph upon this topic generally. There are strip or open mines in the north, central, and south parts of this territory producing, roughly, 10% of the total production. In the north part of Illinois there is a well-developed longwall operation. There are several scattered operations of retreating longwall, for the most part in small panels, with mechanical loading. The Old Ben Coal Corporation has one of the operations of this type, which I enjoyed visiting. This would furnish a fine paper in itself, but I am not qualified to dwell upon it. There is still a good number of room and pillar operations, but the most popular and widespread method of mining in this territory today is the panel system. You are all familiar with it and its many variations, and there are many beautiful maps being laid out in full size in their carbon medium in Indiana and Illinois which are a credit to their engineers and a joy to their owners.

Probably the most extensive system used today, especially in Illinois, has been developed for mechanical loading. It is a straight panel system with opposite pairs of panels off the entry. An average panel being 12 to 15 rooms deep with 250-ft. length of rooms. One loader develops a pair of panel entries until there is territory in each panel for a loader. It also develops the entries to the next panel at this time. When the next panel is uncovered and there is enough territory behind for a loader in each panel, this loader moves forward to the new panels and continues development. One loader then produces in each panel left and develops the panel entries until there is room for two load-



ers in each panel. At that time a second loader is moved in and that panel is in full production until so many rooms are finished that there is not territory left for both when one loader is left to finish up. The largest problem is to keep the speed of development just right to provide territory as needed. Length of rooms and length of panels must be balanced against length of undercut, speed of loading, and local conditions.

One mine has two unusual developments which I will describe. The general conditions of this mine are as follows:

Cover, ft. ....80 to 120
Gas .... None
Height of coal, in. .. 66 to 76 and 71 avg.

Top: Varies greatly; 50 per cent slate, which is good to very poor; rock from very good to very bad.

Bottom: Extremely soft clay generally, though some rock bottom is found.

Water: About 20 percent of the faces wet and must be loaded out daily to be able to handle with caterpillar-equipped loaders.

Operation (percent): Mechanical loaders, 65; conveyors, 35.

Grades: Generally level, but subject to short local grades up to 6 percent slope.

The first development primarily for high extraction has given some interesting results. Conveyor loading eliminated yardage and all bonuses for narrow work and made possible the development of 80 acres by a two-entry system cutting the coal into solid blocks 100 by 200 ft., with narrow entries on all sides. This development was nearly as low in cost as other conveyor territories at work at the same time.

Starting at the boundary of the mine, the blocks were slabbed 180 ft. long, leaving a 20-ft. pillar on one end. Also small pillars or stumps of coal about 10 ft. square were left across the face where needed for safety, and later shot out. This work over a long period was the cheapest conveyor coal obtained. Extraction was over 80 percent of the coal. In this work the track was laid along the 200-ft. face and connected up at both ends. The cutting machine cut 180-ft. face, which was loaded out. On the second cut the cutter pulled out and resumped, cutting five places 28 ft. wide and leaving four sumps 10 ft. wide. The third cut was as the second, except the cutter would grip in behind the sumps. The fourth cut could usually be straight across the entire face, and after this was loaded out, the track, which was on steel ties, would be relayed behind the sumps. As no switches were used, this was not a heavy burden on track laying. The conveyors could reach the track from the face at all times. This would be repeated until the block was finished. The roof rock had to be drilled and shot to form a break behind the operation.

The second development is "Continuously Advancing Rooms Parallel to the Entry." Three years ago mechanical loading replaced hand loading, and working territories were reduced about 50 percent. Eighteen months ago it was found that the majority of territory developed and left idle would cost an unwarranted sum to clean up and start producing coal. One of the major troubles was that heavy slate, which would not come down when first exposed, could not be held up after several months because of soft clay under the crossbar legs. Entries gave no room for slate disposal, and it would have to be loaded out.

These conditions necessitated research for a better system. Two pairs of entries had been developed and were used at the start of this development. They were parallel and 1,800 ft. apart. Each pair were protected by a 100-ft. barrier pillar on each side. A cross entry was driven between them, which also extended south 1,600 ft. beyond the fourth west. This cross entry also was driven north beyond the second west 280 ft. Rooms were driven west on 60-ft. centers from this cross entry parallel to and on the same face as the main west entries.

The layout is then as follows. Starting at the north end of the entire territory, we have the following:

First: Four rooms.

Second: The second west entry and its back entry protected with a 100-ft. barrier pillar on each side.

Third: Twenty-five rooms between the second west and fourth west.

Fourth: The fourth west entry and its back entry protected with a 100-ft. barrier pillar on each side.

Fifth: Fifteen rooms. The room on the extreme south has solid coal to the south of it and is driven narrow for future haulage.

All rooms are on 60-ft. centers with rooms 25 to 28 ft. wide. Crosscuts between rooms are on 80-ft. centers with 60-ft. length of pillar between crosscuts. Sights are carried in all rooms and entries, and the direction is west.

All room faces are carried equal on a north and south line, with the following exception: The fourth west entry, its back entry and the eight rooms immediately north of these entries are developed 320 ft. ahead of the rest and kept at that distance. This is an aid to haulage and makes it possible to keep the main parting close.

Haulage

Both the second and fourth west entries are main haulage roads and have large partings immediately behind the cross entry. All coal has been coming off the fourth west parting, but local grades have made this an uphill gathering pull, and the second west parting is now taking some of the coal.

The cross entry is the inside haulage road and room switches are turned off the cross entry. Haulage is relayed by locomotive with all conveyors and loading machines served by mules.

Every fourth crosscut or every 320 ft. the crosscuts are lined up on sights and become the new cross entry as the faces move beyond it. All track is removed behind the new cross entry as early as possible. The main entries are mined with the rooms on one side and the barrier is cut on that side every 160 ft. The barrier on the other side of the main entries is cut only at each cross entry, or every 320 ft. A fresh-air course leads directly to the four rooms in the extreme north, and the air sweeps south over all faces, being restricted by stoppings in one of each pair of barrier pillars, and also in the crosscuts to the last room in the south.

Operation

Mechanical loaders operate in those territories most suited to them with conveyors keeping up the heavy slate, extremely wet and bad rock conditions. Loaders are frequently changed from one set of rooms to another as conditions change.

The continuously advancing room system does not need any development work away from the main producing territory. It offers a battery of working faces which can be supervised from end to end without leaving the producing faces. All operations such as cutting, drilling, track, deadwork, and timbering can be quickly shifted from one unit of production to another without lost time. The problem of starting and finishing new panels or territories is completely eliminated. It does not give protection against conditions where a squeeze would ride up to the face. A squeeze caused by excessive extraction gave some concern in this operation, but the work traveled so fast that it caused little inconvenience and did not progress when rooms were made their proper width again. These rooms are now approximately 1,500 ft. deep, and the program is to continue them about 2,000 ft. further to the boundary of the coal. This layout, though not entirely developed as planned at this date, has eliminated the delays in mechanical operation caused by territories working out and new territories opening up.

TREATING MACHINE BITS

By H. H. TAYLOR, JR.
Franklin County Coal Company

Since the advent of cutting machines in mining practice there have been many improvements in the machines themselves and in the methods of applying them. Many of the mechanical improvements have probably been the direct result of experience on the part of the mine management or the machine operators themselves. Because of the lack of facilities at the average mine, most of the improvements in design and material used have been worked out in the well-equipped shops of the various machine manufacturers. With a few minor exceptions, the only part of the equipment which has been left to the mining companies to buy direct, on their own specifications, has been the bit steel. This part of the equipment may be purchased from many sources, while the other important parts, like the machines themselves, are manufactured by comparatively few concerns.

In order to make this discussion of value and interest, we must satisfactorily answer two questions:

Can undercutting costs be reduced by the use of improved machine bits?

If so, does the additional expense of providing the improved bits counteract the saving effected through their use?

Any individual considering this problem would have to answer these questions for himself by applying to his own conditions the factors involved.

Importance of Cutting Machine Bits

When bit steel arrives at the mine it is, in a sense, a raw material, and the process of turning out a finished bit for use underground is under the supervision of the mining company alone. It is peculiarly significant that this part of the cutting unit requires more time and labor to maintain and replace than any other.

Bits affect the cost of cutting directly and indirectly in many ways. Direct additions to the cost of cutting attributable to bit steel alone may be as follows:

(a) Cost of bit steel. (b) Cost of heating and sharpening. (c) Distributing to machines.

There are other factors in cutting costs which may also be affected by the bits but which are not dependent on them alone, such as:

(d) Changing bits at machines. (e) Power consumption. (f) Machine repairs.

The personal equation, as introduced by the care of the individual machine operator and the shop crew, the adequacy of the power and the natural cutting conditions, enter strongly into the picture in these factors.

Coal is generally undercut on the tonnage basis or on the day basis. Under either system the first three factors (a, b, and c) and the last two (e and f) are likely to be the same, but the factor "d" deserves special mention, as it depends upon the system used. Under a tonnage system such as is generally followed in hand mining, bits are changed on the machine runner's time, and he suffers a loss in potential earnings. Under a day scale the company pays for this lost time. Every delay chargeable to bit failure raises the cost of cutting in either case by reducing the amount of coal the machine crew can cut during the shift.

All the factors mentioned above have been at work for years, but it is only recently that we have begun to realize how much coal a machine could cut for us if we would eliminate costly delays and allow the speeding up of the cutting action by giving the machine some good, sharp bits with which to work.

It is, of course, recognized that cutting conditions differ and that a given machine with a certain chain and a certain type of bit will cut coal much more cheaply in some seams than in others, and that consequently the advantages to be gained by improved bits will be more attractive from a "dollars saved" standpoint to a mine with hard cutting than to a mine with easy cutting. However, there are few coal operators who have not tried something to improve cutting efficiency at one time or another. To obtain this end through improvement of the design of machine or chain, we must depend upon those capable of working out the complications of such designs in manufacturing plants. However, there are no mines where the simple operations involved in bit preparation may not be practiced by the most inexperienced.

At this point it would be well to state that, as far as is known, bits were first prepared by simple hammer and anvil methods, later with hammer on a stock and die, still later on a mechanical trip hammer, and finally on specially designed bit-sharpening machines. It is assumed herein that all bits prepared in mine shops today are on either mechanical hammers or special machine sharpeners.

The importance of sharp bits of lasting quality was forcibly impressed upon our company when we began to seriously consider machine capacities. Resistance to abrasion was the quality most desired. Heat generated by friction was known to make bits red hot in any kind of hard cutting, and there was no doubt that an ordinary steel would wear away faster in a heated condition. Therefore, any substance offering more resistance to abrasion than ordinary bit steel and remaining hard while at a red heat should be an improvement. As we saw the problem, it would be necessary for us to improve the quality of our bit steel, improve our methods of sharpening and conditioning the bits, or apply some foreign substance to the bit points harder than the steel itself.

Methods of Improving the Bits

Of these three, we considered the bit steel itself first. It was a standard product sold to many mines and handled by any number of houses, being .75 to .85 carbon, .50 to .60 manganese, less than .04 P and less than .04 S. We were told by competent metallurgists that a higher carbon steel would give better results if properly forged and heat treated, but, because of the high carbon content, this steel would be more easily burned in the forging operation, and, with the crude methods used at the average mine, good results would not be as readily obtained as with an even lower carbon steel. We made inquiries about the possibility of getting a steel more resistant to the cutting action and found that many such steels were available, but that most of them were expensive alloys which could cut plenty of coal but were far too high in first cost to be considered. Most of the alloys used for special tool work are hard and tough, but when the points become dull, as they would in time, the simple method of applying an ordinary forging heat and resharpening would not work to satisfaction on any of these alloy steels. It was found that expensive and elaborate heat-treating equipment and highly skilled labor would be necessary, all of which helped us to forget special steels for the time being.

Before passing up this alloy possibility entirely, we considered the application of such a steel cut into very small bits.

If the bits could be small enough, it would seem that a high-priced steel might be used and the bits discarded after becoming too dull, thus eliminating the necessity of special heat-treating apparatus and, in fact, eliminating all sharpening and heating labor and equipment. This, however, would require a special chain and would lead us into difficulties beyond our line of endeavor. We were not yet willing to admit that any application of special steels was beyond the realm of possibilities, but for the time being our thoughts were turned to the second of the three suggestions—that of improving our own methods of sharpening and conditioning the bit steel.

In this field we found plenty of possibilities. To begin with, our bit sharpener had been allowed to deteriorate until its ability to function properly was greatly impaired. Upon further investigation we learned that our operation was not alone in this laxity. Before bit conditioning was regarded with importance, it was quite natural that the man in charge of the shop should overlook the bit machine for more pressed needs, as long as it was able to go through the motions of sharpening bits. Further, he allowed far more bits to be passed through the process than the machine could possibly sharpen.

Most mine blacksmith shops have coal or oil forges for applying the forging heat to the steel. Constant temperature and similar heating periods on every bit are well-nigh impossible. This, coupled with the fact that bits are plunged into water at varying temperatures after sharpening, tends to produce an assortment of tempers which allows for no two bits in a chain to act alike.

Experiments performed on standard bit steel (and on other steels so near the same analysis that they could hardly be classed as special alloys) making use of a good primary heater, a well-conditioned sharpener, and a controlled heat-treating furnace, have shown that improvements can be made over the ordinary sharpening method. However, the necessary care and skill required to perform such treatment is rarely found in the mine blacksmith shop; nor are many companies willing to spend considerable investment required to set up the furnaces.

Here again we decide that a good constant temperature primary heater was not out of the question, but that heat-treating furnaces for ordinary bit steel were not to be considered. This decision left for us only the third alternative, that of applying a hard alloy to the point of the bit.

Special Mine Test.

Concentrated heat is required to melt and weld the alloy to the bit point. There are two methods of applying the heat to coat the point with the resisting material: Oxy acetylene and electric arc. Because of its lower temperature and simplicity, we tried the former and used it to melt an alloy and tip the bits. There are undoubtedly other materials which might be applied and other methods of applying them, but our experience has been limited to this one operation.

A number of bits were sharpened in the standard manner and a thin coating of the foreign material was applied to the flat top of the bit tip extending back about one-half in. from the actual point.

A certain machine territory in the mine was picked for a comparative test between the standard type of bit and this specially prepared type. The territory chosen for the test was known to enjoy rather uniform cutting conditions from room to room. The power supply was such that the voltage at the face was as uniform as could be obtained.

A certain machine cutting on the day basis was subjected to a careful time study as it went through its daily routine equipped with the standard bits. The following day the specially prepared bits were substituted for the standard type and again the results were carefully noted. The time study comparisons are shown in the accompanying table.

Theoretically, the machine crew should work 480 minutes each shift. The sum total as shown in each case is slightly less. This is probably caused by an accumulation of unavoidable errors in keeping the time or by the crews starting late or stopping a little early for some reason. The points illustrated clearly in this time study are that less time is consumed in the unproductive operation of setting bits at the face, less time is required in sumping up and out, and more time is available for actually cutting the face.

Operation	Standard Bits Time (min.)	Standard Bits Percent	Special Bits Time (min.)	Special Bits Percent	Special Bit Superiority
Setting Bits	78.5	16.65	53.5	11.25	31.80% less
Swing and sumping	58	12.30	46.5	9.80	19.80% less
Cutting face only	226	48.00	285	60.00	20.70% more
Swing and load after cutting	26	5.52	32	6.74	
Machine repair	16	3.41	3	.63	
Moving	57.5	12.22	55	11.58	
Blocked while moving	2	.42			
Machine inspection	7	1.48			
Totals	471	100.00	475	100.00	

On the first day 285 standard bits were used to cut 10 places, representing 1,960 sq. ft. undercut. On the following day only 94 special bits were used to cut 13 places, representing 2,657 sq. ft. undercut.

Each standard bit used undercut 6.9 sq. ft. (approximately 1.8 tons), while each special bit used undercut 28.2 sq. ft. (approximately 7.3 tons), or a ratio of about 4 to 1.

While the time studies were going on, a recording watt-hour meter was keeping track of the power consumption. The results obtained are tabulated below:

Operation	Standard Bit	Special Bit	Special Bit Superiority
Av. sumping time per place	4.60 min.	3.57 min.	22.20% less
Av. cutting time per place	22.60 min.	21.90 min.	3.10% less
Av. K.W. demand	46.00 K.W.	36.05 K.W.	21.60% less
K.W.H. consumed per place	17.18 K.W.H.	14.21 K.W.H.	16.80% less
Total K.W.H. consumed	171.80 K.W.H.	184.85 K.W.H.	20.70% less
K.W.H. per sq. ft. of face undercut	.087	.069	
Av. voltage as read	185 V.	190 V.	

It will be noted that the voltage was fairly constant for the two days, the fact that the average demand was less for the special bits probably accounting for the slight advantage on the second day. The cutting machine has a variable feed speed adjustment and the special bit, offering less cutting resistance, enabled the bar to go through the coal a little faster. It will be noted that there is a distinct saving in the power consumed per square foot of face undercut.

The cuttings, or "bug dust," produced on each day's run were hand screened to determine whether or not the sharper, more durable bits reduced the amount of extreme fines. While there was a slight advantage favoring the special bit, the figures are not regarded with enough importance to enter this discussion.

Having clearly demonstrated that cutting costs might be reduced by the use of the special bit, we next found it necessary to determine what extra costs were encountered in bringnig about the improvement. Tabulated results follow:

Our decision to equip the whole mine with the special bit was made through the belief that as many additional advantages as disadvantages would appear later.

Results of Complete Application.

Several months later every machine in the mine was cutting with the new type of bit and the results of the special test were largely substantiated by the figures presented below, covering a period from December 16, 1930, to April 1, 1931. At this juncture it should be stated that the square-foot basis was used on the special test merely because it was easier to record the results. In comparing this test to any other at some future date, the square-foot basis is more equitable because of the variance in seam thicknesses between different parts of a given mine.

However, in checking results over a long period of time, it is well-nigh impossible to use anything but a tonnage basis.

	Standard Bit 285 used to cut 1960 square feet		Special Bit 94 used to cut 2657 square feet	
	Amount	Per sq. ft.	Amount	Per sq. ft.
Cost of new bits @ .0222 per each	6.35	.00324	2.09	.00079
Cost of sharpening @ .004 per each	1.14	.00058	.38	.00014
Cost of special application including labor and material @ .0286 per each	......	....	2.69	.00101
		.00382		.00194

The results seemed to indicate that the saving in sharpening labor and the saving in the amount of new steel necessary overcame the extra labor and material necessary to prepare the special bits. We fully realized, however, that our figures were a guess at the best, and that other factors were bound to appear in the process to further increase the preparation cost.

Test covering period during which 203,981 tons of coal were undercut.

Number of bits sent below	69,972
Number of bits sent out of mine (dull)	64,624
Bits lost or kept in mine (difference)	5,348
Number of bits reground	47,809
Number of bits reheated and prepared again	15,119
Scrapped or discarded on top	4,860
	67,788
Number of new make-up bits used	4,287

It will be noted that each bit sent below accounted for about 3 tons of coal. Using the old type of bit, we used to get only 1 ton per bit sent below. Thus there are now but one-third the number of bits in circulation, and the delivery problems and delays caused by waiting on bits are minimized.

Formerly a bit could be resharpened for use 28 times, while now we find that one bit will take 35 sharpenings before it must be discarded.

Under the old system, every bit had to be reheated and resharpened. Now only 20% to 25% need be sent through this process, and the balance are merely touched up on the emery wheel.

The items of cost involved in delivering the prepared bit to the cutting machine at the face are listed below, together with the difference in cost experienced:

	Decrease	Increase
New bit steel	.0006	
Heating and sharpening labor	.0033	
Special preparation labor		.0033
Supplies		.0008
Repairs to equipment....Negligible		
Delivery to face labor....	.0006	
Investment charges on shop equipment	No change	
	.0048	.0041

The figures, while insignificant in themselves, show that the saving in bit steel balances the extra material necessary in the special process, the saving in heating and sharpening labor balances the cost of the special labor, and the saving in delivery cost makes the total cost slightly less than before.

The ultimate effect of the use of the bits on the various items entering into the cost of cutting coal is shown below:

	Savings
Cutting labor	9%
Machine repairs	36%
Oil	No change
Power	21%
Bits	No change (as noted above)
Machine investment	Not considered

Including all factors the saving was 15 percent.

It has been noted that the floating dust in the air around a machine using the special bit was far less than under the former system. Thus the hazard attending the cutting operation is greatly reduced.

Conclusions.

The cost of cutting coal may be decreased within certain limits by the use of improved machine bits.

This is possible (1) through the elimination of delays to the cutting units caused by frequent bit renewals and waiting for deliveries of bits, (2) through the saving in power consumed and the resulting lower cost of machine repairs, and (3) through the increase in the cutting capacity of a given machine, thus requiring less investment in machinery to cut a given tonnage.

The difference in cost of any two types of bits delivered to the machine, balanced against the difference in actual cutting costs when using the two types of bits, should determine the relative values.

COST OF MINE ACCIDENTS

By R. M. LAMBIE
Chief, West Virginia Department of Mines

Higher conception of our obligations to serve humanity and wider recognition of the certainty of continuous operation of the laws of economics have been the largest major factors in the development of the recent national trend toward safety in industry.

To these two fundamental reasons may be attributed the growth and expansion of the safety movement in the diversified industries which have made America the foremost industrial nation of the world.

It is not my intent to discuss the cause of safety from the humanitarian viewpoint, yet I take this opportunity to say that in the coal-mining communities where we have sought to enlist the mothers, wives, and children of the employes in the safety cause, our direct appeal to dependents of workmen has contributed in no small measure to decrease the toll of accidents. When men are made to realize that others suffer from their carelessness or recklessness, there is usually a cessation of their defiance of known hazards.

Through the organization of safety clubs in mining towns, holding regular meetings at stated times and attended by the families of employes and employers, there has been developed a town or community spirit where safety in employment has been emphasized, although other subjects of community interest may frequently be the topic of discussion. These frequent meetings of safety clubs strengthen the morale of the community and give men and management an opportunity to share in the solution of community problems.

While, in my opinion, the humanitarian aspects of the safety cause are fully appreciated by both employer and employe, I am convinced that the economic phase of the safety problem, for many years disregarded by executives in industry, is now recognized by efficient industrial management as a major objective which can not be ignored.

This belated recognition of an economic obligation has been forced by a consideration of cost sheets. The wide sweep of workman's compensation legislation since 1910, now embracing 44 of the 48 states, brought to industrial management a visualization of the cost expenditures that was formerly obscured in a maze of litigation that challenged accurate or even approximate computation.

Work injuries formerly were thought to be uncontrollable in industry and regarded as a matter of expectation in the operation of mines. Systematic compensation for work injuries, which had its genesis in Germany in 1884 and is now almost universal in scope, demolished the belief that responsibility for work injuries could not be allocated. These statutes afford relief for accidents in terms of wage loss and give substantial assurance of protection to the workman and his dependants. The employe surrenders his right to sue for the recovery of damages for the established wrong, and the employer is divested of his ancient rights of defense when he becomes a limited insurer for work injuries occuring in the industry which he controls and operates.

Coincident with the enactment of compensation laws, employers began to strive for accident prevention. The idea took root that accidents were preventable and that every injury was the result of some maladjustment. Our industrial executives found that the direct cost of accidents could be easily computed, and they have found that industrial efficiency can not be attained without safety in operation.

There is an accumulation of indisputable evidence that industrial executives, where safety has been made a major objective, have lowered the frequency of accidents, and reduced the economic toll that follows in their wake. It is my pleasure to quote from the records of a great trunk-line railroad.

The Norfolk & Western Railway traverses my own state of West Virginia. Coal constitutes 85 percent of its freight tonnage. From 1912 to 1929 the number of fatal accidents on this road fell from 61 to 13; the number of injured persons from 2,675 to 601. The ton-miles per casualty on that railroad increased from 3,372,413 in 1912 to 28,440,665 in 1929, and the casualties per billion ton-miles fell from 296.52 in 1912 to 35.16 in 1929. It is an amazing record of progress and efficiency. It has been duplicated and even surpassed by some of the larger iron and steel organizations, some of which have enjoyed lower compensation rates than concerns which are devoted wholly to agricultural pursuits.

In the coal-mining industry there has been a commendable improvement in the reduction of preventable accidents. It has not been so apparent as the record made in some other lines of industrial endeavor. For a number of years, however, the coal industry has been engulfed in a whirlpool of depression, and this condition has had a baneful effect on both men and management in striving to promote the cause of safety. The realization from sales of coal at the mines has been so meager in recent years that improvements and the elimination of natural hazards have, in some cases, been indefinitely delayed. Yet, with all this, there has been a distinct improvement in the elimination of preventable accidents as operators have realized the staggering losses to which the industry has been subjected in direct losses without a consideration of the higher indirect losses they have sustained.

Last September, before the International Association of Industrial Accident Boards and Commissions, H. W. Heinrich, of the Travelers Insurance Company estimated, on reports made by the engineering and inspection division of that company, that the concealed or indirect cost of accidents was four times as great as the compensation awards, including medical benefits. This estimate was based on research in 10,000 cases, and its accuracy has been frequently demonstrated by application of specific plants.

This indirect cost has been computed to include the following:

Wages lost by injured employes, time lost by other employes, time lost by superintendents and foremen, property damage sustained, cost due to interference with production, cost of subsequent injuries due to weakened morale.

Just as impressive as the explanation made by Mr. Heinrich were the forceful illustrations made by Mr. Rush N. Hosler, superintendent of the Pennsylvania Compensation Rating Bureau, last December before the Coal Mining Institute of America. In a study of the cost to the bituminous coal industry of that state, Mr. Hosler showed that the direct cost of accidents in compensation and medical benefits during the five years 1924-1929 exceeded $25,000,000, or 3.6 cents per ton on every ton of coal mined in that period. In addition to this direct cost, he estimated an indirect cost of $5,000,000 per year, based on the stoppage of work, weakened morale, property damage, etc., a wage loss of

$10,000,000 per year on account of injuries and a loss of time and consequently production of 17 man-years per year.

In the state of West Virginia, during the period 1921-1930, inclusive, the direct cost to the coal industry of workmen's compensation insurance, including medical benefits, has been $28,874,-837, while all other subscribers to the compensation fund paid premiums of $11,569,299. The direct cost of compensation to the coal industry was based on wages paid of $1,465,000,000. The wages paid by other subscribers in this 10-year period amounted to $1,404,000,000. The coal production of the state during these 10 years was 1,204,170,059 tons. Eliminating the tonnage of self-insurers from this production, the average direct cost of compensation of the coal subscribers to the compensation fund of this state over this 10-year period approximates 2½ cents per ton. It has increased in recent years to approximately 3 cents per ton.

Using the Heinrich and Hosler formula for computing the indirect or hidden cost of work injuries, it is safe to assume that the actual cost of mine accidents to the employes and employers of West Virginia is in excess of $100,000,000 for that period, or an average of 8 cents on each ton of coal produced.

Corroborating the estimate made of direct cost per ton of compensation insurance, our reports from 28 individual companies, with an annual production of nearly 35,000,000 tons, show the average direct cost per ton to be in excess of 2.5 cents. These costs on tonnage produced range from 1 to 5.7 cents per ton.

It is interesting to observe from these reports from individual companies that the lowest compensation costs are effective among those concerns which maintain well-organized safety departments. One company which mines nearly 2,000,000 tons of coal annually created a safety division in 1928. In that year the cost of compensation was nearly $50,000. In 1930 the cost of compensation insurance to the same company was $16,000.

Another individual company has a direct cost of 4.5 cents per ton. The manager recites that this cost will be reduced to not more than 3 cents during the next year as a result of the reduction of accidents.

Another large company advised that their active accident prevention began in 1928 when their compensation costs were in excess of 5 cents per ton. It dropped in 1929 to 4.6 cents per ton, and in 1930 to 3.6 cents per ton.

The manager writes: "This steadily decreasing compensation is concrete evidence of the dollars and cents value of our accident-prevention work." This same concern has increased its tonnage per lost-time accidents 76 percent in the same period.

"Our present cost of compensation is just a little over $12,000 per year," we were advised by a coal company operating in the Kanawha district. "Five years ago, on the same wage scale and practically the same tonnage, the cost was $24,480 per year."

These instances of individual progress and the general estimate revealing the staggering cost of mine accidents show conclusively that the operator who has studied the cost sheets has become a supporter of accident prevention and has found to his satisfaction that safety pays.

With these astounding figures proving the economic loss to men and companies, and the fact that many companies who have gone into accident prevention with the full intention of eliminating accidents have seen the accident and compensation rate decline, is in itself sufficient reason for concerted action to the end that all preventable accidents will be eliminated.

However, with all the figures showing the monetary losses, no writer or statistician has been able to compute the cost of accidents in heartaches, sorrow, and suffering and oftentimes actual starvation to the mothers, wives, and children who were dependent on the wage earners. In fact, this suffering in many cases is carried on for several generations.

It seems to me that here is a challenge which we must accept, and I venture to say that any company who will set aside a sum equal to one-third of their total yearly compensation costs and organize a safety department and place it in charge of a man who knows accident prevention, who is sincere in his work and can visualize, comprehend and analyze conditions that are likely to cause accidents, and who is able to instruct and discipline men, will at the end of three years have cut its compensation costs in half. Furthermore, think of the indirect costs, delays, and suffering that will have been eliminated.

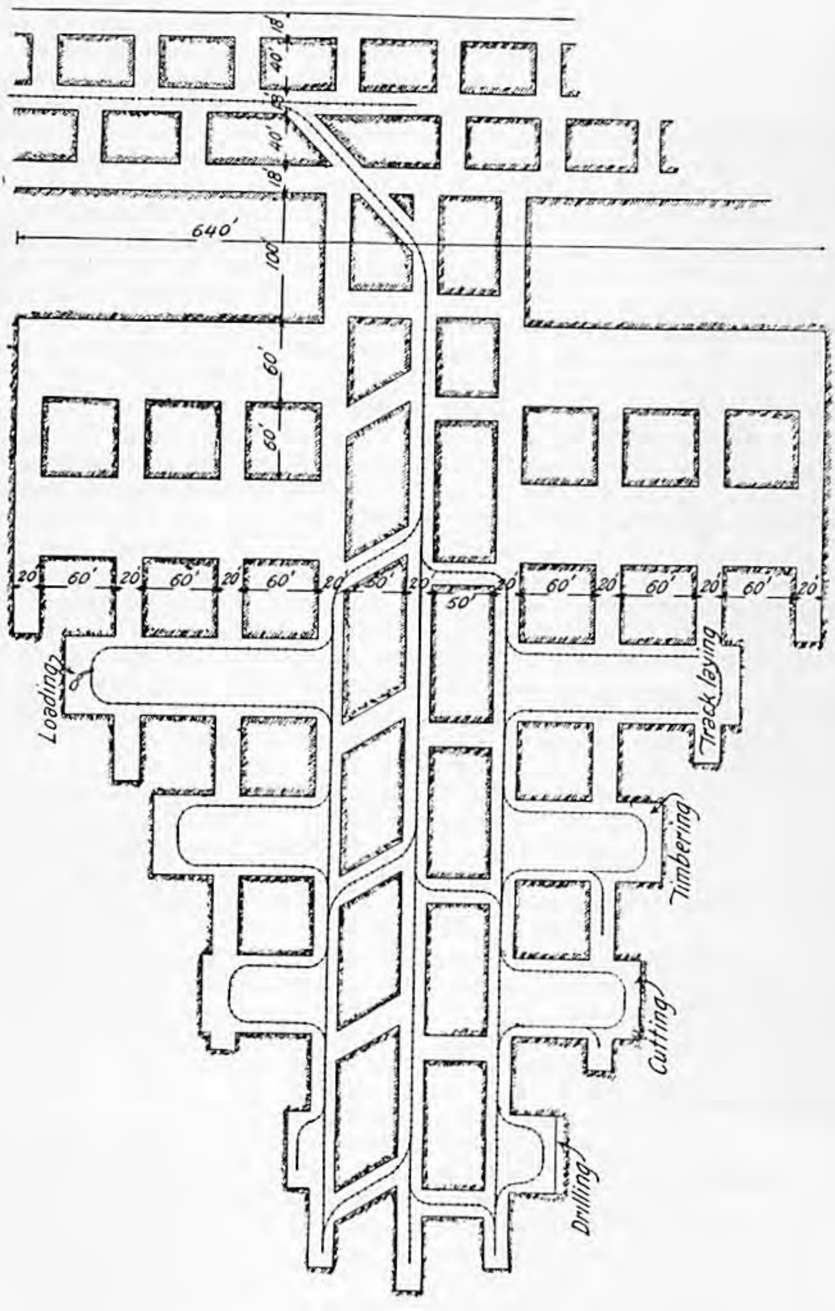
GATHERING SYSTEM IN MECHANICAL MINING

By C. J. SANDOE
Vice President, Perry Coal Company

At the time of the installation of loading machines at Taylor mine of the Perry Coal Company, near O'Fallon, Ill., the company had been using small mine cars and mule gathering. To get a reasonable tonnage from this mine with a loading machine without abandoning or discarding this equipment developed a somewhat serious problem. All of you are familiar with the fact that any reduction in tonnage increases materially the production cost per ton of coal, and that delays due to inefficient haulage or accident in the haulage road are probably responsible for tonnage losses more than any one factor about the mine. It is obvious that a plan had to be worked out that would involve a rapid car change and one that was as simple as possible.

In doing this several factors had to be taken into consideration. There was the arrangement of the haulage system so as to insure an ample supply of empties each minute of the operating day and the keeping in condition of the track and equipment in use. Lost loading time with a loading machine can not be made up. Cars loaded mechanically do not load as heavily as cars loaded by hand. For example, the mine cars at Taylor mine carry about 2,100 lbs. of coal loaded mechanically, while in hand loading these same cars have an average capacity of 2,900 pounds of coal. In other words to maintain the tonnage at the mine this meant that the men had to handle approximately 33 1/3 percent more mine cars both in and out than with hand loading. The small mine cars, of course, to a degree aggravated the situation. This is something that you who are equipped with larger mine cars will not be affected by. The result was that the use of mechanical equipment had to contemplate speeding up the haulage sufficiently to offset the lost weight per unit caused by mechanical loading if the same tonnage was to be produced each operating day.

The system of gathering from loading machines had next to be taken into consideration and worked out. The system of gathering is a determining factor in getting a high tonnage from a loading machine. The fact is a time study of any loading machine during its best days will show much time lost



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Loading
Track laying
Timbering
Cutting
Drilling

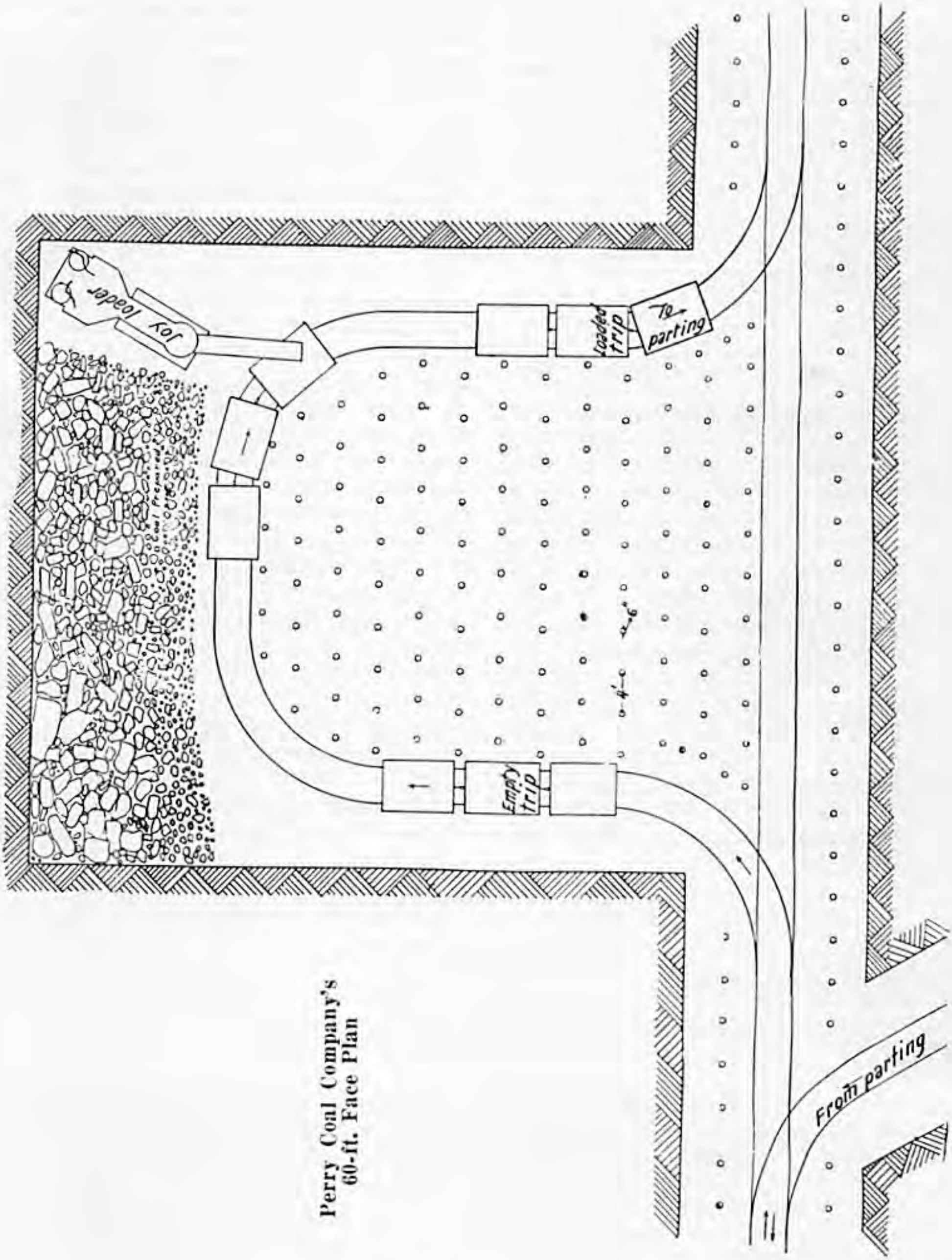
in making car changes at the machine and in getting these cars to the motor road. Some car changes could be made while the loading machine is moving or digging tight coal, but a system had to be worked out with the idea of cutting these delays to the minimum

The mine fortunately has very excellent physical conditions for underground loading. The seam mined is the Illinois No. 6 and averages approximately 7 ft. in thickness. Immediately under the coal there is from 6 to 14 in. of fire clay and below the fire clay is partially decomposed rock. The fire clay is dry and comparatively hard and slick. Above the coal is a thick limestone which is both hard and tough, requiring but few timbers in rooms 30 ft. wide. The limestone varies from 18 to 40 ft. in thickness.

To overcome the difficulties and to take advantage of the favorable natural conditions a modified panel three-entry system was developed. Off the outside, entry rooms were driven 60 ft. wide on 120-ft. centers to a depth of 240 ft. The rooms were not necked but were turned 60 ft. wide off the entry and the crosscuts are driven 60 ft. apart, leaving pillars 60 ft. square. Tracks were laid in all three entries. In the center entry the track was permanent for the life of the panel, while in the outside entries it was removed as the rooms were abandoned. Cross-overs were placed in every other cross-cut from the center entry to the outside entries. This gave an added efficiency in the haulage, as the empty trips came in the center entry and the loaded trips were hauled by way of the outside entries to the parting. The outside entries had two switches for each 60-ft. room, the outside switch being reversed to keep the mine car from being turned around. The track extending into the rooms (slabs as these placed were termed locally) was laid with its center 8 ft. from the rib and continued to a point 35 ft. from the face, then curved 90 degrees on a 15-ft. radius and extended parallel across the face, curved again 90 degrees and returned on the opposite side of the room until it connected with the track in the entry. This track arrangement allowed ample operating room between the track and the face for the caterpillar loader and also allowed approximately 38 ft. timbering space between the tracks. The timbers used were 6-in. round oak props, spaced 4-ft. centers to average rock, with the necessary additional timbers where unusual conditions were met with.

If the explanation made is not entirely clear, the maps here will graphically show the method of development which has been described with the track lay-out and haulage, and will clarify the explanation.

The speed of mine car loading obtained by this plan can best be impressed upon you by following a trip around the room track. For example, the first driver with a trip of four to six cars is headed out of the room by the outside switch. The second driver is at the loading machine with a trip of four to six cars. After 30 to 40 seconds have elapsed mine car No. 1 will be loaded, then car No. 2 follows, etc. The first two cars are placed in reference to the loading machines, so that the conveyor can be swung into position for loading either of these cars without moving the loading machine or the cars. As the cars are loaded, the driver moves the trips to spot the next two cars before the machine for loading, and so on, until the entire trip has been loaded. A time study of this operation has shown as high as eight cars loaded in three minutes. By the time the second driver's trip is loaded the third driver is returning from the parting and coming into the room by the inside switch, which is reversed and is in a position to pull under the loading



Perry Coal Company's
60-ft. Face Plan

machine as soon as the second driver has moved out.

Under the system described we have loaded approximately 350 mine cars a day. For example, the following is one week's record for a loading machine with the tonnage at Taylor mine:

	Cars	Tons
Monday	339	355
Tuesday	318	322
Wednesday	354	371
Thursday	347	364
Friday	328	344
Saturday	390	409
Average	346	360 5/6

Your attention might be also directed to the fact that in getting efficiency in the gathering operations it is quite necessary that the animals as well as the men be trained. In other words, you do not obtain the best results the first day the machine is put in the mine. The mules have to be accustomed to make short pulls and stopping, and doing this rapidly. The mules can be trained, however, and the men accustomed to the system, performing with accuracy and smoothness at the loader within approximately a month's time. To handle the mine cars from a parting to the loading machine and to the parting again for the tonnage mentioned the services of three drivers are required. The minimum distance from the loading machine face to the parting is 700 ft. and the maximum 1,400 ft. The haulage cost per ton per mule under mechanical loading is slightly higher than in hand loading, but any additional increased haulage costs are more than offset by the decrease in loading cost.

It is not believed that the experience or methods used at this mine will solve the problem of mechanical loading and haulage at every mine. This paper is not read with this object in view. Its purpose is simply to give to you this company's experience. It would seem fundamentally, however, that the gathering and removing of the coal from the loading machine is the most serious problem involved in the efficient use and operation of mechanical equipment. To that extent the problem of virtually every company is the same. In working out this problem there is involved the use of the three factors, power, track and cars each one depending upon the other, and all companies have these same materials to work with. The use that can be made of them will, of course, by necessity, vary with the mine.

MODERN TRENDS IN CUTTING, DRILLING AND BLASTING

By G. C. McFADDEN
Assistant Vice President, Peabody Coal Company

Since engaging in mechanical loading of coal practice has continually changed as a result of experimenting in individual rooms and in entire sections so that gradually methods have been adopted which seem to be the most practical.

The objective in cutting, drilling and blasting is primarily to produce the maximum amount of lump coal with mechanical loading. This is limited by the desirability of securing the largest tonnage per loader. Hence there is a continual search for a compromise to produce lump coal and at same time permit maximum production.

Cutting.

In mechanical mining the breast machine has practically passed out of the picture, and indications are that the shortwall machine is rapidly becoming obsolete.

The track mounted machine has many advantages and some disadvantages as compared to the shortwall. The original machines installed have proved successful, but with the constant endeavor to do the work better and cheaper we have recently installed a machine of the track mounted type which has incorporated a number of novel features which have considerably increased the speed of handling of the machine, and consequently increased the production per machine.

It is desirable in a track mounted machine to carry the minimum number of tools and accessories. Two jack pipes, one keg of sharp bits and one keg of dull bits and an oil can are all that are carried and handled on this machine. It will be seen that these accessories require very little time in loading and unloading.

After the machine is run up to the face it is desirable that the cutter bar may be swung quickly to the cutting position; likewise when the cutting is completed time is saved by the quick swing to the straight position as the tramming motor pulls the machine from the face.

A track mounted machine cutting its maximum width cuts a crescent shaped kerf tapering from nothing at the edges to the maximum depth straight ahead; hence a desirable feature incorporated in this machine is four changes of feed or swing of the cutter bar. This enables maximum feed to be used in starting and finishing the cut and the other intermediate speeds as limited by the hardness of the cutting toward the center. This feature saves time by enabling the feed to be adjusted properly according to the depth of cut and hardness of cutting.

Power driven lifting, lowering and tilting of the cutter bar enables changes in level of the cutting to be made without slowing down the cutter chain or the feed. In some sections the track has local dips which make it desirable that sand boxes be added to these track mounted machines to prevent stalling in the tramming operation. With the above features incorporated in a track mounted machine about the only time lost is in setting bits. The next paper to be presented this afternoon deals on the important subject of bits and no doubt will cover such items as time lost in setting, power lost account of running with dull bits, effect on the grade of bug dust with dull and sharp bits.

The position of the cut naturally has a primary bearing on the drilling and shooting of the coal. At first the machines in one group of mines were cutting on or near the bottom in order to provide a smooth surface for the loading machine to operate on. However, in that position the cutting was the hardest of any portion of the seam; also cutting on the bottom left a serious problem of cleaning a band from the coal. The location of the cutting was then changed to a point directly underneath the band that was in fairly good coal and relieved the cutting somewhat by that change. One cut was made underneath the band and then a second cut through the band, depending on the bits to pull the bands out of the kerf. This resulted in an unavoidable mixture of the dirty band with the screenings and other fine coal.

The latest method has been to cut above a second small band called the steel band. It can readily be seen that cutting in the middle of the seam complicates the drilling and shooting by the fact that approximately half the coal has to be shot up and the other half shot down. This proved to be a rather difficult problem to solve but after continued experiments the routine of this work has been perfected so that good results are now obtained.

In this practice all band is loaded out with the coal and cleaned in the tipple.

Drilling.

The drilling problem has been serious, not so much as to the drilling itself, but in securing the holes at the right place to produce the best results.

In order to shoot up the bottom half of the coal to leave a smooth bottom, it was found desirable to drill one row of holes so that the back of the hole would be on the bottom or even penetrating slightly into the fire clay. At this location the drills often struck boulders or sulphur streaks very difficult to cut through.

We are now using the heaviest drill motor and post obtainable and while these parts stand up reasonably well the trouble is transmitted to the drill heads and cutters.

Even at this time further tests are being made with drill heads and cutters to reduce the cost of shapening and to cut longer without changing. Cutters tipped with hardened surfaces have been tried. The four pointed molefoot has probably given as good satisfaction as any but are still not entirely satisfactory.

To facilitate the drilling operation light push cars are used to transport the drills and all accessories from place to place.

The cutting and drilling operations lead up to the final problem of blasting, but it is a combination of the three with the many variations possible which affect the final results.

With the mining machine cutting in the middle of the seam, the lower layer of holes, four to six in number depending on the width of the room, are drilled with the two outside holes gripping slightly into the solid so that these shots will bring out the corners and square up the places. The two inner shots are spaced approximately half way between the center and the two side ribs of the room. The four shots required to bring down the top coal are spaced somewhat similar to the bottom holes but usually down about one-third of the way from the roof to the machine out.

The order of shooting is two center lower holes, then the two outside lower holes, then the two center top holes, finally the two outside top holes. This is general practice; however each mine as well as each section of the mine requires some variation of the above system to give good results.

In all these operations close supervision is of prime importance to secure the most favorable results.

PRACTICAL ACCIDENT PREVENTION

By JOHN E. JONES

Presented at meeting of Claim Adjusters and Attorneys Compensation
Chicago, September 12, 1930

The dictionary definition of practical is, pertaining to or governed by actual use and experience as contrasted with ideals and speculation. My address, therefore, is concerned only with experience with which I have come in contact. The definition of accident as used in this connection is, any unpleasant or unfortunate occurrence involving injury, loss, suffering or death.

Industry, transportation and homes have been subjected to modern safety measures sufficiently long that we may now arrive at conclusions from these practices, and should be able to some extent to choose between those which are apt to fail and those which are apt to succeed.

The same two basic principles operate in the successful prevention of accidents everywhere. The one is to remove and the other is to avoid the hazard. One is of a mechanical and the other a mental procedure. We must, however, limit this talk to something definite, otherwise the time will be spent in generalizing. I will choose the coal mining industry of Franklin County, because of my association with it the greater part of its existence; also, its beginning was sufficiently recent that complete records of its experience are available and reliable.

At the beginning of mining in the county, in 1903, the safety practices were very crude indeed. These were the result largely of the mining practices of the state having developed from mining conditions that were different to those in this newly found field. Especially were the explosion and fire hazards extreme as compared with the mines of the state in general. It was early evident that mining practices, equipment, and methods would have to receive greater attention regarding safety, and practical accident prevention evolved to fit the conditions of the field.

Other than an effort at strict compliance with the state mining law of that period for more careful daily examination and improved ventilation, the first big effort was the adoption of the panel system of mining. This approached a double security, that of isolating a possible explosion or fire, or both, to a limited extent of mine workings, and therefore a limited number of workmen. It also permitted the complete isolation of that territory, by sealing after it was finished, thus limiting greatly the hazards of that territory or panel from affecting workings that were in progress. This isolating feature in progress of working, and upon becoming old works, was an advance in hazard removal in practical accident prevention in those days prior to later methods of increase in efficiency and security.

One of the first and very important single strokes towards such hazard removal was the change from black powder, for blasting down the coal, to permissible explosives. While black powder is an excellent blasting medium for coal, it has the property of long time flame. The flame is of more than sufficient length of time to ignite gas, or coal dust direct, or even the newly blasted coal. The flame from permissible explosives is of such short duration of time, approximately 0.002 of a second, that sufficient time for ignition of anything does not occur. A crude illustration is to imagine one's hand passing slowly through a lamp flame and the consequent burning, as compared with a fast movement of the hand through the flame, so fast as to not feel the heat.

The field, however, still had a high fatality rate as compared with the remainder of the state. In addition to this was the dread upon all concerned of the possibility of explosion. The change to panel system and change of powder was of great safety value but the number of men employed was fast increasing in the entire field, and in each mine. The experience of the nation in its gassy mines was bad, and there was great need for further lessening of the disaster hazard.

The story of rock dusting is a long one and will not be discussed here, except to say that Franklin County developed for the coal mining world, and made practical on a large scale this little known safety measure. It has demonstrated its practicability on many occasions, in the county and elsewhere. It is the most practical measure known in the prevention of coal dust propagation of a mine explosion. Efficiently installed it will extinguish an explosion flame when the flame comes in contact with the non-explosive dust. Cooling of the temperature below the ignition limit also results.

Another accident prevention practice is the installation of closed lights. One can appreciate the hazard of open lights on the surface and the countless damages resulting from them. The hazard is far greater in a gassy coal mine, and in a non-gassy coal mine than in and about inflammable buildings and materials.

All of these safety measures are the greater part of a concerted effort to remove the disaster hazard. Its success can best be told in the following tabulation:

Total tonnage produced in Franklin county 1904-1930	235,000,000
Total fatalities from explosions in Franklin county 1904-1930	258
Explosion fatalities resulting during production of the 1st half of this tonnage	219
Explosion fatalities resulting during production of the 2nd half of this tonnage	39
Difference	180

These figures give undisputed evidence that removal of the explosion type of hazard is an important factor in practical accident prevention.

The following tabulation considers all other fatalities than from explosions:

Total tonnage produced in Franklin county 1904-1930	235,000 000
Total fatalities, other than from explosions 1904-1930	520
Such fatalities resulting during production of the 1st half of this tonnage	336
Such fatalities resulting during production of the 2nd half of this tonnage	184
Difference	152

This difference shows a decided improvement, although not as great a percentage decrease as in the preceding tabulation. The improvement shown here is the net result of the removal of other than explosion hazards and the avoiding of hazards.

A similar table for all fatalities in mines under Old Ben management, follows:

Total tonnage produced	94,500,000
Fatalities resulting during production of the 1st half of this tonnage	181
Fatalities resulting during production of the 2nd half of this tonnage	141
Difference	40

Most other than the disaster hazards are one-man hazards. Of course, it is possible, that more than one man will be injured in one accident. An accident in the hoisting and lowering of men where injury results often includes more than one man. Hoisting has reached a high degree of efficiency and safety since the advent of electric hoists. The safety appliances operate within close margins. Kept in working condition they do not fail in regulating speeds and stops within their very narrow designed limits.

Practical accident prevention concerning the one-man hazard, where that man's safety is largely in his own hands, is indeed a complex problem. At such work where a workman is stationed in one spot and the maximum of hazard is such as a naked gear of flying particles that can be removed by enclosure, the problem is relatively simple. There has been considerable success in many factories from guarding such hazards. But where a man's work is in itself the hazard, such as in loosening more coal, exposing more roof, the removal of the hazard largely consists in removing the man. The development and experiences in mechanical undercutting of coal shows the importance of this procedure. With punchers and breast machines, the man was directly against or under the coal face. In the struggle between precaution and risk, risk often wins. The short wall mining machines do not demand such risk. Removal of the man proved successful. The same is to be expected in track cutting machines and mechanical loading, but these have not yet been used long enough for the data to be of much value.

Removing a hazard is usually a simple procedure, if it can be done at all. Removing some hazards requires special engineering skill. Even then, removing hazards is a simple process having definite possibilities, as compared with the human factor in accident prevention. This factor involves every phase, mental and thoughtless, of human deportment.

Wherever and whenever human beings are concerned, the problem, whatever it is, becomes complex. Accident prevention is no exception. It involves every characteristic, inherited and acquired, logical and illogical, that comprises human mentality. The same human nature that surges for and against laws, for and against predomination, for and against morals, also surges for and against safety.

Organized accident prevention is very young, born just yesterday when compared with the age of industry. Those responsible for its birth were very optimistic for early results, basing their optimism upon the apparent simplicity of its logic. This feeling still lingers as one may sense from safety magazines and safety meetings leading one to believe from bright spots here and there that solution is well on its way, in spite of national statistics showing little if any gain.

All movements depending upon the development of human mindedness, take time. As illogical as the guillotine and witchcraft may seem, it took a long time to develop a majority outspoken mindedness against them. A fitting illustration of education in human mindedness is from insurance data to the effect that it took 79 years to write the first fifty billion dollars worth of life insurance in force and only seven years to write the second fifty billion.

One must know the nature of the problem involved to appreciate the possibility of its solution. In nearly all human endeavor the success of that endeavor brings something in return, whether it be finance, pleasure, progress, or what not. Such success is measured from a datum plane upwards. In accident prevention the maximum of gain must be termed in minimum of loss. No loss is the whole of gain. Its success is measured by approach from below to a datum plane. The entire personnel of an industry would have complete success in accident prevention upon reaching home after the shift's work in the same condition as it left home to go to work. It is not human nature to rejoice because of a stationary condition, even though that condition is of paramount importance. It is human nature to rejoice upon the achievement of something tangible. It is fortunate for the general progress of humanity that this is so, although practical accident prevention is handicapped because of this phase in human nature.

There is no one panacea to stop accidents. There is no one panacea to correct anything in this complex arrangement termed civilization. It is fortunate that there isn't for solution would then be too simple, thus lessening and eventually eliminating the need of effort. As long as we have problems to solve, are partially successful in their solution, but from such solution other problems arise, then there is hope for further progress.

It was logical to conclude, in the beginning of organized accident prevention, that the solution largely consisted in removing the hazards. There were, at first, a multitude of hazards easily removed. It seemed so easy and theoretically sound that accident reduction would be in direct ratio to hazard reduction. It was apparently evident that this was practical accident prevention. In a normal adult there seems to be an elastic coefficient of attention in the make-up of human nature which varies somewhat directly with acknowledged hazards. Minimum, even slovenly, thought is given where attention is not required, and maximum, keen thought is given where the conditions warrant. It is that same mental and emotional process in a man that causes a wife to wonder about her husband's efficiency with his job as she notes his careless, thoughtless, inefficient demeanor and work in and about the house, but let the occasion demand and he arises to a mastery of the situation. The same is exemplified in the general tendency to criticize conditions and the government in idle talk, but when the country calls an entire change in reason and emotion results.

The human equation involves countless combinations of characteristics. These combinations result, in each individual of apparent normalcy, from the moron to the genius. An industrial plant is already handicapped in practical accident prevention if it has little or no choice in its manpower. It is further handicapped if it is deprived of educational and disciplinary measures towards practical accident prevention. The normal individual is exceedingly pliable to suggestion, most of us being followers, and sad is the probability towards constructive thinking when destructive leadership prevails. The chief sufferer is the man himself, for the success, safety and freedom of society depends upon a maximum adoption and compliance of regulations for the welfare of that society.

Statistics indicate that one out of twenty is mentally ill. This does not mean, of course, that all of the other nineteen are mentally sound. Experience indicates that defective mentality of a type extremely difficult, if not possible, to correct is responsible for many accidents. The mentally sound are at times at low mental ebb in regards to their safety, due to experiences over which they may or may not have control. Family illness or misunderstanding, financial or other personal troubles, remorse, are often primary causes of accidents. We work at times under such outside mental strain that the hazard of our normal employment is immeasurably increased. Solutions regarding mental unfitness, either of a permanent or temporary nature, seem remote; yet practical accident prevention is not successful until that phase of industrial hazard is given consideration and some accomplishment results.

But we must accept ourselves as we are. The twenty referred to is an average of most any other twenty placed in the same situations. It is not so much a question of knowledge as it is a question of common sense. It is not so much a matter of analysis as it is cooperation. When we have our men in the congenial frame of mind of cooperation, in their own interest, we have gone a long way towards practical accident prevention.

A group of workmen, including their foremen, firmly impressed in the avoiding of accidents is the best safeguard that that group can have in the practical prevention of accidents. Granting this, it is therefore important that they be impressed. We must acknowledge the tendency to go to extremes in our theories of impression or education. Too often we let our emotions carry us away, and when our ardor has cooled we lessen in our instruction energy. There are many methods, one or more of which we may apply. It is well to choose wisely not more than can be continued, and to stay with the wisely chosen plan.

We are living in an age of advertising and are amazed at the success of certain types. To sell an idea, or a set of ideas, one must somehow get it, or them, to the prospective customers. With this in mind Old Ben has adopted

(1) A year's supply (250) of catchy phrases upon safety, thrift, thinking, statistics, and health. These are printed in big capital letters on placards 12″x18″, and can be read at a glance. One is posted in a frame each morning at the shaft entrance on top, to be read just as each man approaches the cage. Each suggests a subject for discussion among the men, and often just silent thought. Five that are illustrative, were those noted at a mine just inspected:

(A) If you are having trouble at home be exceedingly careful for only a small part of your mind is on your work.

(B) So much depends upon so little.

(C) You will be ahead if you set a thousand props too many in your lifetime, than one too few.

(D) Mine accidents and automobile accidents are usually due to the same cause, taking too much of a chance.

(E) If you want to get ahead better have one to begin with, and then use it.

Such phrases, more than one for each working day for a year, are continuous safety reminders. They are often read aloud. Comments are frequently critical, but even so, he who criticizes arouses interest in others, and quite likely in himself.

(2) A monthly company organ. It is entitled "Old Ben Monthly Safety Report."

Page 1—Consists of an editorial on safety. No attempt is made to write this in simple, primary language. Many comments are made from the men because of this. It is simply human nature to not like to be "talked down" to. Considerable discussion arises from these short safety "forewards."

Page 2—Consists in part of the monthly tabulations, as follows:

(A) **Non-fatal Accidents by Employment.**

In this table is shown the number of injuries at each mine occurring to loaders, tripriders, etc., including each class of employment in the mine and on the surface.

(B) **Non-fatal Accidents by Causes.**

This is similar to the table explained in (A) except that causes such as "roof fall, face fall," etc., are shown instead of employment.

(C) **Accidents by Comparison of Mines.**

Monthly comparisons and data for each mine and totals are given upon: The number of days mine worked, injuries, tonnage and number of employees.

Page 2—Further, and part of page 3, consists of word pictures of fatal accidents, an attempt being made to write these in such language that the reader can visualize the accident. All company and Illinois coal mine fatalities are included.

Page 3—Further consists of mining news and data that will naturally be of interest to the mine worker with safety as the predominating thought.

Page 4—Is nearly always devoted to a lesson in mining. These lessons include mining history, ventilation, geology, and whatever might be instructive to a student of coal mining. Many of our young miners are students in mining.

These reports are supplied to all of our employees, being distributed either in or at the mine. It is encouraging to note that the reports are usually carefully placed in the lunch pail or pocket and taken home. Some have asked that relatives elsewhere, usually a son, be placed on the mailing list.

We feel that safety propaganda in the homes of our employees is an important part of practical accident prevention, and we are pleased to find that these reports frequently find a place in the workman's home.

Practical accident prevention is a close ally to efficiency in production. Whatever is required for the one is essential for the other. The Millennium of safety is probably a long way off but when the recklessness of the age, increase in production, changing ideas and the unsettledness of our generation is considered, we probably have been and are successful in maintaining in the nation's ac cident statistics a status quo.

ANNUAL MEETING, NOV. 6, 1931

PROCEEDINGS OF THE ILLINOIS MINING INSTITUTE

Thirty-ninth Annual Meeting, Held in the Abraham Lincoln Hotel, Springfield, Illinois, November 6, 1931

MORNING SESSION

The meeting was called to order by President Joseph D. Zook, who made the following introductory speech:

Members of the Illinois Mining Institute, and distinguished guests:

This is the thirty-ninth annual convention of the Illinois Mining Institute.

We have, this morning, a very interesting person with us, to whom we would like to devote a little time.

The Mayor of Springfield, the Honorable John W. Kapp, Junior, fortunately, or unfortunately—(interrupted by Mr. Kapp's saying) *Unfortunately*" indulges in the retail coal business as a pastime. He is connected with a retail coal company here in Springfield, and I am sure he understands some of the difficulties surrounding the mineral industry of this State.

He has come here this morning primarily for the purpose of most hospitably welcoming this organization to Springfield. He has not been limited to any particular subject, but I think he should be given free range to say what he pleases, and I believe he has a message for us.

I therefore take great pleasure in presenting to you His Excellency the Mayor of Springfield, John W. Kapp, Jr. [Applause.]

ADDRESS OF WELCOME BY MAYOR JOHN W. KAPP, JR., MAYOR OF SPRINGFIELD, ILL.

Mr. Chairman and Gentlemen of the Illinois Mining Institute:

I consider it quite an honor and pleasure to welcome to Springfield fellow-sufferers in the coal business.

As Mayor of the City of Springfield and on behalf of its citizens I want to extend to each one of you gentlemen a most hearty and sincere welcome to our city.

Springfield, as you all know, is the capital of Illinois. We have here a group of State buildings which I think every person in this room should visit. We have a Supreme Court building, a Centennial building, and the State Capitol.

The Supreme Court building, as you know, is the "highest law" building in Illinois and it will pay all of you to visit the room where the final law of Illinois is made.

In the Centennial building is "Memorial Hall", where you may go and see the glorious and tattered battle flags of our dear old State of Illinois.

Springfield is very rich in history. We have located here the home of Abraham Lincoln. Also the newly reconstructed tomb of the martyred President, and I think it would do all of you good to go out there and be inspired anew by that great American.

We also have in Springfield another interesting institution, operated "by the people, for the people" and that is our municipal light and water plant, among the outstanding ones in the United States today, and I would like to extend to all of you an invitation to visit it. If you have no means of transportation, we would be very glad to furnish it for all the men who wish to go there.

I want to extend to you all the municipal keys of our city and if there is anything I can do to make your visit in Springfield more pleasant or happy, I will be very, very glad to do it. [Applause.]

RESPONSE OF PRESIDENT ZOOK TO MAYOR KAPP.

Your Honor, Mayor Kapp:

You have given us some food for thought. We appreciate your remarks very sincerely and your kindly invitation to visit and enjoy the scenic and historic spots of your city. I am sure if we run out of ideas during the time we are here we will reserve the right to call on you for further information should time hang heavy on our hands.

You have touched upon a very vital matter to every coal miner in the State, which will allow some of us, if not all of us, to take back home some new thoughts, and I thank you on behalf of this organization for appearing here this morning. I also extend to you, Mr. Mayor, an invitation to remain with us during our meeting.

Mayor Kapp: Thank you, Mr. Zook. [Applause.]

Mr. Zook: Now, unfortunately, this room is required at noontime for the luncheon to be served to us at 12:30 and the management tell us that they must have at least thirty minutes to put the room in order, so I am assuming that we had better conduct ourselves this morning in a way that we can give up this room by 12:00 o'clock for that purpose.

It is a great pleasure to be here and welcome the members to this meeting. I am very agreeably surprised that we have such a large gathering. I know of many others who are coming in during the day, and, instead of having a small meeting, which we were afraid might occur, we will have a rather well attended one. And it should be well attended, for if there was ever a time when we should give serious thought and consideration to our business, now is that time.

I am not going to dwell on present-day situations; you all know as much, or more, about it as I do, and what we are going through. I hope each of you may pick up some encouragement as a result of attending this Institute meeting and some light on the probable immediate future, not only in our business, but in every other line of endeavor throughout the State and country.

We have an extremely interesting program, and, this being but a one-day meeting, we will have to conserve our time to give the program proper attention and consideration, so that I am going to limit my remarks with a view to getting along here—not too hurriedly,—but as quickly as may be possible. It seems that we had better follow the Order of Business for those routine matters that are necessary so that we can get down to the program itself.

Accordingly we will hear the reading of the Minutes of the last meeting, by our Secretary, Mr. B. E. Schonthal.

Mr. Schonthal: (Starts to read).

REPORT OF SUMMER MEETING AND BOAT TRIP. (See Page 9.)

Motion by Mr. Paul Weir:

Mr. Chairman, I move that we dispense with the reading of the Minutes, to save time.

[Motion seconded, carried, so ordered.]

Mr. Zook: The next Order of Business is the Report of the Report of the Executive Committee. Chairman, states as follows:

Your Executive Board has held several meetings during the year, but nothing of sufficient importance has developed during that time to require a report.

Mr. Zook: Next in Order of Business comes the report of the secretary.

Mr. Schonthal: I will run through it hurriedly.

SECRETARY'S REPORT

November 6. 1931

To the Officers and Members of the Illinois Mining Institute:

The year just closing has been one of great moment in the coal industry of this state. We all have had our problems to solve, and it has been quite a task for us to watch our affairs. I am happy to report that in the face of all this, our Institute has made some progress this year. You will be interested to know that our membership at the present moment is as follows:

Regular members, dues paid for year ending October 31, 1931..	350
Life members..................	21
Honorary members	4
Total enrollment to date......	375

During this year we dropped the names of 40 members from our list for non-payment of 1931 dues; 9 regular members resigned in 1931, and we lost 3 regular and one life members by death; and ended up the year with a net gain over of 1930 of 44 regular members.

Of the total enrollment of regular members of 350, I find that 220 are connected with coal mines, and 130 suppliers' representatives.

Letters of condolence were written to the families of our deceased members as follows:

Will Ortman—passed on Feb. 22, 1931.

S. W. Farnham—passed on March 12, 1931.

H. C. Perry—passed on April 13, 1931.

A. J. Sayers—passed on October 11, 1931.

Our financial position is healthy and encouraging as revealed by the detailed financial report. We have an increased amount of cash on hand, and have purchased another $1,000 bond during this year. We handled during the year a total amount of $6,099.86. All expenses to date have been paid, except the few small items occasioned by today's meeting which will be paid in November.

The 1930 Year-Book has shown up to good advantage. It was well received by our membership and its supporters, who carried advertisements. The book showed a profit. All suppliers who carried "ads" paid promptly with the exception of one concern, who has not paid our invoice. It might be of interest to our membership to know that in addition to each member and each advertiser receiving a copy of the Year-Book, we sent a free copy of it to each mining institute, trade paper, department of mines in states where these departments are maintained, and to all schools of mines where colleges maintain them, throughout the United States, Canada and Great Britain. We received a very appreciative lot of acknowledgments.

The annual Boat Trip was not quite as well attended as the 1930 meeting, although we had 99 on board. All reports indicate that everyone in attendance enjoyed the trip and was benefited by it. A small profit was shown.

We now have all the advertising space in the 1931 Year-Book sold; and hope to publish a bigger and better book, and have it in the hands of our members shortly after January 1, 1932. The Secretary extends an invitation to the membership to send in criticisms and suggestions that will help to make our Year-Book the outstanding publication of its kind.

Our committees on Program, Advertising, and Vocational Training have been very active throughout the year. The Arrangements Committee have worked unceasingly on this meeting, and the results at the end of this day will prove their work.

Because of conditions existing in the state all during this year, the work of committees was handicapped but I think we all can accomplish much for our Institute by getting behind it and trying to impress on our neighbors the work it is doing, and by our securing their interest and support.

The Secretary wishes to take this opportunity to thank each member, the committees as a whole as well as individual members; the officers and Executive Board for the ready and hearty cooperation given at all times which did much to lighten the burdens of the Secretary's office. It has been a real pleasure to serve you.

Let's all get behind the Institute.

Respectfully submitted,

B. E. SCHONTHAL,

[Applause.] Secy.-Treas.

Mr. Zook: The Auditing Committee report, Mr. A. R. Joyce, Chairman, comes next.

Chicago, Ill., Nov. 3, 1931.

REPORT OF SECRETARY-TREASURER OF ILLINOIS MINING INSTITUTE FOR FISCAL YEAR ENDING OCTOBER 31, 1931

General Account

Receipts		
11/1/30 Cash in Bank		$595.71
11/1/30 to 10/31/31—353 Regular Members paying dues @ $3.00	$1059.00	
Cash 1930 Year-Book	1585.15	
" 1931 Boat Trip	2640.00	
Coupons from three Bonds	160.00	
2 "ads" for 1931 Year-Book paid	60.00	
		$5504.15
Total Receipts for 1921		$6099.86
Disbursements		
Expense of 1930 Year-Book	$ 735.61	
" " 1931 Boat Trip	2380.81	
Purchased one Western Union Bond	1108.39	
Printing and Postage	239.94	
General Expenses	165.58	
Expenses Vocational Committee	130.65	
	$4760.98	
10/31/31 Cash in Bank	1338.88	
Total Disbursements for 1931		$6099.86

Life Account

11/1/30	Cash in Bank	$104.14		
	Interest	1.19	$105.33	
12/3/30	Refund—half payment on Life Membership to Jas. Sneddon		25.00	
10/31/31	Balance in Bank			$80.33

Bonds on Hand

Chicago, Burlington & Quincy Railroad	1000
Missouri-Pacific	1000
Western Union	1000

November 4, 1931.

To the Members of the Illinois Mining Institute:

We, the undersigned, being the Auditing Committee appointed by the President, find the attached report consisting of one sheet, covering the General Account and the Life Membership Account, to be correct.

A. R. JOYCE, Chairman
W. J. AUSTIN

(Mr. Schonthal read same, stating that all the figures would appear in the Year Book, but that he would give a brief resumé. [Applause.]

Mr. Zook: The chair will consider a motion to adopt the Auditing Committee's report.

Mr. Peter Joyce, Assistant Director of Mines and Minerals:

Mr. Chairman, I move the adoption of the report of the Auditing Committee.

(Motion seconded, carried, so ordered.)

Mr. Zook: Unless there is a request to the contrary, we will consider that the Membership Committee has reported through the Secretary-Treasurer's report.

Mr. Schonthal: We took in during the year 95 new members, and, with those who were dropped for non-payment of dues—and deaths—we have 375 members.

Mr. Carl T. Hayden, Chairman Membership Committee: Mr. Secretary, I believe this is the largest number that we have had at any time.

Mr. Schonthal: Yes, I believe it is.

Mr. Zook: Next comes the report of the Advertising Committee, Mr. George C. McFadden, Chairman.

REPORT OF ADVERTISING COMMITTEE.

George C. McFadden, Chairman

Mr. President, and Fellow Members:

Since the renewal of the publication of the Year Book, it has been my privilege and pleasure to be a member of the Advertising Committee. Each year,—or rather,—other years, we have never gotten under way in the securing of our "ads" until after the Fall Meeting, but this year, at the suggested wishes of the President, we started early. Through the efforts of Mr. Paul W. Beda, of "Old Ben," Mr. C. S. DeWitt, Purchasing Agent of C. W. & F., Mr. G. E. Marble of the General Electric, the Secretary and myself, we have been able to sell seventy-four pages of advertising, which is 21 pages more than we have ever been able to sell in any other year. That is the report—that we have sold seventy-four pages, and we have no more space to sell. [Applause.]

Mr. Zook: If all the rest of the business keeps up as well as the advertising, we will be a success.

Next in Order of Business comes the report of the Mineral Industries Committee, Mr. J. A. Garcia, Chairman.

Mr. Garcia: Mr. President, the committee has filed a written report with the Secretary and I suggest that he read the report. (Mr. Schonthal does so.)

Chicago, Oct. 22nd, 1931.

Mr. B. E. Schonthal, Secy-Treas.,
Illinois Mining Institute,
224 S. Michigan Ave.,
Chicago, Illinois.

Dear Sir:—

The matter of a report from the Mineral Industry Committee in connection with the amendment offered at the meeting last year, beg to advise that the present condition of business with the various industries seems to indicate that action in the matter should be deferred, and I suggest that the question be laid on the table for the present.

Yours very truly,
J. A. GARCIA

JAG:HL

(Adopted.)

Mr. Zook: You have heard the report. Is there a motion to adopt the same?

(Motion made, seconded, carried, so ordered.)

The Chairman then called for the report of the

LEGISLATIVE COMMITTEE

Mr. Fred S. Pfahler, Chairman

Mr. Pfahler failed to respond and Mr. Zook called on members of the committee, as follows: Mr. Argust—Mr. Jones—Mr. Hamilton? (No response.)

Mr. Zook: I will say this—the Legislative Committee probably has not much to report, anyway. But they were at least ready to serve the Institute at all times, if (and when) needed. During the last session of the Legislature, I do not know of anything that occurred which required the attention of this Institute.

At the last Annual Meeting, we initiated a program as a part of the activities of this Institute, seeking, if possible, the furtherance of vocational training in this State with particular reference to coal mining. Since that meeting, a great deal of work has been done and while it is, as yet, early to gain any knowledge as to results, I believe that such action as has been taken so far will prove to be, in years to come, one of the most worthy things that this Institute has attempted. I would like to ask the chairman, Mr. T. J. Thomas, to report on that matter if he is present—a rather complete report—because I think it is one of great interest to every man in this room. Is Mr. Thomas here? (No response.) Apparently, he is not in the meeting. This is a very important report, so we will pass that, then, for the moment.

We will now have the report of the Nominating Committee, having in mind that during this morning session we will hold an election of officers for the forthcoming year, who are to be installed tonight at the end of our dinner party, as has been the practice before. The idea is to get these routine matters straightened out beforehand and disposed of, so that at the dinner we will not be encumbered with too much routine. Mr. Garcia is the chairman of that committee.

Mr. John A. Garcia: Mr. President: Because of the fact that this Institute has now become a nationally-known association, your Committee on Nominations has devoted considerable time and study to the new slate. We have a report on the nominees and I will be very happy to present it to the Secretary to read. (Hands it to Mr. Schonthal.)

REPORT OF THE NOMINATING COMMITTEE

(Read by B. E. Schonthal.)

Nominees for Officers and Executive Board of the Illinois Mining Institute for 1931-1932

OFFICERS.

George C. McFadden, President,
Charles F. Hamilton, Vice President,
B. E. Schonthal, Secretary-Treasurer.

EXECUTIVE BOARD

Joseph D. Zook,
T. J. Thomas,
H. H. Taylor, Jr.,
G. S. Jenkins,
George F. Campbell,
C. J. Sandoe,
E. H. Johnson,
J. G. Millhouse,
Harry Moses,
Fred S. Pfahler,
H. A. Treadwell,
Paul Weir.

Respectfully submitted,
NOMINATING COMMITTEE.
(Applause)

Mr. Zook: At this time, I think it would be proper to present a motion for the adoption of the report of the Nominating Committee, and, a little later, hold the election. Is there such a motion?

Mr. Peter Joyce, Assistant Director of Mines and Minerals:

Mr. Chairman, I move the adoption of the report of the Nominating Committee.

(Motion seconded, carried, so ordered.)

Mr. Paul Weir:

Mr. Chairman, I just noticed the Chairman of the Vocational Education Committee, Mr. J. T. Thomas. I suppose he just dropped in here now.

Mr. Zook: Mr. Thomas, will you please step forward? (He does so.) Mr. Thomas, you happened to be out of the room when I spoke about the work of your Committee on Vocational Training, but it will not be necessary for me to repeat those remarks, except that I said I thought you would present a very interesting report. We would like very much to hear from you, if you are willing to make such a report at this time.

REPORT OF VOCATIONAL TRAINING COMMITTEE

Mr. T. J. Thomas, Chairman.

Mr. President and Members of the Illinois Mining Institute:

The Vocational Education Committee, before it undertook to do any active work, conferred directly with the Heads of Labor—Mr. John L. Lewis, Mr. John H. Walker, Mr. Victor Olander and Mr. R. G. Soderstrom,—so that we might discover if these gentlemen would oppose our program in any way, and try to correct the difficulty, in case they would, before we started in on the actual work.

We found that we were all in sympathetic accord in the matter of vocational training for the workmen,—and particularly, the coal miner. So then we came to Springfield and got in touch with Mr. J. W. Thompson, who is the Director of the Vocational Department here for the State of Illinois,—and his Assistant, Mr. Fultz,—and we laid the plan before them. It seems that we got here just a week or ten days before the appropriation had been allocated to the various districts throughout the State, so that arrangement was made to withhold a certain amount of money to take care of this work in the mining districts. We arranged for a tour of the State, or rather, a tour of the southern part of the State and Central Illinois. As a result of these meetings, and particularly the active work done since then by Mr. Thompson and Mr. Fultz, I think it may be of interest to you to know that the following classes have been inaugurated. (In one or two instances, we discovered that vocational training was being carried on before we visited the various communities,) so that this fall there will be:

One class at Dowell
Two classes at Duquoin
One class at Sparta
One class at Belleville
Two classes at Taylorville
Two classes at Gillespie
One class at Valier
One class at Zeigler
One class at Centralia
One class at Staunton
One class at Mount Olive

and probably a class at Riverton and one here at Springfield. [Applause.]

We expect to have a meeting in Danville next week, in the hope of starting a class there, because the local committee there has already waited upon the High School Board of Education and has made arrangement for the facilities to carry on this work during this fall.

I might tell for the benefit of the Mining Institute members that a class can be started in any community and under these terms:

It will be necessary for those interested in vocational training to call upon the High School Board and have them indicate that they will turn over to the classes the necessary facilities in order to carry them on (without charge). That is, the classroom, light and heat. Then the State (out of its appropriation) and out of the Federal Aid that is given for Vocational Training, will permit the classes, to some extent, to select their own director or instructor. If they are unable to do this, then the Director of the Department here in Springfield will undertake to select the instructor. Each school district will be obliged to pay this instructor, based upon one night a week for a period of forty to forty-five weeks, approximately, $225.00 to $250.00. Then, at the end of the school term, upon a statement being certified to by the Superintendent of the school, which, in turn, will be forwarded to Mr. Thompson, (the Director of the Department,) they will then reimburse or return to the school district one-half of the amount of money they have paid this instructor,—so that if one class is carried on (and in one class they can take care of between fifteen and twenty-five students) for a period of forty to forty-five weeks, it need not cost the school district to exceed $125.00 to $150.00 [Applause.]

Mr. Zook: Thank you, Mr. Thomas, for your very interesting report. I think you have made fine progress and have covered a great deal of territory in a short length of time. Results will be sure to accrue. A good many of us probably did not know until recently that there was such an arrangement, which has been going on for ten years, as I recall, where the Federal government cooperates with the States in carrying on this training work. Last year, when I became interested in this subject, I went down to Springfield and secured reports issued for the last ten years, which I turned over to Mr. Thomas. In all those ten years other representative industries had been giving attention to vocational training, taking advantage of the funds available to take care of the expenses, and it seems to be high time that the coal industry should likewise "speak up" and do something for their employees. I congratulate the Committee on the very fine work they have done and I believe a lot more work must be done to benefit more people in the industry.

Mr. Thomas: I think it may be of interest to you, also, to know that if you wish to inaugurate one of these classes in your community the funds will be available to do it now or within the next few weeks, but after that, the funds will be transferred to Chicago, East St. Louis, or places of that kind, to carry on training classes there, so, if you want to start these classes, it will be necessary for you to let us know just as soon as possible.

Mr. Zook: May I say that the noonday arrangements have been somewhat changed? The Hotel management has just told us that we will have luncheon in the room across the hall, so that we will not have to break up here until the meal is ready. One other thing: I presume that the majority of those present have registered, but, if not, (between now and the luncheon period) if you will step to the desk outside and give your name and pay up, you can get a badge and be in good standing. I wish you would do so. I presume there are about two hundred in this room now and we will have to tell the Hotel management about how many to expect for lunch. All those who expect to be there—stand up—and we will count noses and report. (This is done.)

Dr. M. M. Leighton has just come into the room. He is not on the program. A year ago, I had to forego staying at the meeting at Centralia because I had an engagement with the President of the University of Illinois to discuss with him the matter of mineral industries research. Many things have happened in this year, and one of the most (if not the most) constructive thing affecting minerals in this State has been accomplished, largely through the untiring efforts of Doctor Leighton. He has spent a great deal of time, work, and thought on this question and has accomplished a great deal more than any one of us thought would be possible. I have asked Doctor Leighton to briefly set forth the high spots in those accomplishments, because each one of us, I believe, is very definitely interested in what has been done, and what is proposed to be done, in this work in the future.

BRIEF OUTLINE OF MINERAL INDUSTRIES RESEARCH

By Dr. M. M. Leighton

Mr. President, and Gentlemen of the Illinois Mining Institute:

Chief, Geological Survey, University of Illinois, Urbana, Ill.

One year ago, this body took definite action recommending an enlarged program of research on the minerals of Illinois, a program of a type which was designed to carry research work from the study of the raw materials in the ground to research studies leading to utilization and marketing. This body also appointed a committee to work with and to become a part of the Illinois Mineral Industries Committee which was organized by the nomination of delegates from the various mineral associations of the State.

The Illinois Mining Investigations Commission also aided most effectively in this effort to enlarge the scope and usefulness of the mineral research work of the State.

You had a statement regarding the work accomplished up to last June, at our meeting at that time. The appropriation bill for this new work had been passed, but had not been signed by the Governor. In due time this bill was signed and the money became available for this new and extended program. The following has happened since that time:

The University has turned over to the Geological Survey a residence directly south of Ceramics building in which we are now located. They have modified the interior of that building, so far as was possible, for the researches that have to do with the physical side, and have built in addition to that, a fireproof annex for the chemical laboratories. We are now moving our laboratory equipment into these new quarters, which will include, among the physical laboratories, those laboratories that have to do with the physical constitution of the minerals, including microscopic work. The laboratories in chemistry will include the following: A special laboratory of research on the chemical constitution and properties of Illinois coal, for the purpose of providing basic data that will lead to the better utilization of that coal and also to new uses for Illinois coal; it will also include a special laboratory for the non-fuel products of a basic character; also, a high temperature laboratory and an industrial research laboratory.

Now, as to the personnel:

We have said all along that the success of this new program would depend very, very largely upon the type of personnel that would be selected. The following major members of the additional staff to take care of this new research work are as follows:

The Head Chemist of the Chemical Section is Dr. F. H. Reed, who took his Doctor's degree from the University of Chicago in 1917 and since that time has been successfully engaged in industrial research work and carrying the application of that research work into the manufacturing stage,—a man who looks at it from the viewpoint of dollars and cents. May I have the honor to introduce at this time Dr. Reed? [Applause.]

We have selected as our Special Research Chemist on Coal, Doctor Gilbert Thiessen, who took his Doctor's degree in '29 or '30 from the University of Pittsburgh, who, in the course of his graduate work, had a year at the University of Sheffield. I take pleasure in introducing Dr. Thiessen. (Aside—he happens not to be here at this time.) [Applause and laughter.]

Our Special Chemist for the Non-Fuel Products is Doctor Charles F. Fryling, who took his Doctor's degree in 1923, and who took the two following years of research work in physical chemistry at Princeton University under Prof. Taylor, a well-known authority in that line. He is a National Research Fellow at Princeton University. Since that time, Dr. Fryling has been engaged in industrial research work for the Utilites Company of Camden, N. J. (He is not here, but you who are at Urbana will have a chance to meet him.)

For our work on the analyses of Illinois minerals we have selected Dr. O. W. Rees, who took his Doctor's degree last June at the University of Illinois and is highly recommended by the Department of Chemistry at that University.

For our Physicist, we have selected Dr. Robert J. Piersol, who took his Doctor's degree at the University of California and carried on his research work at Mellon Institute and Westinghouse Research Laboratories, and also served as Professor at Carnegie Institute of Technology.

Our Microscopist is Dr. Ralph E. Grim, who took two years of his graduate work at Yale University and then specialized in microscopic sedimentation of the geological formations of the type that we have here in Illinois, at the University of Iowa.

Our Mineral Economist is Dr. Walter H. Voskuil who took his Doctor's degree at the University of Wisconsin and has served as Professor at the Wharton School of Finance at the University of Pennsylvania and during the past year has prepared a report on the competitive position of coal in this country for the National Industrial Conference Board of New York City, so he comes prepared with a large bird's-eye view of the coal industry in this country. I take pleasure in introducing Dr. Voskuil. [Applause.]

Now, many of you are coming over to Urbana tomorrow and we will welcome you to inspect our new laboratories. Early in December, we expect to have a house-warming, when the equipment of our laboratories is complete, to give you who have aided us in forwarding this program a chance to see how things are set up, to start with, to meet the new situation, to learn something about the projects which are being undertaken, and to give you an opportunity to see our laboratories. Although we are just moving in, we will be glad to welcome every one of you tomorrow. [Applause.]

MR. ZOOK'S RESPONSE TO DR. LEIGHTON'S ADDRESS

Mr. Zook: Dr. Leighton, we thank you for your extremely warm invitation to Urbana. Yours is a very purposeful program and one I think every member of this Institute in later years will look back to and say with a good deal of pride that he had something to do with that program.

Are there any other committees to report? If not, we will proceed to the election of officers.

You have before you the recommendation of the Nominating Committee, which recommendation has been adopted. Unless there are other nominations, the chair will consider a motion to the effect that those individuals be so elected for their respective offices and that the Secretary-Treasurer be instructed to cast a unanimous ballot in favor of the individuals nominated.

(Motion made, seconded, carried, so ordered.)

Mr. Zook asked the newly elected officers and members of the Executive Board to rise to their feet as their names were called (which brought forth more applause.) He then asked that said election be made unanimous by a rising vote. (Unanimously elected.)

Mr. Zook: Now, that disposes of the Order of Business and the Election of Officers. If there is no new, or unfinished, business, we will proceed to the program before you, and I will ask Mr. Paul Weir to act as Chairman of this morning's session. [Applause.]

(Mr. Weir takes the chair.)

Mr. Weir: I think the Program Committee this year has done very well and have given up a first-class list of subjects. Heretofore, at most of our meetings, we have discussed, principally, mechanical loading. I think most of us who have mechanical loading on our properties are glad to learn about something else. It is an old proposition now. Two or three years ago, we could not say it was so common. Production records in this State show that mechanized mining has caught up with hand loading of several years ago and is now far in the lead.

The first paper on the program is "Combustion—Cleaning of Coal" by Professor E. D. Snow, of the Department of Chemical Research of the University of Illinois, at Champaign, whom I take great pleasure in presenting to you. Professor Snow. [Applause.]

COMBUSTION—CLEANING OF COAL

By R. D. SNOW
Research Assistant Professor of Chemical Engineering
Chemical Engineering Division
Engineering Experiment Station
University of Illinois

[*Note: Published by permission of the Director of the Experiment Station, University of Illinois.*]

Introduction

A study of processing coal for the removal of sulfur and non-combustible impurities before combustion, and preferably at the mine, is being made in the Chemical Engineering Division at the University of Illinois. This study was initiated by the Utilities Research Commission in Chicago, and is being carried out as a cooperative project between the University and the Commission.

Mechanical cleaning of the coal at at the mine was one of the processes considered for partial elimination of ash and sulfur. The present paper presents a part of the information obtained by a survey of the feasibility of mechanical cleaning.

Status of Coal Cleaning in Illinois

Coal cleaning in Illinois dates back to 1870. Since that time more than one hundred washeries have been built and operated in the state. As recently as 1909, there were forty plants in operation. At the present time, however, there are probably nnt more than two washeries in operation in Illinois. The larger production, in the beginning of the period, if high ash Northern Illinois coal which could not be satisfactorily burned in the hand-fired furnaces then available probably accounts for the rise of coal cleaning. The invention and use of the chain grate stoker, which could burn high ash coal efficiently, together with the development of lower ash coal from Central and Southern Illinois, probably accounts for the decline in coal cleaning. Another contributing factor is the very limited success with which attempts to make suitable metallurgical coke from Illinois have been rewarded.

During the past twenty years, while the application of coal cleaning was declining, rapid progress was being made in the design and development of combustion equipment to burn low grade, high ash coals. Engineers have apparently come to accept high ash content in steam coals as an unavoidable evil. Of course, power plant operators choose coals with the lowest ash content consistent with economy, but their main efforts have been towards improving the combustion equipment instead of the coal. It can be readily shown, however, that in many cases a profitable improvement of overall efficiency may be obtained by the cleaning of coal for even the most efficient modern power plants.

Professors Callen and Mitchell, in their admirable bulletin, have demonstrated the washability of several Illinois coals. The art of coal cleaning has progressed quite rapidly in other parts of this country and in European countries, with the result that several efficient processes which may be successfully adapted to Illinois coal have been developed.

It is the purpose of the present paper to briefly outline the advantages of coal cleaning to the consumer. My plan is to describe the general effects of coal cleaning upon the utilization of coal in power plants, stating those factors which apply in a greater or less degree to all cases, and then to illustrate by a specific example.

Washability

As is well known, the reduction in ash and sulfur content which can be accomplished by mechanical cleaning may be predicted for a particular coal from washability tests made on a representative sample of that coal. Callen and Mitchell[1] have recently published an excellent report of thorough washability studies of several typical Illinois coals. Their results show that in many cases a marked improvement in sulfur and ash content may be obtained, especially in the smaller sizes.

Value of Cleaned Coal in Combustion

The benefits to be derived from coal cleaning at the mine are:

A. General for all types of furnaces.

1. Savings in freight on inert material.

2. Greater heating value of coal.

3. Gain in efficiency of combustion and heat absorption at the power plant due to:

a. less excess air.

b. less sensible heat in ashes.

c. less combustible to ash pit.

d. less combustible gases and carbon particles to stack gases.

e. less sensible heat to stack gases.

4. Longer sustained boiler efficiency; less boiler outage due to ash and slagging difficulties.

5. Greater boiler capacity.

6. Reduced coal and ash handling costs.

7. Decreased corrosion and atmospheric pollution by sulfur compounds.

B. Special for pulverized fuel installations.

1. Savings in cost of drying and pulverization.

2. Mitigation of fly ash nuisance.

3. Decreased erosion of tubes and refractories by ash.

The saving in freight is the result of two factors, namely, the higher

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[1] A. C. Callen and D. R. Mitchell, "Washability Tests of Illinois Coals," Bulletin University of Illinois.

heating value per unit weight of clean coal due to the smaller non-combustible content, and a further small reduction in the coal shipped due to the improved efficiency with which the cleaned coal is burned in the furnace. In the old wet cleaning plants, the freight saving and efficiency gain due to ash reduction were largely neutralized by the addition of water to the coal. With dry cleaning processes, and with modern wet washing plants equipped with mechanical dewatering and heat drying equipment, however, this is not the case. In fact even the inherent moisture content of the coal is in some cases largely removed with additional savings due to freight and a further gain in efficiency of combustion.

The gain in efficiency of combustion and heat absorption at the power plant is due to a combination of several factors. In hand-fired and mechanically stoked furnaces and depth and density of the fuel bed are more or less irregular. Consequently, the air draft tends to channel by concentrating in the areas of least resistance where the bed is thinner. In order to obtain smokeless combustion, however, it is necessary to regulate the supply of air to meet the needs of the thicker parts of the bed. The result is that a large excess of air passes through the thin parts of the bed. The air there attains rather high velocities and tends to carry with it unburned particles of carbon and ash particles. Then, too, in these regions of high air velocities, there is a tendency to quench the combustion reactions, due to the rapid cooling effect, and thus send combustible gases such as carbon monoxide to the stack. Some of the excess air is utilized in the space above the fuel bed for the secondary combustion of the hydrocarbons distilled from the coal and carbon monoxide, but the most of it passes out with the flue gases, carrying away sensible heat. Some excess air is necessary to minimize carbon monoxide and smoke production, but too large amounts of excess air, due to the local high velocities and the quenching effects, tend to increase the losses in the form of smoke and unburned gases. These losses increase with increasing ash content of the coal because increased draft must be used, greater resistance is offered to the flow of air, and there is more probability of channels breaking through the fuel bed.

The higher the ash content, the greater, of course, is the loss of sensible heat to the ash pit. Then, too, during the combustion of a particle of coal, the exterior coating of ash left from the outer layers screens the unburned inner portion from the flame and the oxygen. Thus, there is a tendency for combustible material to be carried into the ash pit. This is especially true where the temperature and the ash composition are such as to permit fusion of the ash. Patterson[2] gives data for the combustible content in the ashes from 15 mechanical stoker plants which show that the average loss of combustible is small for ash contents below 15% but above that value it increases markedly with the increasing ash content of the coal; for example

Range of Ash Content %	Mean Loss of Carbon as % of coal
Under 15	1.86
15 to 20	3.75
20 to 25	5.56
Over 25	15.55

These heat losses are greatest in the hand-fired furnaces and in that case the losses are magnified more by increase of ash content. The estimated proportionate losses for hand-fired boilers under similar conditions with

[2] Patterson, Chemistry and Industry, Vol. 42 page 904, 1923.

coals differing only in ash content are given in the following table from "The Cleaning of Coal" by Chapman and Mott.

Average Heat Losses in Hand-Fired Boilers

Ash content of coal	4%	10%	20%
Cause of Loss	Heat losses as % of heat available		
Loss of combustible matter			
(a) as carbon in ashes	0.6	4.8	10.0
(b) as carbon monoxide and smoke in flue gases	0.9	1.9	3.5
(c) as solid combustible particles in the flue gases	1.0	1.5	2.0
Loss of sensible heat			
(a) in the flue gases	12.2	17.8	23.0
(b) in the ashes	0.1	0.3	0.9
Other losses, radiation, moisture, in the flue gases	7.5	7.5	7.5
Thermal efficiencies	77.7	66.2	53.1

The greatest gain in efficiency due to ash reduction by coal cleaning is to be expected in the hand-fired installations.

In the case of the mechanical stoker, fuel bed and draft conditions are much more uniform and regular. Nevertheless, the channelling which occurs in the fuel bed requires in the neighborhood of 75% excess air and the forced draft carries away unburned carbon particles. Even in this case the losses increase noticeably with increasing ash content, especially above 12-15%. Then, too, higher ash content, has a deadening effect upon the fire and noticeably reduces the flexibility of the furnace to increased demands.

There are very few data available from which to make a fair estimate of the gain in overall efficiency to be expected by a given ash reduction. Certainly there are numerous boiler tests of coals throughout the entire range of ash content. For the most part, however, the tests were made with different coals, having widely different values for the ratio of volatile matter to fixed carbon in the pure coal substance. The value of this ratio, which is the main factor considered in the design of the combustion space for a given coal, has a much more pronounced effect upon the efficiency than does the ash content. The result is that when attention is focused upon only the ash content and efficiency there is much inconsistency in the results. If, however, a sufficient number of comparable data are plotted, a very definite trend toward increased efficiency with decreased ash content is noted. This is well illustrated by charts prepared by the J. G. White Engineering Company in their report to the National Research Council in 1918. They show also that the capacity of a boiler decreases considerably with increase in ash content of the coal, necessitating an increasing capital outlay in boiler equipment for a given plant capacity.

W. L. Abbott[3] made extensive boiler tests on a chain grate stoker unit using the same Illinois coal but artificially increasing the ash content by mixing various proportions of ashes with the coal. While these experiments may not agree entirely with results which might have been obtained by separating the original coal by means of jigs, concentrating tables, etc., into clean coal and middling products of varying natural ash contents, the results show a marked decrease of both efficiency and capacity with increase of ash content.

The only fair way to evaluate this efficiency gain resulting from coal

[3] Abbott, J. Western Soc. Engrs., Vol. II, page 529 (1906).

cleaning is to make extended boiler tests comparing uncleaned coal with cleaned coal of various ash contents from the same mine. McGovney[4] reported boiler tests of several cleaned Illinois coals burned on a chain grate stoker. In the only one case, however, was the corresponding grade of uncleaned coal tested. The following data were taken from his bulletin:

	Herrin 1¾"—1" Coal Unwashed	Washed
Ash, per cent	9.49	8.24
Sulfur, per cent	2.14	1.27
B. T. U. per lb.	12,362	12,604
Boiler and furnace efficiency—5" fire bed	65.90	66.14
Boiler and furnace efficiency—6" fire bed	65.5 (mean of 4 tests)	67.47 (mean of 3 tests)
Boiler and furnace efficiency—7" fire bed	65.97	66.38

In this case the ash content is well below the range in which efficiency drops appreciably with increasing ash content, and the small ash reduction obtained results in only a small gain in efficiency. If coal cleaning and clean coal are to be sold to coal consumers, more such tests should be made, especially with high ash screenings.

In pulverized fuel furnaces, the heat losses attributable to ash are much smaller. There is practically no loss of combustible to ash, and more complete combustion of the gaseous products is obtained with less excess air. This furnace is also very flexible and a high ash content magnifies the decrease in efficiency at high combustion rates much less than with other types of furnaces. The gain in combustion efficiency obtained by coal cleaning would therefore, be much smaller in this case. However, it would be appreciable wherever a large ash reduction can be obtained. This is well illustrated by the results of Westenberg[5] who made boiler tests of three Dutch East Indian coals having approximately the same ratio of volatile matter to fixed carbon in a pulverized fuel installation. His data show an increase in efficiency from 79.44 to 86.03% with a decrease of ash content from 20.5 to 7.4%, as shown in the following table.

Probably the greatest savings to the pulverized fuel plant are to be found in the preparation of the fuel and in the detrimental results of the large quantities of fine ash carried by the gases. Mineral inclusions, such as pyrite and shale particles, are much more

Coal	P. Lavet mixed 0—30 m. m.	B. Asam mixed 0—30 m. m.	Ombilin fines 0—15 m. m.
Analyses: Per cent			
Fixed Carbon	38.8	45.	47.4
Volatile	30.3	37.9	37.9
Ash	20.5	7.7	7.4
Moisture	10.4	9.4	7.3
Ratio: Fixed Carbon/Volatile	1.28	1.19	1.25
Heat absorbed by boiler, economizers and superheater	79.44	85.87	86.03
Heat lost by unburned C in ash	0	0	0
Heat carried away by products of combustion	6.55	5.89	6.50
Heat lost in (a) red hot clinker and ash and (b) radiation	14.0	8.24	7.39

[4] McGovney, University of Ill., Eng. Expt. Sta. Bull. No. 39, 1909.

[5] Westenberg, Transactions of the Fuel Conference, World Power Conference, Vol. 1, page 102, 1928.

difficult to pulverize than is the pure coal substance. Furthermore, they produce more wear upon the pulverizer than does the coal. Consequently, a reduction of the mineral content by coal cleaning results in a disproportionately great increase in pulverizer capacity and decrease in maintenance costs.

The operation and maintenance costs for pulverizing coal range from 20 to 35 cents per ton. While there are no available data showing the effect of mineral content on the costs, considerable savings are possible by coal cleaning.

In passing through the boiler setting, the hot dust particles in the gases tend to fuse into and erode refractory surfaces, to accumulate in deposits on the first pass of the boiler tubes and foul the heating surface, thereby decreasing the rate of heat absorption, and to erode the surfaces of economizers, pre-heaters, and induced draft fans. The result is that the efficiency of the installation progressively decreases and the boiler must be shut down at intervals for removal of ash deposits, and for repairs and renewals. By partial removal of the impurities from the coal before burning, it should be possible to effect savings due to longer sustained efficiency and less boiler outage.

From 50 to 90 per cent of the coal ash may be carried through the entire boiler setting and discharged from the stack into the atmosphere as a finely divided suspension which forms a haze. Where such practice is permitted, it is, of course, a cheap method of ash disposal. In many of the larger cities, power plants have been forced to eliminate the fly ash nuisance by installation of dust precipitators and collectors. Dr. Lessing[6] in England has recently shown that the inherent ash of the pure coal substance tends to fuse and agglomerate into larger particles which deposit within the boiler setting, breeching and stack bottom, whereas the ash from the shale inclusions is more refractive and tends to be carried into the atmosphere as fly ash. In other words, the mineral constituents of coal removable by coal cleaning are the main source of the fly ash. It should be possible to mitigate this nuisance considerably by coal cleaning.

Likewise, the sulfur content of coal leaves a trail of deleterious effects extending from the mine well beyond the top of the power plant stack. The acid formed by oxidation of the pyrites hastens the corrosion of coal handling and transportation equipment. Further acid formed in the power plant corrodes economizer and preheater equipment[7]. About three-fourths of the coal sulfur is discharged into the atmosphere as sulfur dioxide, producing an objectionable pollution. By coal cleaning it would be possible to eliminate from 20 to 40 per cent of the sulfur of the steam coal from many Illinois mines and to proportionally reduce corrosion and atmospheric pollution.

Application to a Particular Coal and Power Plant

The coal which we shall take as an example is a Christian County coal of 3″—0 screenings size. It contains: 13.5—15% moisture, 13.5—15% ash, and 4.5—6% sulfur, of which about 60% is pyritic and the remainder is in the form of organic sulfur compounds. It contains some calcite, pyrite, blue band shale, and bone partings.

Dr H. F. Johnstone[7] has recently published some results of washability tests of this coal in the finely crushed form. The Koppers Rheolaveur Com-

[6] Lessing, Fuel in Science and Practice, Vol. 9, page 348, 1930.

[7] H. F Johnstone, Univ. of Ill. Eng. Expt. Sta. Bulletin 228.

pany have made a more thorough study of the washability in the screenings size, and I shall use their values for the composite 3″-0 coal.

As increasing proportions of the raw coal are rejected by the cleaning process, the ash and sulfur contents of the clean coal become smaller at a decreasing rate, whereas the loss of heating value in the refuse becomes larger at an increasing rate. To illustrate:

Refuse as % of Raw Coal	Sulfur in Washed Coal %	Ash in Washed Coal %	Per cent reduction in sulfur	Per cent reduction in ash	Loss of Heating Value of Raw Coal
0	5.33	14.13	0	0	0
9.92	4.44	9.44	16.7	33.1	4.28
12.02	4.33	9.07	18.75	35.8	6.06
19.77	4.03	8.15	24.4	42.3	13.3
50.00	3.63	6.1	31.9	56.8	44.6

The most economical extent of separation must be determined by balancing the savings resulting from cleaning against an increasing loss of heating value. This would appear to be reached when about 10, or possibly 12, per cent of the weight of the raw coal is discarded. Let us assume that 10 per cent is discarded as refuse. It is conservatively estimated that a well designed cleaning plant will give a product containing not more than 0.5% ash above that predicted by float and sink tests. The ash content of the clean coal would then be 9.94% and the loss of heating value would be about 4.8% of that of the raw coal. In the clean coal, 95.2% of the heating value of the raw coal is contained in 90% of the original weight, provided no water is added, or the heating value of the clean coal is

$$\frac{95.2}{90} = 1.058 \times \text{the B. T. U.}$$

value of the raw coal.

About three years ago Mr. A. E. Grunert of the Commonwealth Edison Company made a boiler test with a two-carload sample of uncleaned screenings from this mine, and a similar test with a two-carload sample cleaned by a dry table process. The ash content was reduced from 14.48% in the raw coal to 11.57% in the clean coal by a discard of 6% of the weight of the raw coal. The overall efficiency of the furnace and boiler was 78.4% for the uncleaned coal and 81.7% for the cleaned coal. Assuming that the increase in efficiency is proportional to the decrease in ash content, the efficiency in our present case would be raised from 78.4% to 82.9%. Mr. Grunert has estimated that in average plant operation the increase in efficiency would be from 75.9 to 78.7%. The cost of the raw coal at the mine is $1.95 and the freight to the powerhouse is $1.60 per ton.

Then, the fuel cost per B.T.U. absorbed by the boiler from uncleaned coal is:

$$\frac{1.95+1.60}{0.758 \times H} = \frac{4.68}{H}$$

where H=heating units per ton of uncleaned coal.

In order to produce one ton of clean coal (10% rejection) the cost of raw coal at $1.95 per ton is

$$\frac{1.95}{90} = \$2.17$$

The total cost of cleaning, including operating, maintenance, and all capital charges, would not be more than $0.15 per ton. The total cost of clean coal at the power plant would be $2.17+$0.15+$1.60=3.92 per ton. Its heating value is

$$\frac{95.2H}{90} = 1.058H \text{ per ton.}$$

and the cost per unit of heat absorbed

by the boiler is

$$\frac{3.92}{0.787\times1.058H}=\frac{4.71}{H}$$

The fuel cost of H units of heat absorbed by the boiler has been increased 3 cents by coal cleaning.

Due to the lower ash percentage of the clean coal, the higher heat content, and the greater efficiency with which it is burned, only

$$\frac{9.94\times75.8}{78.7\times1.058}=9.05$$

units of ash need to be passed into the furnace, whereas, to obtain the same heating effect with raw coal, 14.13 units would have been put into the furnace. The overall effective ash reduction is then

$$\frac{14.13-9.05\times100}{14.13}=36\%$$

The fusion point of the clean coal ash, as determined by laboratory tests, is about 20°F. higher than that of the raw coal. This ash reduction would probably give rise to a proportional saving in the cost of boiler outage due to ash and slagging difficulties. The saving for this particular plant has been estimated as 11.5 cents per ton of fuel. The savings due to handling less coal and ashes at the plant would be about 0.5 cents per ton.

Similarly, only

$$\frac{4.54\times75.8}{78.7\times1.058}=4.13$$

units of sulfur need to be passed into the furnace when using cleaned coal, whereas 5.33 units would be involved in the use of uncleaned coal. The overall effective sulfur reduction would be 22.5%. It has been estimated that this would result in a saving of 1.5 cents per ton of coal.

The above conservative estimates indicate that an overall profit of several cents per ton could be realized on the cleaning of coal at the mine. The calculations are based upon average normal operation of both cleaning plant and power plant, and not upon the maximum beneficiation predicted from washability curves and boiler operation under test conditions. If, for example, the increase in efficiency of 78.4 to 82.9% indicated by the boiler tests had been assumed, the saving in freight and fuel alone would have exceeded the cost of cleaning plus the loss of heating value to the refuse by 6 cents per ton. In addition to the savings estimated above, there are some which cannot at present be evaluated, such as increased capacity of boiler, longer sustained efficiency, and decreased atmospheric pollution.

The objection may be raised that wet washing processes add water to the coal and at least partially neutralize the savings in freight and efficiency. In a modern wet washing plant the water added to these screenings should not exceed 3 per cent of the weight of the coal. By means of heat dryers at the mine, it should be possible to remove this 3 per cent of surface moisture and a large proportion of the inherent moisture content at a cost smaller than the freight saving on inherent moisture. However, in some cases the tendency towards spontaneous combustion will make such a procedure impractical, so the practicability of heat drying must be determined experimentally for each particular case. This removal of inherent moisture further increases the efficiency of plants burning dry fuel. This is true of all pulverized fuel plants, but may not apply to all mechanical stoker plants, where frequently the coal is wetted before burning.

Summary

In the past twenty years remarkable improvement has been made in combustion equipment for utilization of high ash bituminous coals, which exist in much larger reserves than do the low ash coals, and which ultimately must be burned to a greater extent as the reserves of high grade coals become depleted.

In the same period of time mechanical cleaning in Illinois has not only failed to keep pace with development of combustion equipment, but has actually degenerated almost to the point of extinction. However, much progress has been made in the art of cleaning in other parts of the country and elsewhere in the world, with the result that numerous processes which can be successfully adapted to the cleaning of Illinois coal have been developed.

In many cases mechanical cleaning can be profitably applied to Illinois coals, even for use in the most modern and efficient combustion equipment. This is illustrated by an example of an Illinois coal rather difficult to clean.

On completion of the above paper:

Mr. Weir: Thank you for your very interesting paper, Professor Snow.

Discussion
Dr. R. D. Snow's Paper

The subject matter of Dr. Snow's paper should be and is of particular interest to us as consumers of raw—Central Illinois coal but it is difficult to understand why the producers have not exerted greater efforts in the development of coal cleaning processes. The advantages of cleaned coal to the consumer are now pretty definitely known and, judging from the data of Dr. Snow's paper, an opportunity also exists for the producer to profitably improve his product and thereby, it would seem, be in a better position to compete with other higher grade raw coals and natural gas.

The practice of cleaning Central Illinois coal was at one time greater than at the present time and perhaps a revival by the producers in self-defense would go a long way toward mutual profit for both consumer and producer. My own experience in the utilization of Central Illinois coal extends over a period of over twenty years and I think I can say with assurance that all during that time there has been no improvement in delivered coal quality and I could cite several reasons which might even indicate the reverse. Many of us understand that the coal business in this region is "in the dumps" so to speak, whatever that may mean. If this situation is due to a variety of causes I venture to say that one important cause has been the failure to produce and improve a better product which would enable the consumer to better meet his problems at the plant. Some of the items in Dr. Snow's list of conditions suggest what many of these difficulties are and I will say that the list is conservatively put. The matter of atmospheric pollution alone certainly dampens the desire of the consumer to use a coal afoul with sulphur and dirt, so it is not surprising that he looks elsewhere for his requirements.

Dr. Snow has been engaged in researches in regard to the elimination of sulphur from coal as a partial solution, at least, for the reduction of sulphur fumes in flue gases. Quite naturally this led to investigating the possibilities of various cleaning processes because it would now appear that the solution of this problem should begin at the mine and just because the elimination at the mine is only partial, is small reason for not taking advantage of it and the incidental advantages of the practice. It might be overly optimistic to expect as an immediate prospect some process of complete sulphur elimination before utilization of the fuel in the furnace but Dr. Snow's efforts in that direction should be of keen interest to those of us whose job it is to contend with the sulphur problem at the plant.

I can think of no better way to discuss the subject matter of this paper than by considering the possibilities to us in the Chicago district which may or may not represent the situation in general. The major portion of power generation in the Chicago district is from coal mined in the Central Illinois fields and what I have to say may be specific to that situation.

I am both unfamiliar and unwilling to discuss the relative merit of the various coal cleaning processes now available, the developments at present would indicate that there are already processes which will remove about 37% of the ash substance from raw coal and about 25% of the sulphur content with a weight rejection of about 11.1%. These figures check essentially with those given by Dr. Snow. Obviously such a separation entails some discarding of the heat-producing components along with the reject. This heat rejection would hardly exceed 3%.

Such a cleaning operation may be represented in practical weight balance as follows:

at the time. The price of heat at the mine is fixed, for example, by mine cost per ton ($1.79 per ton of 10,000 B.t.u. coal) which is equivalent to $8.95 per 100,000,000 B t.u. The freight is $1.60 per ton regardless of any heat value. Let us now consider the total fuel cost to produce 10,000 Kw-hr. merely as a convenient unit of comparison. In a particular generating station in the Chicago area the use of 10,000 B.t.u. coal would produce a delivered boiler room efficiency of 75.8 per cent and the heat rate per Kw-hr. would be 15,159 B.t.u. per Kw-hr. The amount of 10,000 B.t.u. coal that we would require for our selected power unit (10000 Kw-hr.) would cost $13,567 at the mine and it would cost us $12.127 to transport it or a total of $25,694.

If this amount of power was produced with 10,936 B.t.u. coal at the same efficiency the cost at the mine is the same (13.567), because we have not reduced the price of heat as an original premise, but the weight is

	1 lb. Raw Coal 100%	.889 lb. Washed Product. 88.9%	.111 lb. Reject 11.1%
Moisture	14.50	14.50	14.50
Ash	15.10	9.50	56.60
Carbon	52.79	58.15	10.26
Hydrogen	4.40	4.84	.90
Sulphur	4.36	3.26	13.12
Nitrogen	.85	.94	.09
Oxygen	8.00	8.81	1.53
	100.00	100.00	100.00
B.t.u. per Lb.	10,000	10,936	2,469

It is obvious that the moisture content of the cleaned product must not be any more than in the raw coal because the substitution of ash with water would only defeat the purpose.

The proposition from the viewpoint of Chicago conditions is what benefits could be derived by buying a coal of 10,936 B.t.u. per lb. instead of the normal raw coal of 10,000 B.t.u. per lb. if the same price per heat is paid

now less and it would only cost us $11.089 to transport the heat required or a total of $24.656.

This means that we have reduced the total fuel cost at the plant about 4 per cent or stating it in another way, the freight bills have been reduced about 8.5%. Also at the same heat price at the mine (8.95 per 100,000,000 B.t.u.) the producer would be entitled to a ton price of $1.958 for his washed product instead of $1.79 which means that the limiting cost of his cleaning process is the difference or .17 cents per ton. Dr. Snow quotes the total cost of cleaning, including operating, maintenance and all capital charges as being not more than .15 cents per ton. From available data it would appear that this cleaning cost on a sizeable cleaning plant operating at a reasonable load factor would be materially less.

From this specific set of conditions it would appear that the same heat price assures the producer a profit reasonably well. Any cleaning process should and necessarily so justify itself on the same heat price. The purchase of coal is not ordinarily done on a B.t.u. basis but whether we will or not a car load of coal bought at a certain price per ton means that we are paying some definite price for heat. Therefore any proposition that merely uses a cleaning process to increase the price of heat in the raw state would defeat its purpose at the start.

The advantages to the consumer are, of course, no concern to the producer. The author has listed the many advantages which can be particularly evaluated in the case of increased efficiency to definite savings. The increase in steaming efficiencies apply to pulverized coal firing to approximately the same extent as stoker firing and that on modern plant conditions.

As I see this proposition of cleaning coal there exists much on known facts that is mutually advantageous to both producer and consumer and in view of present conditions it seems fair to ask why more intensive development along these lines does not interest more than is evidenced. I consider Dr. Snow's study on this subject real and purposeful, and he has added no little store of information to the present state of the art.

Mr. Weir: The Utilities are probably the largest users of Illinois coal, outside of the railroads,—and what they have to say carries quite a little weight, but I do not know of any institution in the State using mechanically cleaned coal. I really believe that mechanically cleaned coal will be extensively used in the next five or ten years, but its use certainly cannot come when, as Mayor Kapp said a while ago, he knew of coal being given away. I do not think we can do anything along that line until the market improves considerably.

If there is no further discussion, I will turn the meeting back to the President.

Mr. George C. McFadden: I do not like to do all the talking this morning, but I happen to know something about the figures which were used in that particular paper. In the days when that test was run, it was on a ton basis, and it is only natural that you would have to take into consideration the shrinkage and the rate you were paying the miners per ton in loading impurities. Conditions are somewhat changed now. The cost would be somewhat less, for the reason that a good portion of your coal is being loaded with machines and you are not paying out that certain fixed rate per ton for impurities that are being loaded, so that would warrant adjustment, when you are drawing a comparison of your costs.

Mr. Weir: I wonder if the railroads have given any consideration to this subject? Cannot someone give us something on that?

Mr. Crawford (of the Burlington R. R.) Having had some few years' experience inspecting coal for railroad use, which we have obtained anywhere from Pennsylvania and West Virginia on the east and Colorado and Wyoming on the west, all I can say is this: *We want clean coal.* We cannot insist that the coal contain as low a percentage of removal of impurities in southern Illinois as we can in the lignite fields of Wyoming. Nevertheless, according to my recollection of southern Illinois coal, we consider mine run coal the standard if it does not contain more than one and one-half percent impurities. Now that means, of course, that there is some very small portion of the coal clinging to these impurities. It is not as much as the figures removed from Table 10; it has got to be more than one and one-half percent in case of coal that is that dirty. Now, one and one-half per cent of the removal of impurities does not mean all of the ash that can be removed by washing or some mechanical process, but that one and one-half per cent is worth getting rid of.

It will probably surprise you to know that in the case of one of the southern Illinois coal companies in Franklin County, two of whose mines are not operating at present,—as a result of a discussion with the President of the coal company, it might surprise you to know that the percentage of removal of impurites in egg coal (3x6 egg coal) ran over five per cent and that was the reason for the rejection of that coal. So I think any railroad is interested in mechanical cleaning of coal, providing it is a paying proposition to the railroad.

Mr. Zook: You mean that is the reason for those two mines not operating at present?

Mr. Crawford: I would say that the two mines are not operating at present because the company which owns those mines can close them to better advantage,—but it is only a question of time when they will be operated,—and, if and when they are operated, it will be necessary, I believe, to go to far more expense in cleaning the coal than they have ever done before.

Mr. Zook: Well, it is certainly a most interesting subject. All these papers will be printed in the Annual Year Book, but, later in the day, if some question arises on this subject-the matter will be open for further discussion.

If there is no further business for this morning, we will adjourn until two o'clock to meet in this room. In the meantime, I hope you will all come to the luncheon and come back this afternoon, for we have some more very interesting speakers to follow. A motion to adjourn is in order.

(Motion made, seconded, carried, so ordered.)

Adjournment till 2 P.M.

AFTERNOON SESSION

The afternoon session of the Illinois Mining Institute was called to order promptly at 2 P.M. by President Joseph D. Zook, who made the following announcement:

Mr. Zook: Gentlemen your Chairman for the afternoon will be Mr. D. D. Wilcox, of the Superior Coal Company, Gillespie, Illinois. I have the pleasure of presenting Mr. Wilcox.

[Applause.]

Mr. Wilcox takes the chair and requests that Mr. Paul Halbersleben and Mr. L. A. Wasson see that all the members who are outside in the foyer come in to the meeting. He then put the question: "Are there any further remarks concerning the paper this morning?" There being no response, Mr. Wilcox announced "That disposes of the Unfinished Business." He then spoke as follows:

Mr. Wilcox: I consider it a great honor to preside at this meeting. I do not think many of us, except those who have been in the Institute for years, appreciated the President's statement and the Secretary's report this morning. If you had been in the Institute as long as I have been, you could see what those figures mean. I might remind you that the Institute has been in existence for many, many years, and my recollection is, that when the Institute was turned over to our present Secretary-Treasurer, after many years of fighting for funds, I think they turned over to him less than two of three hundred dollars.

This "Scotch" (?) friend of mine has been able to change those financial conditions until he can tell you about the accumulation of bonds, and I think you fellows ought to remember that, after you go home.

I think you have, in the election of new officers, selected as a fine a lot of men as any we have had in the past.

Personally, I again want to say that I am proud to preside as a representative of the present President.

[Applause.]

The first paper we have this afternoon is entitled: "Fan equipment—ventilation and its relation to power consumption," By Mr. L. R. Robinson, (From some unpronounceable city in Pennsylvania.) (Laughter.)

Someone has asked me if it is Robinson Senior or Robinson Junior? From his scarcity of hair, I presume it is Robinson Senior? (Laughter) No? He says he is Robinson Junior.

Mr. Robinson: I am Robinson, Junior.

FAN EQUIPMENT

Ventilation and Its Relation to Power Cost.

By L. R. ROBINSON
Robinson Ventilating Co., Zelienople, Pa.

To the Coal Mining Industry the Mine Fan is, without dispute, the most essential equipment. When the ventilating fan stops, production stops. This is realized more where the mine is gaseous. Without Ventilation the electric pumps must not operate should any gas be found near them. We are all acquainted with these facts and yet many mine operators neglect to give this equipment serious consideration.

Some operators will keep on hand a spare electric motor for driving the Fan; others who are still more cautious maintain an emergency generating set driven by gasoline or oil to provide against Central Station Power failure. These facts are all probably well known. How many Mines have spare fans? Very few in fact even keep a spare set of bearings on their Fan.

Mine fans have been manufactured for a great many years with substantial bearings and extra large shafts to insure constant operation. The construction of Fan Wheels is very important and most manufacturers have been able to produce a wheel that would operate without repairs. Less than 1% of the fan business is repair parts.

This has probably been the experience of most mine operators and for this reason continual and constant operation without repairs is expected and the result is that few spare parts or spare units are purchased.

Fan wheels vary in design very much, mostly due to the experience of the various fan designers and manufacturers.

The common types of fan wheels are the Disc Fan, the Propeller Fan and the Centrifugal Fan.

The Disc Fan and Propeller Fan are much less expensive to manufacture and answer the purpose very well for temporary ventilation and for small development. Either of these fans is well adapted for low volumes of air at low pressures. When working at pressures exceeding one or two inches water gauge their low efficiency does not justify the expense in power. In many cases they can be direct connected to electric motors or mounted on the motor shaft. This makes a desirable unit. But for larger volumes of air than 40,000 to 50,000 C.F.M., they have not been suitable for mine work where the size and condition of rough airways cause considerable friction and develop pressures beyond the efficient operation of these types of fan wheel.

The Centrifugal Fan is constructed with either one inlet or two inlets for the entrance of air into the wheel and are called Single or Double Inlet Fans accordingly.

The Centrifugal Fan takes the air or gases into the fan wheel at the center line of the wheel and toward the circumference of the wheel as far as the outer diameter of the intake.

All types and designs of Centrifugal Fans vary as to volume of air delivered per revolution and pressure developed.

The ratio of the volume of air delivered per revolution to the cylindrical volume of the wheel is known as volumetric capacity. This is sometimes called volumetric efficiency, but this term is very misleading. The volume of air delivered per revolution varies from (according to the equivalent orifice of passage) zero percent to as much as 800% of the volumetric contents of the centrifugal wheel. The cubical or volumetric contents of the wheel is considered as the product of the area enclosed by the outside circumference and the width of the blades at the outside circumference.

The term "volumetric efficiency" is often misleading to engineers as well as to laymen since it partially conveys the idea that the power input varies as the air delivery per revolution or volumetric capacity varies. This is not the case, in fact every centrifugal fan when operating at constant speed will develop two different volumetric capacities at exactly the same mechanical efficiency.

The Centrifugal Fan is made in three styles or types: Radial, Forward Pitch and Backward Pitch. It may have several vanes extending to the hub or part way to the hub beyond the depth of the outer shrouds or rims of the wheel, or the vanes may extend only the depth of the rim.

Mechanical Efficiency

Mechanical efficiency is a term which is probably better understood by most mine operators than any other term applied to fans, pumps or motors. By the Mechanical Efficiency of a fan is meant, the percentage of the power input at the fan shaft that is recovered in the form of useful air power. The useful air power is considered as the product of the volume of air passing through the fan per unit of time and the total pressure that the fan creates. The total pressure that the fan creates will be defined and discussed later, in detail.

Manometric Efficiency

Manometric Efficiency is a term applied to the ratio of the actual total pressure developed by a fan to the theoretical pressure developed by a radial blade fan. This term is no longer used by most fan manufacturers. (?) It was formerly used before fans were designed in accordance with a performance curve.

Rim Ratio

The speed of the circumference or periphery of any fan wheel in relation to the absolute speed of the air leaving the tip of the blade is called "rim ratio." As any fan is operated at a constant speed and is chocked at its outlet or inlet by opening or closing the orifice of passage of air, it will develop a series of pressures according to volume delivery. At zero volume delivery the pressure developed is always greater than at free air delivery.

The rim ratio changes and may vary from 80% to 130%. The velocity of air necessary to produce a definite pressure varies inversely as the square root of the density of the air, and is found by the formula, $V=4008\sqrt{W.G.}$ for a specific air density. This is explained in the following formula:

$$V=1097.4\sqrt{\frac{W.G.}{W}}$$

In which,

V = Velocity (ft./min.)

W.G. = Water Gauge (inches of water)

W = Weight of air per cu. ft. at the temperature.

Standard air at 70 degrees F. and 29.92" Hg Barometer weighs .07495 lbs. per cu. ft., therefore: water weighs 62.4# per cu. ft.

$$g=32.175 \text{ ft./sec.} \quad V=1097.4\sqrt{\frac{W.G.}{W}}=4008\sqrt{W.G.}$$

One inch water gauge equals 4008 ft. per minute velocity for a specific air density of 0.07495 lbs. per cu. ft for 1" W.G. pressure the rim speed or peripheral speed must be 4008 ft. per minute should the fan wheel have a rim ratio of one or unity. For a rim ratio of 80% the rim speed should be 3200 ft. per min. approximately and for 130% it would be 5200 ft. This rim speed varies according to the pitch of the blades, arrangement of blades and casing design, and inversely as the square root of the density of the air.

The Centrifugal Fan varies greatly in blade design construction, a combination of small blades or vanes extending from the periphery to the inside diameter of the outer rims and several large vanes extending farther toward the hub and shaft are used.

The forward pitch or forward curve fan may be designed with the same variation of blades or vanes as to number, the arrangement and the depth or length as are used in all centrifugal fans. The pitch of the blades at the tip or periphery of the wheel may be from 10 degrees to 45 degrees. This governs both volumetric capacity and rim ratio. This type of fan delivers more air per revolution and also has a lower rim ratio at the best point in its efficiency curve, but, as has been the experience of most fan manufacturers, has a very narrow range of high or peak efficiency. When it is too small for the equivalent orifice of passage, the power increases very rapidly and the efficiency drops off sharply. When it is too large the efficiency drops off rapidly, and the power is, of course, greater than it should be for the work performed. The rim ratio is higher when the fan is too large for the job and consequently shows a dip in the pressure curve between the point of total shut off and its best point of efficient operation. It also collects dirt on the blades if any is present in the air flow. The Forward Curve Fan is a slow speed fan due to its high volumetric capacity and low rim ratio, and consequently a smaller fan can be used for the same requirements.

The Radial Fan is constructed and designed with various arrangements of blading. When only a few large vanes are used the volumetric capacity is low. On account of the lower volume delivery and lower efficiency the fan is seldom used today for Mine Ventilation. It has a wider range of high mechanical efficiency than the forward pitch fan but not as wide a range as the backward curve fan.

The Backward Curve Fan is also constructed with various arrangements of blades and the pitch varies from 10 deg. to 60 deg. The greater the pitch the higher the speed necessary to produce the required pressure and volume. The rim ratio varies from about 90% to 150%. The 10 degree pitch blading shows a smooth power characteristic and a slight drop in pressure near total shut off which gradually rises as the orifice of passage is increased, and then decreases out near the full opening of air passage. The volume does not increase as rapidly as on the forward pitch or radial fan and at wide open discharge the power input drops off instead of rising. This is also true of other backward curve fans except where the pitch is in excess of 20 degrees, then the pressure at shut off is greater than at any other delivery and the pressure gradually drops off as the volume increases and the power is limited near the wide open point of discharge. With the pitch of blading between 35 deg. and 50 deg. the maximum efficiency is maintained and the range of efficiency is greater.

Obtaining good pressure and power characteristics, is not all due to blade construction but is governed very greatly by the development of the spiral volute or scroll of the casing as well as by the width of the casing. When passing a fixed volume of air per unit time the backward curve fan if properly designed has less intake loss due to the lower speed of the air passing through the intake, but it must operate at a higher speed than the forward curve fan. It maintains a much wider range of higher efficiency and has a higher peak efficiency than other types of centrifugal fans. This higher efficiency is due in part to an equal volume of air passing through a larger wheel, resulting in lower rubbing friction losses and less conversion from velocity pressure to static pressure, which conversion always results in heat loss.

The backward curve fan has a lower volumetric capacity than either the forward curve fan or radial fan, thus requiring a larger size and necessarily a higher initial cost than either the forward curve or radial blade fan. Over a period of years this initial cost is justified especially on Mine Ventilation where airways change continually and the pressure varies considerably.

Ventilation and Its Relation to Power Cost

The air power required to produce a certain volume of air at a given or known total pressure is called "Air Horsepower."

Air Horsepower is found by the formula:

$$\text{A.H.P.} = \frac{\text{Vol. x W.G. x 5.2}}{33{,}000}$$

Vol.=Cubic feet of air per minute.

W.G.=Total water gauge pressure in inches of water.

5.2 =Pressure in lbs. per sq. ft. per inch W.G.

33,000 =Ft. lbs. per min. per H.P.

The formula reduces to:

$$\frac{\text{Vol. x W.G.}}{6350}$$

In checking your fan, measure the volume with a calibrated anemometer taking at least 36 sectioned readings in the main air course. The air course should be sectioned according to the width and height so as to get equal area; for example, an airway 4 ft. high by 9 ft. wide should be sectioned with 4 vertical spaces and 9 horizontal spaces. Fine wire or heavy cord should be used in order to obtain the most nearly accurate readings. The mean velocity is used for determining the volume.

Since there has been a great deal of discussion concerning the methods and places of reading air pressures in mines, a short discussion here may be useful.

First of all, it must be remembered that the purpose of taking observations of the air flow in a mine is that of establishing the relation between volume and pressure in the mine—to ascertain the air characteristics or equivalent orifice of the mine. This relation or net orifice of passage is independent of and can in no way be affected by the fan. The fan is merely the agent which should be built to fit the characteristics of the mine. If the pressure-volume relation (E O.) changes due to roof falls, etc. after a fan has been installed, then, in order to maintain the same volume of air, the speed of the fan must be changed. And, since the characteristics of the duct through which the fan is passing air have changed, the fan must work at a different point in its range of performance.

Now we have two different conditions when taking air pressure readings. The air may be passing through a mine above atmospheric pressure when "blowing" or at a pressure below that of the atmospheric pressure when "exhausting." In either case the pressure readings should be taken at the shaft or air drift mouth, since it is the duty of the fan manufacturer to build his fan, air drifts and connection of such proportions that no appreciable pressure loss is caused by the airways between the fan and the mine, and since it is accepted by all engineering societies that fan efficiencies must account for all losses from the fan inlet to its outlet. It, therefore, follows that all readings must be made just outside of the fan. If this were not so, the fan with the poorest design of casing—requiring the highest velocities for passing air through the casing would be credited with work which is useless to the mine.

To determine the total pressure it is customary to base all readings on the absolute pressure.

We, therefore, must consider the temperature and barometer. Should we assume standard conditions, namely 70 degrees F. temperature and barometer at sea level 29.92" hg. or 407" W.G. as the balancing pressure, we can then compute the total pressure on the fan whether it is blowing or exhausting.

On a blowing fan the air is taken directly into the intake without ducts, and we, therefore, only have atmospheric pressure to consider. No differential pressure should be credited to (or charged against) the fan on the inlet side. The total head on a blowing fan is read on the discharge side only. The total useful head is, therefore, the sum of the static water gauge in the air shaft or air drift plus the velocity head either measured or computed at the same point the static head was read.

With an exhaust fan the total head is computed in a different manner. In this case air enters fan inlet with an absolute pressure below atmospheric and with some velocity head, depending upon the area of the drift and the quantity of air being passed. The fan then does work upon the air and exhausts it into the atmosphere, the air leaving the exhaust stack with an absolute pressure equal to atmospheric pressure and with some velocity head depending upon the area of the exist of the stack. In this case the total head sums up to be the static water gauge at the air drift or air shaft minus the velocity head at the air drift or air shaft plus the velocity head at the outlet of the exhaust stack.

When a fan is working both exhausting and blowing; namely, with a duct on the inlet side and also on the outlet side we have the following conditions:

The inlet air enters the fan at an absolute pressure below atmospheric and with some velocity head depending upon the area of the drift and the quantity of air being passed, the fan does work upon this air and exhausts the air at an absolute pressure above atmospheric and with some velocity head depending upon the area of the drift and the volume of air being passed. In this case the total head created by the fan sums up to be the sum of the static water gauge at the fan outlet plus the velocity pressure at the fan outlet, plus the static water gauge at the fan inlet, minus the velocity pressure at the fan inlet.

After obtaining the total head and volume, the power should be read and then the unit efficiency can be determined by the relation of input power to motor and the useful air horsepower found.

Motor and drive efficiency vary according to size and input power. Assuming the fan to be 70% efficient, drive 90%, and motor 90%, then the unit efficiency would be 56.7%.

Compare the unit efficiency of your fan and estimate the K.W.H. savings that could be made with a fan unit having 50 to 60 percent unit efficiency. Other factors, however, should be taken into consideration as well as the operation of the fan.

How much pressure is present for the volume of air required in the mine?

How high is the coal?

Can the pressure be reduced by clearing airways and balancing the mine to eliminate regulators?

Is the air short circuiting and the volume reading at the face considerably less than the amount of air passing through the fan?

No two mines are identical. Each one presents a different problem. Roof conditions, structure of the rock strata found in the roof and many other conditions govern the pressure.

It should be remembered, however, that at all times the velocity of air in the mine should be kept as low as possible. This is governed by the volume in the air courses and sizes of air courses. Speed of air in air courses should never exceed 1000 ft. per minute.

High velocities cause roof falls especially when the fan is handling warm dry air. When the fan is exhausting, these falls are mostly found on the haulage ways and must be cleaned up before the day's work is begun. When the fan is blowing the falls occur mostly in the air courses that are seldom travelled and they are usually neglected until the volume of air reaching the face is reduced to the minimum requirement. Often the fan is speeded up to give the required air at a higher pressure. This means more power waste. The power increases as the cube of the speed of the fan at the same equivalent orifice.

Airways or air courses should be kept as clean as is practical but it is not always good economy to clean out falls in the air courses. This expense may be greater than the increase in ventilation power cost even over a number of years, perhaps for the life of the mine. It may be desirable from the point of view of power consumption to change the fan wheel to meet the equivalent orifice of the mine. Decisions upon questions of this kind should not be made without careful study of all details after examination of the mine by Ventilation Engineers.

Upon the completion of Mr. Robinson's very interesting paper, Mr. Wilcox said to him:

Mr. Wilcox: We thank you, Mr. Robinson. We appreciate your coming so far to give this very interesting paper. The discussion of it will be led by Mr. Raymond Mancha, Junior, of the Mancha Storage Battery Locomotive Company St. Louis, Mo., who will please come forward. (He does so.) Gentlemen,—Mr. Mancha.

[Applause.]

Discussion

[Submitted by—Raymond Mancha, Jr.]

Following the paper just read by Mr. Robinson I feel it in order to discuss in brief the effect that a difference between mine temperature and outside temperature has upon the performance of a mine ventilating fan. This subject has caused a great deal of confusion and has caused doubt to be expressed in regard to the validity of the fan laws that deal with the changes in pressure and flow as the speed of the fan is changed.

It must be clearly understood that the fan laws that deal with changes in pressure and flow as the speed of the fan is changed apply only when the fan is operating against a resistance that varies as the square of the quantity of air circulating, which resistance is called a fixed and constant effective equivalent orifice. Such a resistance is the mine pressure which is caused by friction, changes in velocity, and shock.

When a difference in temperature exists between the outside air and the mine air an additional factor; namely, gravity is introduced which either assists the fan to force the air thru the mine (as is the case in the winter), or bucks the fan's attempt to force air thru the mine (as is the case in the summer. This gravitational effect is spoken of as Natural Ventilating Pressure (N.V.P.) and is constant regardless of the quantity of air being forced thru the mine. In the case where the upcast shaft and the downcast shaft are of equal depth the N.V.P. is only present after the air has been artificially set in motion, and in the winter will continue of its own accord after the artificial source of agitation is removed, but in the summer the N.V.P. will not continue after the fan is stopped. This N.V.P. should be kept apart from the mine resistance. If this gravitational resistance is present the fan laws based upon operation against constant effective equivalent orifice do not apply.

In the discussion that follows the term "equivalent orifice" will be used repeatedly and for that reason I wish to devote a few minutes of this discussion to explaining exactly what is meant by the term "equivalent orifice":—

(a) By "mine equivalent oriflice" is meant the area of a round hole in a thin steel plate which, when placed against the fan outlet presents the same resistance to the fan that the mine presents with no N.V.P. assisting or opposing the flow of air.

(b) By "effective equivalent orifice" is meant the area of a round hole in a thin steel plate which, when placed against the fan outlet presents the same resistance to the fan as does the combined effect of the mine resistance and the N.V.P.

(c) By "rated equivalent orifice" is meant the area of a round hole in a thin plate against which the fan in question will operate at its point of maximum efficiency. When the effective equivalent orifice equals the fan rated equivalent orifice the fan will then put air thru the mine developing a maximum mechanical efficiency. When the fan is operating against any other equivalent orifice than rated equivalent orifice, the fan will deliver air at a reduced mechanical efficiency, depending upon the present rating at which the fan is operating, viz., the ratio of the effective equivalent orifice to the fan rated equivalent orifice expressed in terms of per cent.

If a fan is working against mine resistance with the N.V.P. opposing the fan, doubling the speed of the fan will more than double the flow of air and conversely if the fan working against mine resistance with the N.V.P. assisting the fan, doubling the speed of the fan will fall short of doubling the quantity of the air.

First, let's consider the effect in the winter when, as I have stated, the N.V.P. assists the mine fan. The outside air being at a temperature below the mine air causes the weight of the column of air in the downcast to be heavier than the weight of the column of air in the upcast. This effect will cause air to flow thru the mine even without the aid of the fan, and this N.V.P. has a definite value which we will assume to be 1" of water gauge during this discussion. Regardless of whether the fan is blowing or exhausting if the total pressure head created by the fan is determined as outlined by Mr. Robinson in his paper, this head created by the fan plus the 1" water gauge N.V.P. represents the total amount of pressure head required to circulate say 100,000 cfm of air thru the mine. If the head by the fan is 3" water gauge it follows that the total head required to pass 100,000 cfm of air thru the mine is 3" plus 1"; namely, the sum of the head created by the fan and N.V.P. The effective equivalent orifice against which the fan is working is represented by

$$\frac{0.0004 \times 100{,}000}{(3)^{1/2}} = 23.2 \text{ sq. ft.}$$

Now, let us assume that it is desired to circulate 200,000 cfm of air thru the mine. The N.V.P. will remain 1" water gauge; however, since 4" of water gauge is required to overcome mine resistance set up when 100,000 cfm is being circulated it follows that 4 x 4=16" water gauge will have to be supplied by the combined efforts of the fan and N.V.P. in order to force 200,000 cfm of air thru the mine; therefore, since the N.V.P. will remain 1" water gauge the fan will have to create a pressure head of 15" water gauge. Under this new set of conditions the effective equivalent orifice against which the fan operates will be

$$\frac{0.0004 \times 200{,}000}{(15)^{1/2}} = 20.6 \text{ sq. ft.}$$

Now, when we compare the two operating conditions of the fan we find that the fan when passing 100,000 cfm of air thru the mine operates against an effective equivalent orifice of 23.2 sq. ft., whereas the fan when passing 200,000 cfm of air thru the mine operates against an effective equivalent orifice of 20.6 sq. ft.; namely, the fan when passing double the amount of air thru the mine must do so against a smaller effective equivalent orifice than when passing half of that volume.

Since the fan laws are based upon a fan operating against a constant effective equivalent orifice it is obvious that such laws do not directly apply in this case because when the fan passes 200,000 cfm of air thru the mine it does so against a smaller effective equivalent orifice than when passing 100,000 cfm of air thru the mine, which will prevent the fan from doubling the quantity of air handled by doubling the fan speed. Therefore, in the winter time it is safe to say that to obtain twice the volume of air thru the mine it is necessary to more than double the speed of the fan. The extent to which the speed has to be increased depends upon the characteristic curves of the fan under consideration.

Now, let us consider the effect in the summer when the N.V.P. opposes the air flow. The outside air being at a temperature above the mine air causes the weight of the column of air in the downcast to be lighter than the weight of the column of air in the upcast. This effect will not cause a flow of air thru the mine of itself; however, when the mine fan is forcing air thru the mine the summer N.V.P. is present to oppose the fan, and has a definite value which we will assume to be 1″ of water gauge during this discussion. Regardless of whether the fan is blowing or exhausting if the total pressure head created by the fan is determined as outlined by Mr. Robinson's paper, this total head must be equivalent to the 1″ water gauge N.V.P. plus whatever pressure head is necessary to overcome mine resistance.

Again, assuming the fan to be circulating 100,000 cfm of air thru the mine we will consider the pressure necessary to overcome mine resistance as 4″ of water gauge, as we did in the previous discussion of winter conditions. Since the head created by the fan is the sum of the N.V.P. and the natural mine pressure it follows that the total head created by the fan will now be 1″ plus 4″=5″ water gauge, which we will consider as the necessary head that the fan must create to circulate 100,000 cfm of air thru the mine against 1″ N.V.P. The effective equivalent orifice against which the fan is working is represented by

$$\frac{0.0004 \times 100{,}000}{(5)^{1/2}} = 17.9 \text{ sq. ft.}$$

Now, let us assume that it is desired to circulate 200,000 cfm of air thru the mine. The N.V.P. will remain 1″ water gauge; however, since 4″ of water gauge is required to overcome the natural mine resistance set up when 100,000 cfm of air is being circulated it follows that 4 x 4=16″ water gauge will have to be supplied for the sole purpose of overcoming natural mine resistance when the fan forces 200,000 cfm of air thru the mine. Therefore, since the N.V.P. will remain 1″ water gauge it will be necessary for the fan to create a pressure head of 1″+16″=17″ water gauge total pressure when passing 200,000 cfm of air thru the mine. Under this new set of conditions the effective equivalent orifice against which the fan operates will be

$$\frac{0.0004 \times 200{,}000}{(17)^{1/2}} = 19.4 \text{ sq. ft.}$$

Now, when we compare the two operating conditions of the fan we find that the fan when passing 100,000 cfm of air thru the mine operates against an effective equivalent orifice of 17.9 sq. ft., whereas the fan when passing 200,000 cfm of air thru the mine operates against an effective equivalent orifice of 19.4 sq. ft., namely, the fan when passing double the amount of air thru the mine must do so against a larger effective equivalent orifice than when passing half of that volume. Therefore, in the summer time it is safe to say that to obtain twice the volume of air thru the mine it is not necessary to double the speed of the fan. The extent to which the speed has to be increased depends upon the characteristic curves of the fan under consideration.

A study of the winter time and summer time operating conditions will show why it is that a fan operating at constant speed delivers more cfm thru the mine in the winter time than in the summer time; for example, when the fan is delivering 100,000 cfm of air thru the mine in the winter time it does so against an effective equivalent orifice of 23.2 sq. ft.; however, in order that the fan circulate 100,000 cfm of air thru the mine in the summer time it is necessary for the fan to operate against 17.9 sq. ft., so it naturally follows that since the summer time operating conditions present to the fan a smaller effective equivalent orifice per cfm of air delivered than do the winter operating conditions, it is easily understood why more air is circulated in the winter time than in the summer time. The easiest way to see this is by applying common sense since one would naturally expect the fan to circulate more air for a given fan speed when assisted by the N.V.P. than when opposed by the N.V.P.

Just a word to explain how the N.V.P. may be determined. It is possible to measure the N.V.P. by closing the mine opening at some point and determining the difference in pressure on the two sides of the stopping. The most convenient places should be selected because it is immaterial where the reading is taken if the stopping is tight. The N.V.P. depends only on the difference in weight of the air columns, which is not changed by the change of air volume circulated.

It seemed to me that this discussion on the effects of N.V.P. would dove-tail very nicely with Mr. Robinson's very complete paper on "Ventilation and Its Relation to Power Cost", and would be in order to serve as an answer to questions which might arise in the minds of many of you operators. In the state of Illinois, as I go from one mine to another testing fans, I am constantly told that the natural fan laws are all right in theory but they do not apply in practice. I feel that this discussion will serve as a means of showing that the practical results obtained at the mine do not disprove the natural fan laws or any theory based thereon. The saying that theory has no place in practical problems is an old "wheeze", but if one will stop to analyze the problem in every detail one will find that wherever theory falls down the man who applied the theory failed in his true analysis of the problem at hand by neglecting many factors which though apparently obscure were real in their existence.

Since the time is short, and my discussion has probably been too long for the time allotted, I will ask any of the gentlemen present to please ask whatever questions there may be in his mind and to, at this time, bring up any disagreement which he may have upon any of the facts mentioned by either Mr. Robinson or myself. We will be glad to attempt to show the reason for any and all of our statements, and we both feel that now is the time for the asking of questions.

Mr. Mancha: If I have said anything which anyone here does not agree with, I would be glad to explain a little bit more. (No response.)

Mr. Wilcox: Before we go any further, I would like to ask if Mr. Robinson and Mr. Mancha are in entire agreement? Have you any quarrel among yourselves?

Mr. Robinson: No, I think we are in entire agreement. But there is one thing which probably I did not bring out as much as I could have brought it out. I do not know whether Professor Callen is in the audience this afternoon or not? But he has made quite a study of velocities in airways and I think he would bear me out that in order to advise you regarding a fan for your mine, the true volume of ventilation in a cross-section is absolutely necessary for a fan manufacturer to have.

In the last year, or more, we have made a number of surveys of mines, and we find that we get an average of twenty-five to thirty per cent lower volume of air by taking the velocity readings in the cross-section of an air shaft. Your mine foreman or inspector is only concerned with relative quantities. If he has ten or fifteen thousand feet of air in an entry one day and he has about the same volume the next day, he knows his condition is as near as he needs it. However, for a fan manufacturer, it is absolutely necessary that we get the right volume of air before designing a fan. If we attempted to put one hundred thousand feet of air through a mine at one inch of water gauge—and you told us you were getting that much air—(and you only took a center reading—) and we took a cross-section reading and you were only getting seventy thousand feet—the fan would be too small and would not be efficient.

If there are any more questions, I will be glad to answer them.

Mr. Wilcox: Anyone else any questions?

Mr. Haywood: I would like to ask him what system is most suitable in our mines—the vacuum system—or the blowing system of fans?

Mr. Robinson: Mr. Chairman—and Mr. Haywood: That is a pretty big question. It depends a great deal upon the mine. For a gaseous mine, sometimes it is better to exhaust—sometimes it is better to blow. It depends upon what your system of ventilation is, and whether you can dilute your gases. If your mine is gaseous, you always have the possibility of blowing polluted air back over your haulageway, and, with a trolley system, it is very apt to cause an explosion. On the other hand, you get into a mine that has bad roof conditions. If you are exhausting, with bad roof conditions on your haulageway, it means practically every day cleaning up on haulageways. If you are blowing, and your airway is large enough to pass the air without too much expenditure of power, you can afford to let your airways close up a little bit and by leveling them off here and there and you can keep your pressure almost constant. So it depends almost entirely upon the system of mining and the conditions of your mine, as to which is the best system to use. Does that answer your question, Mr. Haywood?

Mr. Haywood: Pretty well. I just wanted to bring that out. In my early days, I was raised in the mines of England, and we had the vacuum system there; and afterwards, in the mines of Illinois where I worked they had the blowing system, and I have worked out in Utah where they have the vacuum system. I know there is great danger of explosions where you have a trolley wire, and I just wanted to bring that out.

Mr. Wilcox: Has anyone else anything to ask?

Mr. Smith: Mr. Robinson mentioned the necessity of taking what he calls cross-section readings to get the true quantity of air. I think that point is well taken. The only answer is to pick a number of points (twenty or thirty points) and we have been doing that, for some time, in our ventilation work in the University of Illinois. We found that the only solution was to take a number of readings through the cross-section— twenty or thirty being suggested.

Mr. Robinson discussed the forward curve and backward curve fans. I wonder if he would give as a notion how much larger fan—say we wanted to handle one hundred thousand cubic feet of air—perhaps a 4x10 forward curve fan is doing the work—what size of backward curve fan would have to be used? Can you give some indications of that? Mr. Robinson goes into detail, and finally says that to explain fully would take at least an hour's time, but that to replace a 4x10 forward curve fan it would take about a 10x6 backward curve fan.

Mr. Wilcox: Has anyone else any more questions to ask?

Mr. Marsh: Mr. Chairman, I have one question I would like to lay out and see if there is any information available. If you have an air course entry with the air of high velocity and there would be a rock fall in that entry and you would have to do some timbering down there and the only thing you can do at the time is probably to set a row of timbers right down the middle of the entry for quite a distance. As I understand it, a row of timbers is a big obstruction and from what I know of streamlining, it would probably reduce the pressure to board up these timbers so that you would have just a wall in there with a timber in the front and a timber in the back and smooth boards on both sides—that would reduce your pressure again. Is there any information as to whether that would, under ordinary conditions of velocity be worth while?

Mr. Robinson: Well, in the first place, that would depend upon how much power you were putting into your fan, but you could save power, because you would reduce your coefficient of friction by boarding up those timbers. The timbers being boarded up in the same manner as you stated would reduce the friction losses. There is no definite formula that I know of on that.

Mr. Wilcox: Has anyone else any more questions?

Mr. Thomas English: With the fans as we have them at present, producing two, three or five inches of water gauge, would placing new fans for the same quantity of air in our mines reduce the water gauge? Some of the fans in our mines are old and antiquated?

Mr. Robinson: No, Mr. English, they would not. The fan has nothing to do with the water gauge only as a matter of speeding it to assist the conditions that are set for your mine. (Mr. Robinson goes on to explain about "equivalent orifice", giving a formula for the same.)

Mr. Anderson: Mr. Robinson, I take it from your explanation, that the only object in buying a new fan is to replace an old one? (Laughter.)

Mr. Robinson: Mr. Anderson, I am a little bit timid about saying that you ought to buy new fans, because you know mine fans never wear out; they run for twenty-five or thirty years, twenty-four hours per day, three hundred and sixty-five days in the year,—so you do not buy new fans to replace old ones. But there is this about the mine fan. By changing the type of fan or the size of the fan you can make reductions in power to justify that change. You can cut your cost of coal per ton from a fraction of a cent per ton to several cents per ton.

Mr. Mancha: In many mines, the fans are too large. 99 times out of 100, smaller fans could be used.

Mr. Anderson: What you say I believe is all right from an economical point of view. I was thinking about the ventilation of the mine. We have a type of mine that is hard to ventilate. It is rather costly to clean up the air courses, etc., and we wanted to get a fan, and we were advised to get a new and bigger type of fan,—but according to what you say, that would not help us.

Mr. Robinson: You may be able to get more air with less power by putting in a fan suited to the mine. You said a larger fan—a larger fan does not mean more air with the same amount of power; you cannot reduce your pressure in your mine by putting a larger fan in your mine.

The discussion being ended, Mr. Wilcox said: The most impressive thing about this paper and its discussion, to me, was the fact that these ventilation engineers are putting it down the air shaft, and I was wondering how many of us are giving as much thought to this as these efficiency engineers? You are losing a good opportunity, if you have any questions on this subject, if you do not put them to these fellows now.

Through the efforts of our Secretary, and our new President, Mr. McFadden, we can take these excellent papers by Professor Snow, Mr. Robinson and Mr. Johnston back home with us and read them at our leisure.

If you fellows do not know what the Proceedings of our Institute are like and what they mean, you had better read them and find out about it.

(Here a count of the attending members of the Institute who desire to go to the banquet was taken. Mr. Wilcox urged all to attend.)

Mr. Wilcox: We are now getting down on our program to the fellows who really know how mines are run.

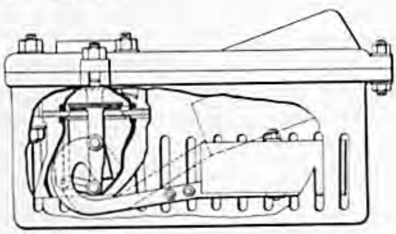
The next paper is by Mr. J. M. Johnston, Chief Engineer of the Bell and Zoller Coal & Mining Company, of Zeigler, Illinois. I take pleasure in introducing Mr. Johnston, whose subject is: "Mine pumping, automatic controls, float switches, and automatic suction valves."

MINE PUMPING, AUTOMATIC CONTROLS, FLOAT SWITCHES, AUTOMATIC SUCTION VALVES

By J. M. JOHNSTON

Chief Engineer of Bell & Zoller Coal and Mining Co.

Mine drainage systems have a wide variety of application, ranging from large capacity centrifugal pumping units driven by AC motors and equipped with automatic primers and control panels to the small gathering pumps driven by DC motors and hooked up directly across the trolley line circuit.



It is not uncommon for a mine in the Anthracite or Western Pennsylvania fields to discharge 20 to 30 tons of water per ton of coal hoisted. In these mines the usual method of solving the pumping problem is to establish a pump station at the low point in the mine, sink bore holes from the surface to the station and develop a large sump area in which to impound the water. Ditches and relay pumps discharge into the large sump from which the larger units deliver the water to the surface. It is not unusual to see five or six pumps of 4000 gallons per minute capacity installed in one pump room. Where the mines are deep these pumps are either multistage or single stage centrifugals in series, direct connected to 2300 volt motors.

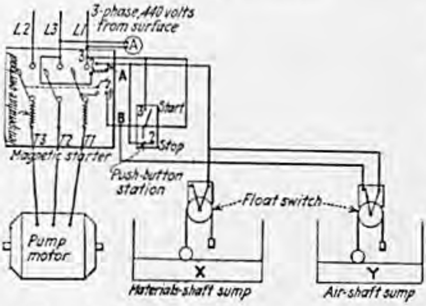
Pumping as a general rule is done during the off-shift period. This increases the load factor of the entire operation with the resultant reduction in cost per KW as power service companies schedule reduced rates on power consumed during the off-peak hours.

In the Southern Illinois field no such pumping records as these just mentioned are obtained. Many of the mines here discharge very little water to the surface and although the rainfall is at times abnormally irregular, very little surface water percolates through the overlying strata to the mined out areas.

The Ziegler Mines of Bell and Zoller Coal and Mining Company at Ziegler, Illinois are typical of the Southern Illinois field to pumping requirements. The water producing areas are widely scattered throughout the property but at none of these locations is there any great accumulation of water.

In No. 1 Mine the water discharged to the surface is handled by two pumps. One of these is located at the Material Shaft Bottom and the other discharges through a bore hole in 12 left entry, a distance of 1.2 miles north east of the shaft.

The pump installed in 12 left is a 3 stage Cameron Centrifugal Pump of 220 gpm designed to operate against 500 feet head, driven by a 50 H.P. motor. This pump operates approximately 6 hours per day and handles all the water from the North East Section of the Mine, comprising approximately 200 acres of mined out area. Ditches and a syphon 650 feet long carry the water from the various sources to the pump station.

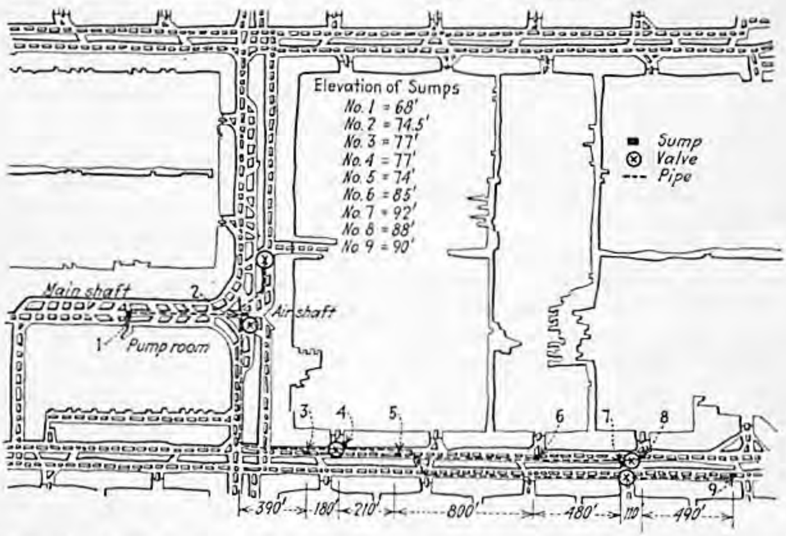


The installation at the Material Shaft consists of a 4x6 Deming single-acting triplex plunger pump, designed for a working pressure of 230 pounds, driven through an Allis Chalmers Tex-Rope drive by a 10 H.P., 220/440 volt, 3ph., 60 cy., ball bearing motor. This pump handles water from two sumps, one located 20 feet from the pump at the Material Shaft Bottom and the other at the Air Shaft Bottom, 700 feet away. The greater part of water handled in the Material Shaft sump is relayed by a Gould Horizontal Triples Pump from the 9 left area about .8 miles north-east from the shaft and from the sump at the Hoisting Shaft. The pump at the Hoisting Shaft is a Deming deep well pump which will be described later. General Electric Company type CR 2931 Float Switches installed at each sump start or stop the pump motor when the water rises or falls to predetermined points in the sumps. The following wiring diagram shows the arrangement of electrical connections to float switches and indicates the operation of the system.

Suction control valves on the ends of the suction lines open or close the suction lines as the water in the sumps rises above or falls below the end of the suction pipe. These valves are float controlled but do not control the operation of the pump, their function being to close the suction line to either sump when the water in the sump has been drawn below the end of the suction line. The float switches are set to make contact when the water rises to a certain level above the suction valves. To illustrate the operation, when the water flows into the sump marked "X" the float in the suction valve is lifted and releases the roller on the stem of the valve. Then as the water rises sufficiently to operate the float switch the pump suction opens the valve and draws water from the sump until it becomes low enough to permit air to enter the suction line. As soon as air enters the suction line the valve drops and is locked into closed position by the float. If sump "Y" has been filled to the elevation at which the float switch, at this point, operates while sump "X" is being drained, the pump will continue to operate after the suction valve in sump "X" has closed but will then be drawing water from sump "Y". With this arrangement the pump operates whenever either sump has sufficient water to operate either float switch and will continue to operate until the water in both sumps becomes low enough for both float switches to break contact, thereby always keeping the water level in both sumps at the required elevation.

The discharge line rises directly from the pump for 6 feet then horizontally for 50 feet, and again vertically up the shaft 400 feet. The line up the shaft is 4 inches in diameter and the line from the shaft to the pump is 2 inches in diameter. A gate valve at the base of the 4 inch line provides means for draining the column when the pump is out of service or during the winter months. A 2 inch check valve is installed in the horizontal line to protect the pump against the high water column when the pump stops, and a Boyts, Porter air relief valve tapped into the top of the horizontal line between the check valve and the pump relieves the air from any air pocket that might tend to build up excess pressure in the line. This valve is especially effective when the pump begins to pull water through the 700 feet of suction line from the Air Shaft sump.

of five gallons of oil, a system of ½ inch pipe lines leads to all bearings requiring oil. The oil pump is chain driven from the pinion shaft of the triplex pump and, of course, operates when the Triplex is in service. Oil is carried continuously from the reservoir to the bearings; pet cocks above each oil cup can be closed or opened to regulate the supply of oil to each point. During continuous operation, the oil overflows the oil cups and drips back into the reservoir from which it is re-circulated. Any water that may leak from the pump into the oil supply is drained off through a pipe in the bottom of a 12 inch square tank built into and extending 18 inches below the bottom of the reservoir. Turbine oil has been used for lubrication with satisfactory results. It does not mulsify and the water settles readily to the bottom of the tank from where it is drained off.



Since the installation was designed to require a minimum of attention it was necessary to provide a positive oiling system. For this service a Joy hydraulic pump was mounted on the pump base, a reservoir 6 inches deep built around the base has a capacity

An ammeter installed in the power house and connected into the pumping circuit serves to indicate the operating time of the pump. This ammeter is connected also in the circuit leading to the pump in the Hoisting Shaft. From ampere readings the power house attendant can determine when either or both pumps are in operation. The importance of this instrument is very much appreciated for without it during idle time there would be no assurance that both pumps were operating.

The Deming "Oil Rite" deep well system installed at the Hoisting Shaft consists of a pumping head with 10 inch stroke, driven through a Tex-Rope drive by a 3 H.P., 440 volt, 3 ph., 60 cy., motor mounted on top of the pumping head. The pumping head, is mounted on the shaft timbers at the dumping level and a 4 inch drop pipe extends 44 feet down into the sump. On the end of the drop pipe there is a brass lined artesian well cylinder in which two flat disc type valves connected to the drive head by wood sucker rods in the drop pipe operate with each stroke of the pump head, forcing the water up through the drop pipe. The discharge line is made of 707 feet of 1½ inch pipe delivering water to the material hoist sump.

The operation of this unit is controlled by a float switch similar to those installed at the two sumps mentioned above.

Oiling of this unit is automatic. The oil is stored in the crank case and carried to the main bearings through a splash system. A force feed through a tube to the top of the pump provides oil for the connecting rod bearings and cross head. In this way all bearings are assured a positive oiling. Change of oil is required every five or six months under ordinary operation.

These pumps have been in service for eight months and have given very satisfactory service.

At No. 2 Mine, the water producing areas are not so widely scattered as in No. 1. Two 4"x6" Gould horizontal triplex pumps and one 4"x6" Deming single acting triplex discharging to the surface constitute the entire pumping equipment.

One of the Gould relay pumps is installed at the bottom of the Air Shaft and draws water from several sumps along the 2nd and 4th South West Entries indicated on the following sketch. The total length of suction line on this pump is 5000 feet. Suction control valves of the Yough automatic type are in service at five of these sumps that require pumping daily. Four smaller sumps are controlled by gate valves in the line. This pump discharges into a reservoir at the Hoist Shaft bottom from where the water is lifted to the surface by a Deming triplex pump automatically controlled by a float switch similar to those previously described.

The equipment used to make these units self-operative is all standard material assembled to provide installations that will give continuous service with a minimum of attention and maintenance. The application of automatic pumping is especially desirable where mines are operating part time as the presence of an attendant is not required to keep the sumps properly drained, so as not to damage haulage ways, etc. With suction control valves one pump is made to do the work of several. This reduces maintenance and investment and simplifies the pumping requirements.

(Applause.)

Mr. Wilcox: The discussion on all the papers is open to all members. Has anyone any questions to ask?

Mr. Weir: The question of pumping in Illinois is a very minor item of cost excepting in those mines which are operating one or two days per week or in mines which are shut down for a period of months. When pumping has to be done under those conditions, it becomes an item of considerable importance. I would like to point out to you several things which Mr. Johnston has described. Water rising in a sump automatically opens an automatic suction valve. When the pump is started and the sump pumped down to a certain point, the automatic suction valve automatically closes. These features permit the use of a long suction line from one pump. This suction line may have a large number of branches. It is only necessary to start the pump in order to have automatic pumping from a number of sumps. Mr. Johnston has told you that we have one suction line 5,000 feet long on which there are 5 automatic suction valves. At No. 1 Mine we have at the shaft bottom a pump which takes care of two sumps. The control equipment is so arranged that the pump will be started automatically by means of a float switch in either sump. Once started, the pump continues in operation until both sumps are pumped down. These suction lines are equipped with automatic suction valves. Previous to one year ago, we used large centrifugal pumps to move the water from sumps at the main shaft bottom to the surface. They were manually operated and gave reasonably satisfactory service when properly looked after. We replaced these centrifugal pumps with triplex plunger pumps of smaller capacity. These new pumps were fully equipped for automatic operation. The main coal hoist shaft at No. 1 mine has a sump 44 feet below the dumping level. Instead of placing the pump in the shaft below the dumping level, we installed a small deep-well pump. It is driven by a 3 H. P. motor and is automatically started and stopped by a float switch. The big advantage in using automatic suction valves and automatic starting equipment lies in the reduction in attendance required. Under ordinary conditions when a mine is shut down, inspection is required at two week intervals. In addition to the underground pumps, we have in use a number of small automatic outfits in scale pits and in basements below the drainage level. We have found them to be very effective and dependable.

If there are any questions, Mr. Johnston will be very glad to answer them.

Mr. Wilcox: Thank you Paul, and Mr. Johnston. [Applause.]

Mr. Wilcox: Mr. Jones, have you any questions you would like to ask?

Mr. Jones: The question he brought up of the deep-well pump I think is quite interesting, because most shaft pumps are too deep to have the automatic suction control, and I was just interested in how they put that in.

Mr. Johnston: Our sump at the main shaft stands about 50 feet below the dumping level and we have a 44 foot dropping head, making about 6 feet to the extreme bottom of the sump. Our main shaft is well drained and we can automatically control the water. We have another little pump in there. When we want to drain the sump dry to remove any accumulations of fine coal or dust, we can pump it down with that, but ordinarily, the automatic deep-well pump will keep our main hoist sump dry.

Mr. Wilcox: Does anyone else want to ask any questions or offer any suggestions? (No response.) Mr. Jones? How about you?

Mr. Jones: The pumps in our mines are practically all placed at individual large sumps, but the water is discharged into them by gathering pumps, or drawn into them by gravity, and while we have automatic floats to control the elevation of the water in the sumps, we have not gone to any extent into the equipping of our mines with special automatic control equipment.

Mr. Wilcox: In this paper by Mr. Johnston, there are several interesting and valuable diagrams. There is an easy way to obtain these, (that is, if your dues are paid.) They will be sent to you, gratis, and the charts alone are worth that amount.

This is the last of our program, and after we adjourn, any member of this Institute who has not paid his dues will be merely a guest.

If you have anything nice to say about going officers, you had better say it now. I know Mr. Zook has come down here with a feeling of relief, but after he has turned his office over tomorrow to the new President there will be a certain element of sorrow about it, or a sentiment attachment. Before I turn this meeting back to him, this Institute should, by a rising vote, express their appreciation to him and the officers who have served them so well during the past year.

(Motion for a rising vote of thanks made, carried, so ordered, making it a unanimous vote of thanks.) [Applause.]

Mr. Wilcox: I take great pleasure in now turning the meeting back to Mr. Zook.

Mr. Zook: Thank you, Mr. Wilcox. I appreciate very much the expression of appreciation you have given to me and to the officers of the Institute, of which I have had the pleasure of being one for the past year. Needless to say I have enjoyed very much being your President, and do, with considerable regret, relinquish the job, but I also take pleasure in doing so in favor of a better man. The cooperation of each officer, each committeeman and each member has been very much worth while and I think that the past year will go down as a real year of progress, due to the efforts of the individual members and officers, more especially in the two items of Vocational Training and Mineral Research. If the proper attention is given to these matters, I think we will make great strides for the betterment of the industry, which will redound to the credit of this Institute.

During the year, I suffered a severe illness, which knocked me out for a couple of months and this is my first appearance away from Chicago since June. I am glad to say that I have not been worn down, so far, and feel physically fit to go on. I am mighty glad to be through with that experience and still be able to stand up here and talk to you fellows and mix with you again.

We are going to have a very interesting program tonight in connection with the dinner and I hope every one of you will be present, as it will be very much worth while.

Unless there is some other matter of business of interest to any member, I think it is proper at this time to adjourn, to meet across the hall at 6:30 P. M. for the dinner. Let me say that you can secure tickets at the desk outside. [Applause.]

Mr. Schonthal: Please accept my thanks for your patience during the year and your cooperation. I wish you every success for the future, and if I can contribute in any personal way to the welfare of the Institute, I will deem it a great privilege to do so. [Applause.]

Mr. Zook: A motion to adjourn is now in order.

(Motion made, carried, so ordered.)

(Adjourn till 6:30 P. M. for Banquet.)

THE PRESENT INDUSTRIAL SITUATION AND THE IMMEDIATE FUTURE

By HON. CHAS M. THOMPSON,
Dean, College of Commerce, University of Illinois.

I have been asked to present some observations on the present economic situation and to advance an opinion on what the probable immediate future may hold for business and industry. The first of these assignments is comparatively simple, although I suppose that no two of us would possess the same set of observations. The second assignment, however, is extremely difficult, since no one can speak with any reasonable assurance as to what may be just ahead of us, and it is doubtful if my opinions or the opinions of any one else would carry any great weight, especially with those already possessed of opinions contrary to the ones expressed. Moreover, it is doubtful if any one knowing what was about to happen industrially at any time would be willing to make that knowledge public, preferring to keep it to himself in order to profit financially.

My understanding of an industrial depression is that it is nothing more or less than an industrial maladjustment. Under normal conditions, industry, as such, is delicately poised and, therefore, easily disturbed. The factors of disturbance are many and varied. One such factor is war; another is too rapid territorial expansion; a third is the excessive freezing of capital; a fourth factor is over-expansion in production.

The first of these factors, that of war, has a long history in its influence on industrial progress. The carrying on of wars, and the cessation of wars, during the Middle Ages were constant sources of industrial maladjustment. Even in those days, primitive as they were, when most of the people lived on the land, the assembling of any appreciable number of men for the purpose of carrying on war created new production problems, stimulated consumption, and threw normal industry out of balance. Of the great periods of maladjustment caused by war the first came with the downfall of Napoleon early in the Nineteenth Century. Every one of the nations of Western Europe felt its influence. Tens of thousands of discharged soldiers, unemployed and out of touch with industry, created social and economic problems difficult of solution. Fifty years later in our own country, with the closing of the Civil War, both the North and the South found it extremely difficult to adjust industry to the conditions which the war itself had created. To the way of thinking of many authorities, the late War, with its demand for millions of men and billions of dollars worth of supplies, was the cause of the greatest maladjustment of industry the world has ever seen.

The second factor which I have mentioned, that of too rapid territorial expansion accompanied by an era of speculation in land, is exemplified in our own history in a significant way. The year 1837 marks the end of one such expansion; the year 1857, the end of another. In both instances the American people threw the whole machinery of industry out of gear, as it were, by their too rapid movements toward the West.

The excessive freezing of capital as a cause of industrial maladjustment is perhaps best illustrated in the building of railroads. As everyone knows, capital invested in railroad building is frozen about as hard as any capital can be frozen and still possesses any degree of liquidity. This is true because right of ways and railroad equipment are relatively long lived, and there is scarcely any other use for them. The depressions of 1873 and 1893 followed such freezing of capital, and it is not too much to say that one was effect and the other cause.

The fourth factor which I have mentioned is over-expansion in production. Many influences contribute to over-expansion. During the years immediately preceding 1929, the people of this country were caught up with the idea that there were no natural limitations on production and hence no such thing as a saturation point in consumption. The result was that, through a wide system of installment buying, we anticipated markets years ahead of their normal occurrence and embarked upon public projects out of all proportion to normal needs and to ability to pay for them out of current income.

Each industrial depression has its own earmarks. The one through which we are going is characterized by falling prices, by excessive stocks of goods on hand, by unemployment, by the plentifulness of idle money, and by an extreme apprehension on the part of the people in general that matters are constantly getting worse.

Many proposals have been offered as a solution of the problems arising from the present industrial situation. We find in some quarters a demand for a shorter working day; in others, that married women be discharged from industry. Many advocate a back-to-the-land movement. One group demands that taxes be increased; while a second group, moving in the opposite direction, insists that taxes be decreased. One group advances the theory that the public expenditures should be greatly curtailed, while another offers the solution to the effect that public expenditures should be increased. Other solutions advanced have to do with a decrease in public personnel, modification of the Volstead Act, decreases in wages, increases in wages, a decrease, if not the elimination, or reparation debts, a return to bimetallism, higher tariff rates, lower tariff rates, price fixing, and a great many other plans.

Out of the welter of discussion, little has been said about personal thrift, about sobriety, about plain living on the part of the individual. To put the matter in another way, most of the discussion on methods of recovery have had to do with groups and governmental units rather than with the individual.

The best minds of the country have always been interested in analyzing industrial depressions with the idea of doing something either to lessen the severity of the ones that may follow or to eliminate them altogether. May I quote from one of these authorities?

"The breakdown of prosperity," he writes, "was a breakdown of confidence. Whatever the several causes of it were, this was the result. The depositor lost confidence in his bank; the merchant lost confidence in his customer's ability to pay; the manufacturer lost confidence in the merchant's ability to pay; everybody at once wished to collect his debts; and the banks lost confidence in all but the soundest of borrowers. Around this wide circle a general fear ran; and general fear is another name for panic.

"The task now is to restore confidence. But restoring confidence is not a mere mental performance. You cannot go about saying to persons with whom you have mental dealings, 'Now my confidence in you and your business is restored'; nor can men hold mass meetings and remedy the matter by resolving that commercial confidence is again at work. Yet the restoration of confidence is pretty nearly all that is needed to set the wheels of prosperity going again."

A month later another authority viewed the situation in a somewhat different manner.

"Commercial conditions," he contended "may be likened to an automobile with a loose clutch; there is almost every indication that a rapid forward movement is imminent, yet progress is slow. Fuel is abundant in the shape of easy money, and the engine is working freely to all appearances, while depleted stock of goods suggest that the wheels ought to be turning rapidly, but somehow the transmission of confidence is not quite right. Convalescence must be slow after so severe an illness, and it is one of the best signs that conservatism dominates the situation.

"During the past four months," he continued, "the country has gone through a process of readjustment in nearly every department. Prices of commodites have declined steadily, even the grain and cotton markets sharing in the downward trend. Wages have resisted most stubbornly the general tendency, and the army of unemployed has assumed alarming proportions at several manufacturing centers, although wildly exaggerated stories have been circulated for speculative effect. It is announced by the heads of the trade unions that all propositions to reduce wages will be fought, yet labor will not be immune from the effects of the setback, unless, of course, prosperous conditions return very quickly."

Later in the year a third writer drew a picture as dark as anyone is likely to find in current literature on business conditions.

"To determine the existing situation with a close approximation to accuracy [he] the writer recently entered into correspondence with more than 100 of the leading industrial corporations in the United States, inquiry being made as to the condition of business at this time as compared with last year and also as to the employment of labor at unreduced wages. The replies present a bird's-eye view of the commercial situation. Briefly stated, they show that nearly every line of business is seriously affected and that, with one or two exceptions, there has been but slight recovery. In no instance have normal conditions been resumed. The number of unemployed is appalling. In New York City alone there are thousands and thousands of people out of employment. In other cities there is the same lack of work for willing hands. A report from one locomotive factory shows that whereas 18,000 men were upon the payroll one year ago, there are now only 5,000 employed, and even this reduced number is working less than full time and at lower wages than formerly prevailed. In a large steel corporation where 9,000 men were formerly engaged, only half that number is now at work and the amount of business is 55 per cent of the usual volume. An Eastern coal corporation reports that the price of ordinary labor has been reduced 25 per cent and that business conditions are still unsatisfactory. A concern which manufacturers textile machinery received substantially no orders during the first three months of this year and even now is operating only about sixty per cent of the capacity of the plant. A hosiery manufacturing company is doing only forty per cent of the business of last year and sixty per cent of the force is idle. In Pittsburgh and vicinity, conditions have not improved to an appreciable extent and only forty to fifty per cent of the iron and steel business is in operation."

Perhaps we can with profit turn our attention to certain specific aspects and to certain specific industries. Here follows the opinion of an authority on the railroad situation as he viewed it:

"Several of our railroads," he said, "are now in the hands of receivers, and a large proportion of the remainder sees insolvency staring them in the face. Not only is the capital invested in railways entitled to a return as a matter of economic right, but as a matter of economic law it must receive such profit if we are to have further industrial progress. The grave consequences to the United States which would ensue upon a universal failure of our transportation companies are clearly apparent to thinking men. Moreover, commercial conditions throughout the country are set to low freight rates, so that the carriers would lose their traffic if tariffs were advanced."

A few months later a leading financial journal printed pointed observations on certain aspects of the depression in a way that makes them extremely valuable in attempting to see our way out of the present situation.

"No one," he wrote "can question the gravity or the needlessness of the present financial strain—our financial system has broken down; the strain has been so great at the pivotal point that intense friction has been developed until it has become palpable to every one that the government cannot any longer perform the function it has been charged with unless some material change in the conditions is made.

"The trouble is," he went on, "the mood of the week has not been so expectant in Wall Street circles as it was, notwithstanding the great telltale markets of iron and dry goods have been giving new signs of promise.

"The financial situation is critical, it is already having a depressing effect on general business, and if not arrested that influence will increase."

This same journal, in discussing monetary and commercial affairs during the depression, set forth its ideas on another occasion as follows:

"Now, if we accustom ourselves to regard in its true light the depression of business which has prevailed and still continues, we shall at any rate put ourselves into that attitude of mind which will enable us to appreciate and to profit by the earliest gleams of hope as they appear on the financial horizon.

"In briefly summing up the principal features of monetary and commercial affairs during the year it may be stated," the editor wrote "that the results are notably unsatisfactory; business is disappointing and profits exceedingly small; a strict economy in expenditures is still practised by consumers; manufacturers are curtailed, and wages of skilled and raw labor have declined; in financial enterprises capital is timid and money accumulates without means of employment.

"A recuperation has for months been looked for with much confidence, since the financial crisis of two years ago had been passed; but it failed to take place, and it appears that the disastrous effects of the depression have been underestimated and considered more transient and temporary than is really the case."

Perhaps the best description of industrial development is found in one of our more popular magazines. It reads as follows:

"It is a gloomy moment in history. Not for many years— not in the lifetime of most men who read this paper—has there been so much grave and deep apprehension; never has the future seemed so incalculable as at this time. In our own country there is universal commercial prostration and panic, and thousands of our poorest fellow-citizens are turned out against the approaching winter without employment, and without the prospect of it.

"In France the political caldron seethes and bubbles with uncertainty; Russia hangs, as usual, like a cloud, dark and silent, upon the horizon of Europe; while all the energies, resources and influences of the British Empire are sorely tired, and are yet to be tried more sorely, in coping with the vast and deadly Indian insurrection, and with its disturbed relations in China.

"It is a solemn moment and no man can feel an indifference (which, happily, no man pretends to feel) in the issue of events.

"Of our own troubles no man can see the end. They are fortunately, as yet, mainly commercial; and if we are only to lose money, and by painful poverity to be taught wisdom—the wisdom of honor, of faith, of sympathy and of charity—no man need seriously to despair. And yet the very haste to be rich, which is the occasion of this widespread calamity, has also tended to destroy the moral forces with which we are to resist and subdue the calamity."

You will agree with me, I am sure, that each of the quotations which I have just read to you fits the present situation in a most admirable manner. You may be surprised, however, to know that the first three were printed in 1908, that the fourth was printed in 1894, that the fifth was printed in 1895, that the sixth was printed in 1875, and that the seventh was printed in 1857. The object in bringing this testimony to you at this time is to show that the present situation is not unique. At other points and at other times in American history we have had unemployment and distress, we have fed the hungry and clothed the naked, we have complained of lack of income, we have, in an effort to better our circumstances, thrown the ins out and the outs in. In other words, without attempting to justify the present situation, each generation seems to have its own problems, all of which were very much alike.

We hear a great deal these days about the purchasing power of the people and the accumulation of large stocks of goods. In some instances such statements are true; in others, they are untrue. We may, for example, have too many radios, too many automobiles, and too much furniture, but, according to the records of the past year or two, we have not had too much professional baseball, too much professional football, too much gasoline, or too much grand opera. In other words, there seems to be an important point overlooked in discussing the purchasing power of the people, and that point has to do with what the people want rather than what they do not want. To put the matter in another way, we may say that the mere accumulation in large quantities of any particular goods or class of goods which seem not to be able to find a market is no indication whatever that the purchasing power of society is not what it ought to be.

More important than a mere analysis of the present situation is the probable immediate outlook.

We should keep in mind, first of all, that the factors of production in this country are undiminished. We have as much capital, as many workers, and as great a volume of natural resources as we ever had. What we need is to get them together in the proper amounts and to make the things which the people want. The second thing is that the United States is a young and virile nation. We hear much of the downfall of peoples and civilizations, but, so far as history shows us, no nation as powerful as the United States has ever disappeared in its youth. Finally, we must keep in mind that depressions, however severe and however prolonged, always come to an end.

If I were speaking to a group of college boys I should give them five bits of advice in this connection. The first is that they spend less than they earn; the second is that they pay as they go; the third is that they accustom themselves to take the lean with the fat; the fourth is that they depend on themselves rather than upon some one else; the fifth and last is that they have implicit confidence in the future. This same advice, it seems to me, is worth considering by all of us whatever our age and situation in life and whatever our economic status.

[The following article "Fifty years of Coal Mining" are four installments of a series appearing in October, November and December, 1931 and January, 1932 issues of THE EXPLOSIVES ENGINEER *and we are indebted to them for the permission to submit to our readers—the balance of the story will appear in our next year book.]*

FIFTY YEARS OF COAL MINING

PART I

By OSCAR CARTLIDGE

Preface

My paternal grandfather came to this country from County Durham, England, about 1850, and settled at Wood River, a small town near Alton, Illinois, because there was cheap land and coal. And since he was a miner, coal naturally came first.

He and a William Rutledge had been cronies in the old country, and a son of this William Rutledge, at the age of nineteen, crossed the sea and two years later settled at Alton. This was Walton Rutledge, the father of Dr. J. J. Rutledge, now chief engineer of the Department of Mines of Maryland.

Walter Rutledge was the workingman's friend. For over thirty-six years he was state mine inspector in Illinois, and everyone knew and loved him. It is a safe bet to say that he was the inspiration and help of more young men than any coal man who ever lived. It was his delight to confidentially whisper to some struggling young miner that he had in him the making of a fine foreman or superintendent and to engage him in a correspondence course in mining which he had prepared, and for which service he never asked (and never received) a copper cent in the way of compensation.

I was one of his special charges since he and my father had been boys together and were warm friends. Many were the hours Uncle Walton spent grooming me for higher things than loading coal. To him, J. T. Beard, and the late Prof. H. H. Stoek, of the University of Illinois, I owe most of my advancement in my chosen profession. Unselfish, modest, gifted—to them, the chief pleasure in life was found in aiding others.

Land at $1.25 an acre

Grandfather, being a thrifty man and a hard worker (and land around Alton being cheap), accumulated some property. My uncle, Henry Brayford, who came over at the same time, "dug" coal, as they termed hand mining then, and bought land at $1.25 an acre, owning at his death 2,200 acres of fine farming lands near Macoupin Station.

Men worked hard in those days. I remember, when a small boy, visiting Uncle Henry, who at that time was eighty-four years old. He arose every morning at four o'clock to help milk and then rattled over the rough country roads in his old spring wagon to the railroad, four miles away, in time to reach Macoupin Station before the daily milk train passed through. And Uncle Henry drove as he worked—helter-skelter, rush and go! His team knew his ways, and when we topped a hill and started down the other side, both horses broke immediately into a wild gallop with no thought of holding back on the load; and, as Uncle Henry scorned such things as brakes, the wagon rambled some. I remember his boasting to me one day that he could make better time on the road than anybody in the country. He said that he had a system of his own, which was to let a team walk up hill, but to give 'em h—— going down.

I was born in Shelbyville, Illinois, the same year John Rutledge first saw the light of day at Alton, but that is not saying I am going to give away his age to any quidnunc.

My grandfather settled at Wood River because there was cheap land and coal.

My father's name was John, but owing to a strong prediliction for bird dogs of the pointer breed, he was known to all his intimates as "Birder." In pursuit of his calling, he located at Bloomington, when I was small, and later at Minonk. He made a living digging coal, but he spent his leisure hours with his dogs hunting quails and prairie chickens. The Illinois prairies were simply alive with game birds. I can recall even yet the noise of thousands of prairie chickens at early dawn. They literally lined the fences and covered the haystacks. I was too young to shoot, but proudly carried the game, manfully struggling along under an ever-increasing load until the hunters would refuse to permit me to be burdened further.

Early mining by long-wall system

At Bloomington and Minonk, mining was carried on under the long-wall system. The coal was 30 in. to 48 in. thick; and no blasting of the coal was necessary the roof pressure being relied upon to bring down the "fall."

The manner of operation was the same as that employed throughout the district, the coal being left solid around the shaft bottoms for a distance dependent on the thickness of the cover. Through the solid pillar, main and air-course entries were driven, usually in two directions with the strike. These roadways were continued throughout the long-wall workings, brushing of the roof being necessary to maintain height when the roof subsided upon removal of the coal. The brushing was generally done in the roof, which was hard shale or soapstone, and this necessitated shooting, nearly always with black powder, but sometimes with 40% dynamite. The shale so blasted was packed in solid walls about 4 ft. to 6 ft. thick on both sides of the roadways.

From the main roadways, branch roads at 45 degrees were started at stated intervals, and others were turned from these on 45-degree angles to give each man a certain number of face feet in which to work. This was designated as a "room," the entire face, when fully developed, becoming a irregular circle, ever increasing in circumference. Mining was done by hand in the fire-clay bottom, and this clay was used to fill in the open spaces between the pack walls. A miner usually had about 25 ft. of face which he "mined" to a depth of about 30 in. with what was known as "mining" picks in contradistinction to "cutting" picks which had shorter and blunter points and which were used for coal cutting.

I was too young to shoot, but proudly carried the game.

The roof weight was deepened upon to assist the miner in loosening up his "mining," but woe to the man who "laid off" a day, because if his mining once got pinched he had his work cut out for him! After the face was cleaned up, the miner and his helper (who helped load the fall and who pushed the cars to the neck of the "room") started in on the mining, which was supposed to be completed by quitting time and then left over night for the roof to bring down. Sometimes, if water was handy, the miner would pour some along the face to soften up the next day's mining. The water compartment in the dinner-pail was always filled to capacity so that some water should be left for this purpose, but care had to exercised not to overdo it and cause the fire-clay bottom to heave.

The cover over the coal was from 300 ft. to 500 ft. thick and pliable enough to conform to the final setting of the pack walls without breaking, so that even under the Illinois River all coal was removed without a particle of seepage ever reaching the workings.

Usually the mining and brushing were not sufficient to fill properly all the space after the removal of the coal, so cogs of wood were constructed, these being made of timber pieces about 36 in. long, laid in the form of a square (or sometimes triangular) pillar with the middle filled with clay and shale.

All mining by hand

In those early days all mining was done by hand, and the Northern longwall field, known locally as the "Third Vein," was one of the most important in the state. Now it has been superseded by the thicker coals from the Central and Southern fields. Such mines as are still operating have been forced to put on modern dress, and some are now equipped with undercutting machines, conveyers, loaders, and every new appliance for the economical production and cleaning of the coal.

I don't know what year it was when my father left Minonk to go back to Shelbyville again, but I was quite small. I can recall two incidents that were impressed upon my mind during the time we were there: First, water became so scarce that everybody bought it from the coal company, which shipped it in oil tanks. The other important event happened when I saw some larger boys jumping over the board sidewalk on our main street. After they had gone, I took a good run and tried to clear the walk, landing about midway thereon, and running a huge splinter entirely through the fleshy part of my left heel. My yells quickly brought my mother to the scene, and she had to use her teeth to pull the splinter out. I also can recall being on the Illinois Central train going from Minonk, for I thought it so wonderful that all the fence posts were running to get behind our train!

We again settled in Shelbyville, and my father went to work at a mine owned by an Englishman named Richardson. Richardson's was a country or "local," mine, a designation given to mines that did not ship coal by rail, but retailed it to the local trade.

Shortly after this my father took us out to Mike Brophy's mine, about two and one-half miles in the country. Brophy was an Irishman about forty years old and a strong Democrat. My father had taken up the Greenback cause, and many were the arguments they engaged in, until, finally, Brophy was won over—a feat I have since regarded as speaking volumes for my father's argumentative capacities, for you must admit it takes something out of the ordinary to shake the faith of an Irish Democrat!

This was the year I first started to school—eight years old. At this time, I had one sister, two years younger than I was, and a baby brother, Frank. We must have stopped off in Indiana before this as Frank was born at Clay City, but of this period I have no recollection. We lived in a small cottage on the Brophy farm, which was on the Kaskaskia River, even at that time beginning to be known as the Okaw. Our home rested at the foot of a long hill, two and one-half miles from the school-house. My reluctant feet, that early September morn, dragged me finally out of sight of my mother's watchful eyes. About halfway lived another Irishman named Jimmy Kingston. His daughter, Minnie, and son, Willie, were waiting to guide me the rest of the way, for I never before had been so far from home by myself. I was late getting to Kingston's, and, of course, we were late to school. I had been told by my mother not to talk out loud or to make any noise and took what she said literally, with the result that during the whole of that first day, I almost choked forcing back coughs and sneezes.

Log schoolhouse

The schoolhouse was in a small clearing surrounded by woods on three sides and a cornfield on the other; and since all schools must have a name, ours was called "Dugout."

Our school on "Nubbin Ridge" was named "Dugout."

Most of the timber was post oak and hickory. The land was alkaline, of the kind usually found where post oak timber flourishes, and the neighborhood was known to everybody as "Nubbin Ridge," supposedly because of the stunted, ill-formed ears of corn grown. The school building had been constructed of hewn oak logs, the interstices plastered with lime and sand. It was a one-room affair with five corners, the fifth containing a huge wood-burning fireplace. It was part of the curriculum for the boys to keep its great maw plentifully supplied with logs. The seats and desks were "puncheon" which meant they were of sawed slabs of rough oak, and the seats had no backs.

The teacher was a tall man with a flowing gray beard. He lived in Shelbyville, five miles away, and walked the distance each morning and evening five days a week for the school term of six months. His name was Brigham Young. I remember him chiefly because of the name and because at lunch time, he always ate his pie first.

The Kingston children were the only pupils I knew, but I must have fallen into pleasant lines, for I could hardly wait long enough to get my breakfast before starting out the next morning, and forever after school was always the most pleasant spot on earth to me.

Fortunately for us the school building burned down the second week of school, and we got a new one of lumber with plastered walls, but it was still a "one-roomer." Instead of the fireplace there was a huge horizontal sheet-iron stove with a big door at one end. It burnt wood of "cordwood" size, which meant each stick was 4 ft. long and of indeterminate girth. Anything that would go through the door was permissible, and it was laughable to see some small shaver lugging in a stick almost his own size. Going after wood was one of the stock excuses to get out-of-doors, and it took a brilliant teacher to keep track of the "turn." If the miner's "turn system" for getting empty cars had been in vogue then, I am sure it would have been unanimously adopted by every teacher!

Learning the three "R's"

Pupils were assigned to classes according to age and previous progress, and recitations were in order from the A B C class, the first thing in the morning, to the grammar class, in the late afternoon. We had reading, writing, spelling, arithmetic, geography, grammar, and once in a while some over-ambitious teacher would ring in an extra course or two. I remember very distinctly one term of majoring in orthography and hygiene.

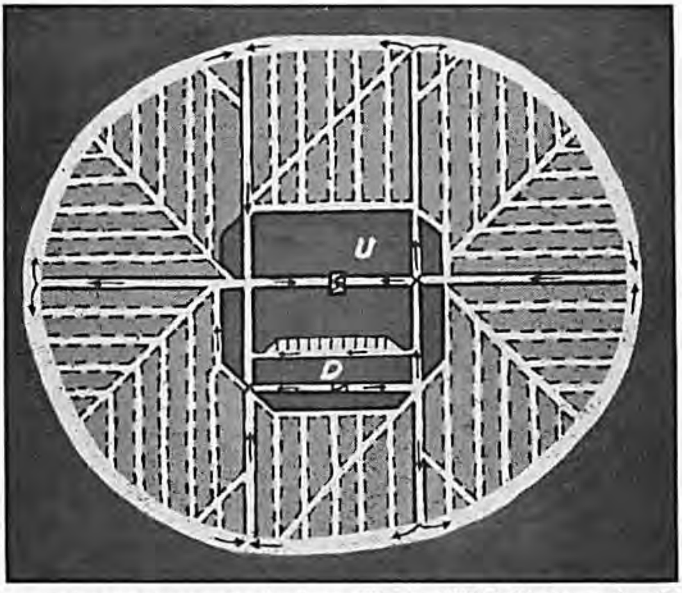
Spelling was the great classic, and every Friday afternoon was spent in spelling contests. All pupils of every grade were permitted to "spell." We lined up along the wall, and the teacher would "give out" from our old National Spelling Book until only one was left standing. The American Book Company had secured a strangle hold on our directors, so I am not one of those who can say he is a McGuffeyite. Our readers were Appleton's; our grammars, Harvey's; our arithmetics, Ray's.

Nothing exceeded the thrill I experienced over my new Congress shoes.

We became so proficient in spelling that the teacher had to resort to unusual means to down the class. One favorite way was to give out a sentence well known to all, and we had to spell correctly and in the right order, all words of like sound. One set of exercises began thus: "Deign to tell what can ail the Dane. He ate eight pears and drank ale," and so on for several pages. The words to be spelled were "deign," "ail," "Dane," "ate," "eight," and "ale"; and every capital letter, apostrophe, etc., had to be in its right place or down went Mr. Speller, pronto. On the last Friday afternoon in each month the teacher was accustomed to give a prize to the best speller, ruling out as ineligible previous winners. I was apt at spelling and early won a championship. I well remember, it was pouring rain, and the teacher tried to get me to leave the prize, which was a cheap print of *The Young Continentals,* until the next day, but I was so eager to show it to my parents I wouldn't listen, and, buttoning it under my thin jacket, I rushed home through the downpour, to the very sad damage of my beloved picture!

The semi-annual spelling match

Twice a year we had a spelling match with a rival school across the river, known as Maloney. They had some four or five famous spellers and were usually able to nose us out of first prize if they were fortunate enough to entice our one outstanding champion into going somewhere else on the night of the match. But if they couldn't get our man into the clutches of some of their vamps (coached to work for the honor of old Maloney), and he showed up, everything was over but the shouting. His name was Otho V. Leonard. He was thin and tall, and had red hair and the smallest feet I ever saw on a boy of his age. He wore No. 4 shoes and because of his small underpinning was not successful as a racer, but he could spell any word ever thought of—Latin.



Map of longwall mine in Northern Illinois. "U" indicates main shaft, and "D" indicates the escape shaft.

French, English—it was all the same to Otho— and we never lost a match when he was entered.

He was my special chum and intimate, and we could be found together on all occasions. Many were the happy day-dreams we had under the old apple trees. We hadn't much idea of what the future had in store for us, but on one thing we firmly agreed, and that was that when we got rich, the first thing we would do would be to buy all the Beadle Dime Novels in existence and have the finest library in the world! I don't know where Otho is now and haven't heard from him since I left old Dugout, but I do know that there are no Beadles on my shelves, and I hazard a guess that there are none on his.

During my Dugout school days, my father worked at Brophy's or at Richardson's, depending on which place operated on the best time. Generally, Richadson's in town, was the better place to make money, and he walked to his work and back home each working day. We had moved by that time from Brophy's house to a log house about one-quarter mile from Kingston's.

Kingston owned an eighty-acre farm which he worked during the summer months while he attempted to augment his meager income by digging coal in the winter. He was a runt of an Irishman with a bushy red beard and the finest brogue to which one ever listened. He was never able to accomplish the same amount of work as other men and did everything in the most awkward manner imaginable. My father was the most accomplished mimic I ever saw, and many were the hearty laughs we had at Jimmy Kingston's expense when Father would get under way imitating Jimmy cradling wheat or doing some other stunt.

Recollections of father's voice

Father was peculiar in that he could imitate the exact voice and mannerism of any person he ever saw and yet he could not sing one single note of the musical scale. This inability to sing was the more remarkable because of his gift for imitating other sounds. He could instantly reproduce the exact brogue and tone of voice of any man he heard, foreign or native, and he was a good judge of music; but when it came to singing, he just couldn't do it.

In all my life I have never known but one other man who was totally devoid of this singing sense, and, strangely enough, he was a brother-in-law of Jimmy Kingston, with whom he lived. His name was Pat Hickey. Pat was a raw-boned Irishman about ten years older than I was and a great flirt with the ladies of our district. It was considered good form in those days to improve oneself by joining the winter singing school, annually conducted at Dugout on Friday nights by some of the "high-brows" of Shelbyville who found the need of adding some extra dollars to the old bank account. Pat was always one of the very first "patrons" and lifted up his voice in loud if not musical cadences at every session. One winter, by some hook or crook, I know not how at this distant date, I raised the necessary dollar and a half and joined. I remember one beautiful fall evening when we were walking home that Pat suddenly tore the air wide open with a series of sounds resembling a steam calliope, and, turning to me, he said, with quite evident self-satisfaction: "Well, Oscar, I have the old scale down pat at last!" meaning he could now sing the musical scale of eight notes perfectly!

But I would have seen good in anything in heaven or earth just then, for father had that day bought me a new pair of shoes! I have a picture of myself at the age of three in velvet dress, gold finger-ring, and red top boots with copper toes, of which I must have been inordinately proud; but nothing I can now recall exceeded the thrill I experienced over the shoes I wore that night. They were of a new design, without laces or buttons. The sides had insets of black elastic, which, while new, fitted snugly to the ankle, but after the rubber had decayed, the appearance was anything but neat. They were known as Congress gaiters and cost five dollars.

PART II

The coal seam in the vicinity of Shelbyville is about 20 in. to 26 in. thick and is classed geologically as No. 16, although some authorities name it No. 14. It is hard, black, clean, and blocky. At regular intervals of about 18 in., prominent micaceous faces parallel each other throughout the seam, and places working at right angles to these faces were said to be "on the butts." The coal was 80 ft. to 125 ft. below the surface and was reached by a single shaft which was partitioned off at one end for air. All workings were single entry with rooms turned from each side, and curtains were depended on to force the air current to the face of the rooms. Ventilation was obtained by keeping a powder keg full of burning coals at the foot of the upcast. Rooms were driven in until the air became so polluted a miner had to give it up and start at another place. Because of the poor ventilation no shooting was done except in rare instances, and only pure lard oil was burned in the lamps, as it made less smoke. The lard oil cost $1.50 a gallon and was purchased at drug stores. Carbide and electric lamps were unheard of.

All coal was undermined by hand in the fire clay and each rib cut from the top to bottom to the full depth of the mining, after which steel wedges were placed from 4 ft. to 6 ft. apart over the coal and driven in with a specially made sledge until the coal fell. These sledges had long tapered shanks of iron not much more than 2 in. in diameter at the handle, with steel faces, tempered to withstand the hard pounding against the wedges. As the fall would spring down several inches before giving loose, especially if on the "butts," the wedges would sometimes be driven some distance beyond the face and could be reached only with sledges such as those described.

Mining as deep as a pick handle

Mining was done in the fire clay, which was soft, the picks used being long and tapering with duck-bill points. The handles were of hickory or pecan, and from 30 in. to 32 in. long. A "mining" was supposed to be as deep

Ventilation was obtained by keeping a powder keg full of coals burning at the foot of the upcast.

as the handle was long, for which it served as a measuring stick.

With only about 2 ft. vertical space in which to work, the worker, naturally, had to recline on his side, and he had to learn to be ambidextrous. No man was considered a first-class miner who could not mine and cut both left- and right-handed with equal facility.

Each miner received $1.00 a ton for coal delivered to the shaft bottom. He hired his own helper, called a "pusher," if he was so unfortunate as not to have a boy of his own big enough. No attention was paid to child labor laws, and possibly there were none. A boy went to work as early in life as his father would let him. I never knew a boy who did not look upon his father as a hero and who was not anxious to emulate him. And, too, most boys preferred to push coal than go to school.

"Pushing" coal was an exact science. The pit cars, holding about a thousand pounds, were about 4 ft. by 6 ft., mounted on 8-in. wheels; they had no side boards. The track consisted of 2-in. by 8-in. planks with a 1-in. by 3-in. strip nailed to them on the inside in lieu of flanges on the wheels. There were no switches, the cars turning on flat steel sheets.

When a fall was wedged down, it came in an almost solid piece, which the miner proceeded to break up into large slabs and shove to within reach of the pusher who loaded it on the cars and pushed it to the shaft bottom. There he found an empty car awaiting him, or if the car had not yet been returned, he waited for it to descend, and, the shaft being only 100 ft. deep, if it did not appear when he thought it should, the top cager was told in no uncertain language just what kind of a man he was.

The cars had iron loops on each side at the middle, and the pusher removed the empty car from the bottom landing and substituted his loaded one by hooking the chains, which were attached to the lower end of the hoist rope, into the loops. He then yelled at the top of his voice, "All ready, hoist away!" The top cager answered by calling back, "Hoist away!" and the cage was lifted about 4 ft. and held there while the car was steadied by the pusher until he thought it was all right, when a second signal of the same character was given, and the car was hoisted to the surface. No guides were used in the shaft, and the 1½-in. hemp rope to which the bottom chains were attached let the old car spin as merrily as it pleased.

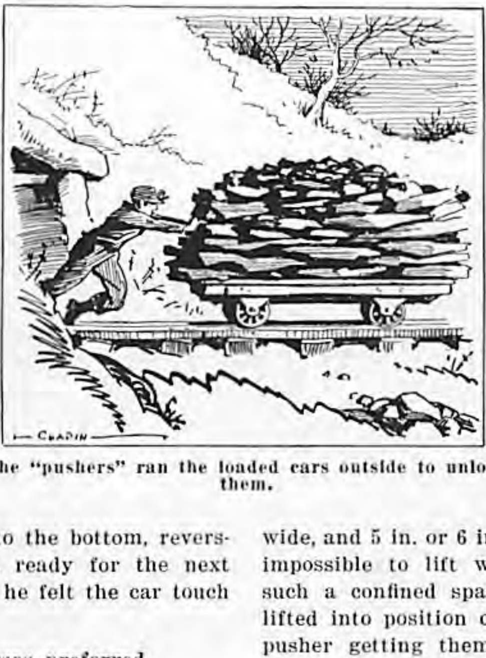
The worker had to recline on his side, and he had to learn to be ambidextrous.

The "hoist" was invariably a blind horse hitched to shafts which were attached to a long "sweep" extending out from the drum on which the rope wound and unwound. The drum was vertical, and about 6 ft. in diameter. When the loaded car reached the surface, the cager dropped two doors over the shaft with a loud "Bang," which was a signal to the horse to halt and back up until the car rested on the doors. Here the horse rested until the cager had removed the load and substituted an empty, when, at the cager's command, he raised the car high enough to permit opening of the doors, when he immediately turned the shafts in the opposite direction and lowered the car to the bottom, reversing his position, ready for the next hoist the instant he felt the car touch bottom.

Blind horses preferred

A blind horse was used in preference to one with sight because a horse who could see would begin to back up the moment he saw the car appearing above the surface and before the cager could lower the doors. A blind one, on the other hand, always waited for the sound of the falling doors before backing. It took about five revolutions of the drum to raise a car 100 ft., and the horse traveled about 260 ft. at the end of the sweep, which, at 3 mi. an hour, required one minute a round trip; allowing for changing cars took, perhaps, five minutes.

As before explained, the cars had no side boards, having only a flat oak bottom, so the sides were built up of the long slabs of coal with the small amount of "fines" thrown in the center. By inserting a thin steel wedge, the large chunks could be split up into thin, plank-like slabs. Often these slabs were 4 ft. or 5 ft. long, 18 in. wide, and 5 in. or 6 in. thick—a weight impossible to lift while reclining in such a confined space—so they were lifted into position on the car by the pusher getting them on his leg and using this as a lever.



The "pushers" ran the loaded cars outside to unload them.

Pushers became very adept at loading, and there was great rivalry between them, it being something to boast of if one pusher beat another to the bottom and deprived him of his turn.

Entrance to the shaft bottom was by a pole ladder suspended at the top from a long iron rod laid across one corner. These poles were spliced for length, and the rounds were wooden pins driven into 2-in. auger holes, 2 ft. apart, the pins projecting about 8 in. on either side of the pole, which hung loose in the shaft.

We younger chaps could skin up and down these crude vertical ladders with incredible speed, and often became so adept that even this means of descending was too slow, and we would wrap a leg around the hoisting rope and slide down. This was great fun and worked fine unless there happened to be ice on the lower end of the rope, when all control was lost, and the victim struck the bottom with enough force to know something had happened.

Brophy's mine, Shelby County, Illinois. A gin hoist and blind horse for the motive power. In the foreground, left, is the loading platform. Note the loaded mine car to the right of the shaft. The gin sweep with the horse in the shafts can be seen back of the car. The drum is above the men.

Jimmy Kingston was the bruut of all our jokes, and it was a poor day's work when at least one funny event was not recorded at his expense. Bill Helton was our chief jokester. One cold morning Bill slid the rope and struck about 20 ft. of ice which precipitated him to the bottom with stunning force. Jimmy saw him start and concluded that it was too cold to skin the pole so he called down, "Faith, and how is it, Bill?" Without an instant's hesitation Bill replied, "Fine, Jimmy, come ahead"! Needless to say, the result was not what Jimmy had been led to expect!

On another occasion, Bill, on the way to work, killed a long green snake. He hastened to the mine and suspended it inside the leg of Jimmy's pit pants. (We always washed and changed clothes at the mine.) Reaching the mine a little late that morning, Jimmy hurried to get into his clothes, and when his bare leg came in contact with that cold snake you can imagine the results!

Work around Shelbyville became slack, and father, now about 36 years old, was an operator for the first time. He leased a small mine at Fancher, 14 mi. south of Shelbyville. Here the Shelby County coal outcropped in a ravine east of the town. It was my first experience in a drift mine.

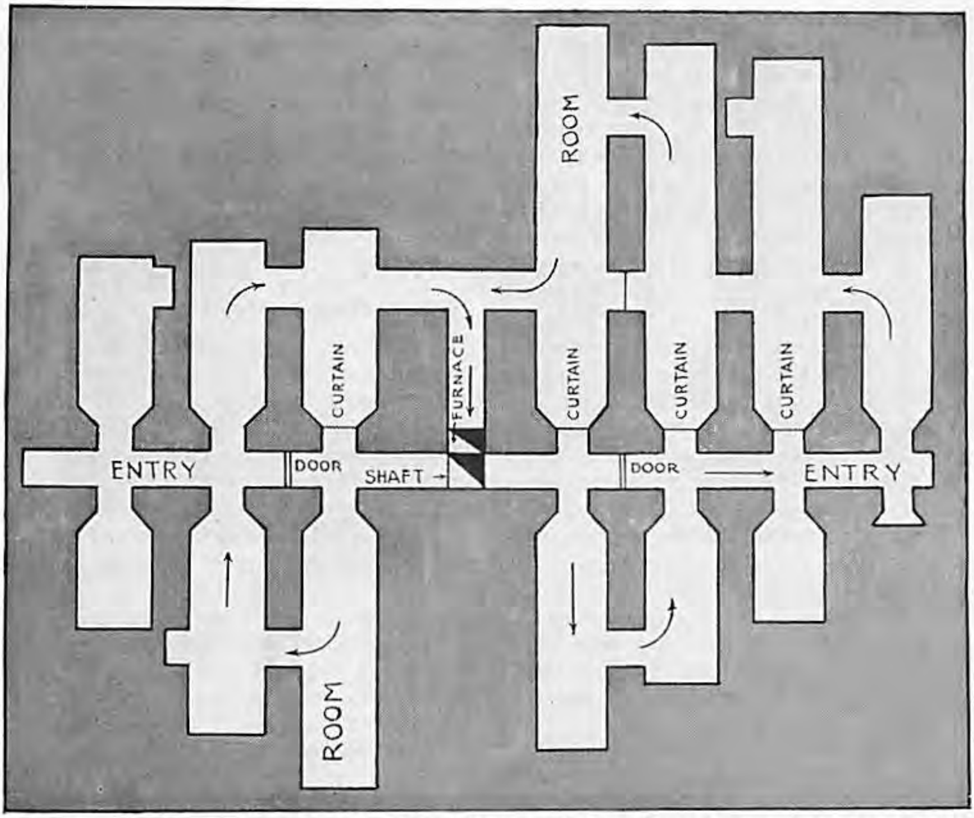
Drift mining

Mining was carried on in the same manner as at Shelbyville except the "pushers" ran the loaded cars outside to unload them. The coal was piled on a large wooden platform where it was loaded into wagons by the customers themselves. We furnished the shovels.

Our busy time was in the fall and winter. Farmers came from 25 mi. to 30 mi. around to get threshing coal and to lay up their winter requirements. We employed all the men we could, yet were never able during the rush season to keep a supply ahead, and we had to adopt the rule of "first come, first served." I have counted as many as twenty wagons at one time, waiting in the yard at four o'clock in the morning.

Father remained outside, overseeing the loading and collecting for the coal. All transactions were cash. The mining scale was $1.00 a ton, and the price to the consumer was $1.50. We had no scales so each load was guessed, the purchaser having to take our word for it as to the weight.

No regular hours were observed by the miners, each man coming and going when he pleased. I helped my uncle, Jack Yarbrough; and it was nothing unusual for us to be at the



A single entry system using one shaft only, which is partitioned through the middle; one side for hoisting and ingress and egress, the other for furnace ventilation. Such air as existed was directed throughout the mine by doors and canvas curtains. In summertime practically no air circulated.

mine at four in the morning, remaining until dark, whenever there was an extra influx of wagons. We did our best, but I have since wondered at the patience of some of the farmers who, after driving 20 mi. or more, were compelled to wait often until two or three in the afternoon before their turns would come to load.

Father was doing fairly well, and I, with my brothers and sisters, was regularly attending school. There then were six living children, four boys and two girls, none large enough to work except me. Father was elected justice of the peace, and I assisted him with the books. He was also a member of the school board. Besides what help I was giving him, I was making up the time sheets and payrolls for the local section foreman, who could not read or write.

One summer I worked as a section hand on the railroad. This was the year the Clover Leaf Railroad was converted from narrow gauge to a standard track. Several months' preparation had seen new ties and heavier steel laid down, and the entire track from Toledo to St. Louis was widened in one day. It was on Sunday, and I can recall how everybody was thrilled when the big new locomotive and one or two private coaches passed through, loaded down with officials of the road.

Widening a great railroad to standard gauge is interesting work. First, we had to put the drainage ditches on each side far enough out to give proper clearance and then lay larger and longer ties and ballast them with crushed stone. Next, we replaced the 56-lb. rails with 90-lb. ones, after which we drove the outside rows of spikes about half way in to the standard width. Each section crew along the entire line was doing this preparatory work at the same time.

When all was ready, the big day came when every foreman mustered his gang, put part of them to yanking the narrow track's spikes and the other to shoving the rails over against the spikes previously set on the outside, while still others pounded them home and set those on the inside. Orders went out from headquarters that every boss must have his section finished before quitting time, and all did, much to their credit. It all sounds easy enough, yet the amount of planning and work necessary to do it was stupendous and required two or three years' time.

When I was nineteen and Frank fourteen, father contracted a fatal malady. Our mother, being afflicted with a slowly-growing deafness, was very sensitive and retiring. Frank and I found ourselves with a family to support and educate. There was nothing for us at Fancher. Our grandfather, then dead, had married the second time, and his widow was residing at Gillespie, Illinois. Through her influence and that of our Aunt Mary Brayford, father's sister, Alex Butters and Johnnie Craig, retired mine foremen and former friends of grandfather, got us jobs at the mine there.

Back to the Mines

We arrived at Gillespie late one afternoon and early the next morning reported at the mine for work, fortified with an introduction to the foreman, C. J. Ramsey. This was in the days before there were any labor organizations, and Ramsey was the czar. He was of the old bulldozer type, and he counted that day lost in which he had not discharged at least one man. He was my first "boss," and, to a green youngster who, up to this time, had never had to come in contact with men of this kind, it was a trying experience. Young men of today have but little conception of the autocratic, domineering "boss" of that period. It was the generally accepted theory of coal operators that a mine foreman must be rough-and-ready and a "cusser" of more than average ability. His word was law, and from his decisions there was no appeal.

This type of foreman and the exceedingly low wage paid was the direct cause of the later powerful miners' union, which, even then, was in course of transformation from what was known as the Knights of Labor of my father's day. I must say in passing, though, that under Charlie Ramsey's rough exterior beat a heart of gold, which years of service under him taught us to know and respect. I have had many "bosses" since then, but he was the best in general all-round ability I ever knew.

The mine, a shaft 360 ft. deep, was on the eastern border of the town. The coal was No. 6, 7 ft. and 8 ft. thick, with a very bad soapstone roof about 20 ft. thick to the first limestone. Some 12 in. of top coal was left up in mining, which made a safe overhead for about three months when it would break, and as soon as the air came in contract with the soapstone, the roof would begin to cave. The workings were room-and-pillar of the simplest kind. Entries were 9 ft. wide, and from the mains, which ran north and south, cross-entries were turned both ways. Rooms were holed into each other, resulting in several pairs of entries being connected. This played havoc with the ventilation and made it difficult to control fires, of which there was no end.

The mine was considered very modern, and was equipped with machines for undermining the coal before it was shot down. These were actuated by compressed air, which was delivered through an intricate system of piping from a compressor, located in the engine room on the surface. The coal was hard and had plenty of sulphur balls in it, and the mining was made in the fire-clay bottom. This was thrown back in the gob, and, together with the pyrites and pieces of coal, made the prettiest combination of elements for spontaneous combustion imaginable. Nearly every room developed a fire, so men were regularly employed in digging trenches through the old gobs, exposing it to the atmosphere, to prevent the generation of too great heat.

With the exception of one overcast at the shaft bottom, the air was directed throughout the mine by doors and board stoppings. These stoppings were usually plastered at the cracks with yellow clay, which soon dried and fell off. Ventilation at the working faces was terrible. There was no marsh gas, but the many smoldering gobs were prolific in throwing off carbon dioxide. Oil lamps were used, but there the oil was not rendered from pure lard such as we had burned at Shelbyville but was made from cotton seeds, and smoked like a furnace. About this time, the Standard Oil Company tried to introduce a solid paraffin substance called "Sunshine" as a substitute. This preparation melted from the heat generated by the flame. It made less smoke but required a special make of lamp in which to burn it. After a short period of popularity, it fell into disuse, and the old oil-burning lamp came back into general favor.

Paid 12½c a car for loading

The workers were classified under five general headings: machine runners and shovelers, loaders, timbermen, track layers, and pipe men. All were paid a day rate except machine men and loaders. The machine runner got one cent a square foot for undercutting and his shoveler three-fourths of a cent. Loaders were paid twelve and one-half cents a car! The cars were supposed to hold about 1,700 lb. each, but actually averaged over a ton, for each one had to be topped a full 12 in. or better, or the loader was docked the entire car.

Frank and I were placed as loaders with experienced men. Neither of us had previous experience in drilling and shooting, it being our first introduction to thick coal. The loader was required to timber his place, drill and shoot down the coal, and lay his own track, which consisted of 2-in. by 4-in. scantlings spiked to hewed ties. And remember, that all this was gratuitous on the part of the loader. He was a fortunate mortal who had been given the opportunity of throwing in this extra work!

Our father was rapidly sinking so we returned to Fancher. There he died, July 18, 1890.

After a period of adjustment, we went back to Gillespie, taking the entire family with us. Frank and I again resumed our work at the mine. Loading coal was hard work so we aspired to something easier and better, and I hit Ramsey for a machine shoveler's job—machine runners being the aristocrats of the industry. I was given a run in "The Dip." Every mine has its one undesirable place where unfavorable conditions make it a hard place in which to work. Newcomers and greenhorns are always initiated in these places. "The Dip" was one of them. The coal pitched to the northwest at about four per cent, and the mining was so hard, it was practically impossible to keep a runner on the entry. I had several runners in the next few weeks but did not quit myself as these vacancies gave me opportunities to mount the board and practice running the machine, for I had resolved to become a runner.

The machines, mounted on two wheels, consisted of a cylinder in which was an air-actuated reciprocating piston which protruded through a sleeve at the front about 3½ ft. At the end of the piston was a removable fish-tailed bit, and the force, speed, and direction of the strokes were directed by the operator who held to a handle at the rear end. The machine was operated on a reclining platform, called a "board," which pitched toward the coal. This kept it against the work, assisted by a chock held against the left wheel by the operator's foot. Power was provided through a flexible hose from an air pipe carried in the place. These were "Harrison" machines, manufactured by the George D. Whitcomb Company, and known to every miner as "camel backs," because of a very high hump in the middle. The weight was about 400 lb., and they made an undercut about 14 in. high at the front, tapering to about 3 in. at the back, and 4 ft. deep. There were about thirty of these machines and eight or ten of another type, much longer and lower, which made an undercut about 5 ft. deep and were called "whippoorwills" because of the peculiar screeching sound made by the exhaust. Each machine crew had a given "run" and enough loaders to keep them busy.

Walton Rutledge, of whom the author wrote last month: "I owe most of my advancement to him." His son is Dr. J. J. Rutledge, chief engineer, Maryland Bureau of Mines.

Running a machine was a very scientific operation, and some men became much more adept at it than others. The foreman "measured up" every two weeks by taking the distance each place had advanced times its average width. There was great rivalry between the topnotch runners to see which would have the biggest pay.

Certificates of competency necessary

I had not been shoveling on "The Dip" very long before a square-set Frenchman, named Jules Greisey, was sent in as runner. He proved to be a master operator, and on a "run" which had hitherto been a joke he began to turn out more yardage than any man in the mine. Jules was a big-hearted chap and soon began to teach me the finer points of the game. Upon his recommendation, Ramsey gave me a "run" and it was not long before I was considered one of the three best he had.

It was while running a machine at this mine that I received my only injury during my long years of mining. I was making the last cut through a crosscut when the entire face of the coal suddenly rolled forward, driving the machine through the "board" and my left leg with it. The leg was broken in four places, but careful surgical attention brought it out all right and nobody can at this day tell that anything of the kind ever happened.

All this time I was continuing with my studies. I took a course in mining engineering and in addition carried on studies in Italian, commercial drawing, shorthand, bookkeeping, and higher mathematics.

Our state legislature passed a law which required that all mine managers, mine examiners, hoisting engineers, and state inspectors should obtain certificates of competency before they could serve as such, so I went to Springfield, appearing before the state mining board, to be examined for a mine manager's certificate of the first class.

PART III

The board was composed of five men one of whom, by law, had to be a mining engineer, and another, a hoisting engineer. It also consisted of Richard Newson, president; Patrick McCann; James Taylor; Hugh Murray, E. M.; and Cochran Johnston, hoisting engineer.

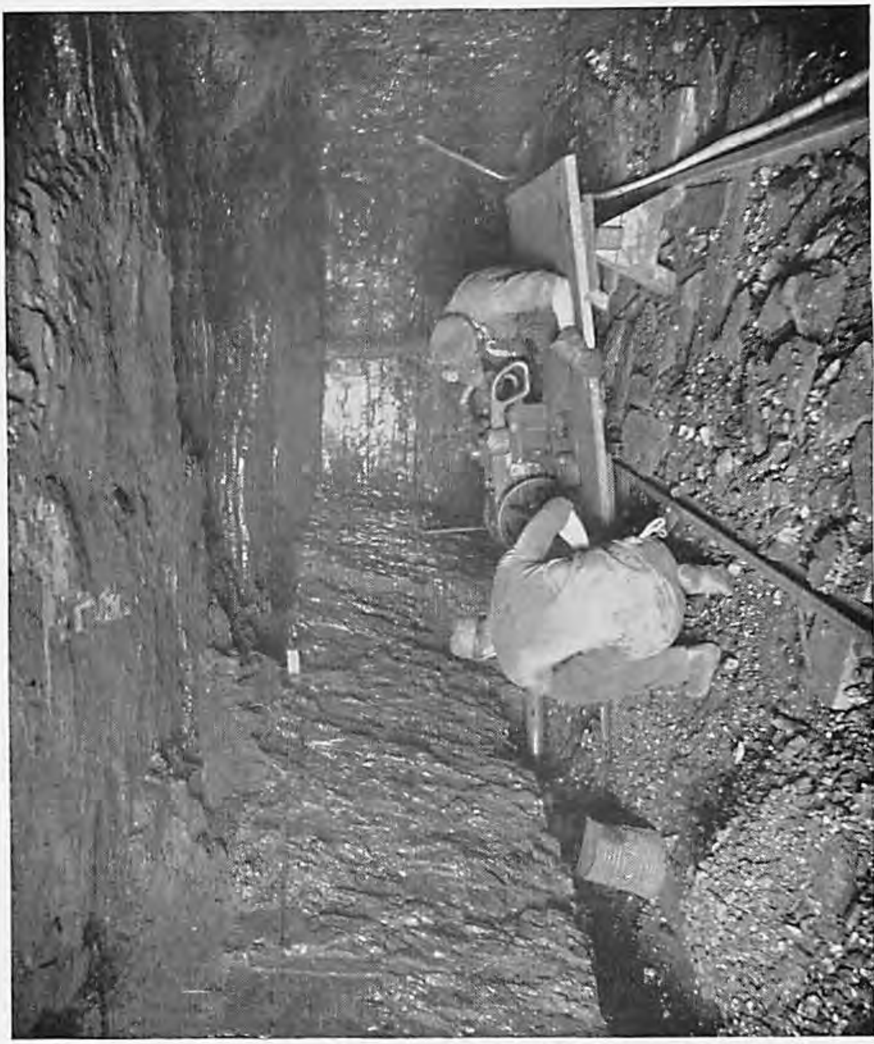
I didn't know a soul and had no idea how such examinations were conducted, but fortune favored me and I was one of the thirteen, out of forty applicants, who passed. In due time, I received from the board a certificate which set forth that I had been examined as to my citizenship, technical knowledge, and practical experience in coal mines. It certified to my fitness to perform the duties of mine manager and declared that I might be employed lawfully as such in any coal mine in the state.

Four feet or eight feet?

About this time some business men of my acquaintance, residing at Raymond, organized a company and decided to sink a shaft. About ten years before, the citizens of Raymond had employed a well-driller to prospect for coal. He drilled through a seam at a depth of 444 ft. and pronounced it 44 in. thick. The town folks, observing a black, coal-like appearance to the drill cuttings, said there was 4 ft. of coal unreported, and declared the driller had been bought off by the Litchfield Coal Company. This belief was strengthened when certain ones collected a portion of the drill cuttings, dried it, and found that it burned quite freely. During all these years the belief prevailed that there was 7 ft. of coal, and finally the gentlemen I mentioned, four in number, screwed up courage to prove the thing.

Instead, however, of using a core drill to make the test, they started a shaft.

The work was carried on in three eight-hour shifts. I had charge of one, Robert Campbell another, and Louis LaDassie was the third man. Sinking was through shale and three or four thin strata of limestone, and it was so remarkably free from water that we had to send the water down from the surface to have enough with which to drill. We reached coal in one hundred and eleven days and found it to be exactly as the driller had reported. The supposedly 4 ft. of unreported coal proved to be bituminous slate. I consider it somewhat remarkable that a man could, at that depth, with a churn drill, so accurately gauge the thickness of a seam of coal, especially when di-



Undercutting punchers—forerunner of the modern cutter bar.

rectly overlaid by a material so nearly the same color and hardness.

Finding this thin seam completely took the wind out of the promoters' sails, and all but one man threw up his hands and quit. Frank Todt assumed the indebtedness and proceeded to operate. "Bob" Campbell and I were employed to manage the property jointly, but after a few months Bob resigned and I was put in complete control.

The coal was clean, of good quality, and had a remarkably fine roof. I laid out the work after an old English system, using "puncher" machines with which to mine the coal. Butt entries, 500 ft. apart, were driven from the mains, and from them places 20 ft. wide were worked through in pairs at 100 ft. centers. After these rooms had holed through from one "butt" to another, they were widened by taking slabbing cuts from the ribs until the roof would no longer stand up.

$100 a month

We had a large wagon trade and, also, shipped considerable coal. Mr. Todt made a proposition to me, which I accepted—that, in lieu of a straight salary, I was to get $65.00 a month and one-third of the profits, but the total was to amount to not more than $100.00 any one month, which was a princely salary for those times.

Silas A. Shaeffer, schoolmate of the author's mother, and famous mining figure.

I boarded at the home of one of the leading citizens. The table fairly groaned with good things to eat, and my room and meals cost me the huge sum of three dollars a week!

We operated six or seven months under these changed conditions and I was drawing my maximum compensation regularly. But Todt was offered a farm by some coal men in trade for the mine, and he accepted. This left me without a job and I returned to Gillespie, taking a job as machine runner again.

Charles Ramsey had gone to Staunton, and Henry Keiffer was mine manager and F. E. Weissenborn, superintendent. Mr. Weissenborn was the brother-in-law of the general superintendent, J. P. Hebenstreit, and a mighty fine man. He remained at Gillespie for several years; was promoted and transferred to Staunton; and is now commissioner for the operators in the Belleville district, with headquarters at St. Louis.

It was while running a mine here that my brother Frank and I conceived our first invention. The puncher machines, as before mentioned, carried a removable fish-tailed bit for doing the cutting. These bits were placed in the machine with the points in a vertical position, and in hard cutting there would be formed what was known as "pockets," although, to be exact, they were the very reverse, as the pick would slip sideways, causing sharp ridges or points to form that would be very hard to cut out, and reducing, therefore, the cutting speed.

One day, while having trouble with one of these "pockets," I said to Frank who was shoveling for me, "All we need, to do away with trouble, is to have some means for turning over the picks so that the points will be horiztontal and straddle the ridge."

He said, "Well, let's make a machine that will do it."

The master mechanic at the mine, George Wright, was a pretty fair mechanic so we discussed the problem with him, resulting in the invention of a device that would do the trick. It was accomplished by extending through the rear plate a portion of the piston, reduced to one inch in diameter to which was fitted a short lever and ratchet segment which permitted the operator, at will, to give the piston a quarter turn and lock it in position.

Dear to our hearts are the fond memories of "Four Plank"—favorite promenade of the town's lovers.

There was a small machine shop at Bunker Hill, 10 mi. from Gillespie, operated by the mayor, a man named Richards. He was about sixty years old and reputed to be worth at least half a million dollars, which, at that time, was an immense fortune. We interested him in the invention and contracted to him the exclusive manufacturing rights. He was to make ten experimental machines which we were to place in the mines on trial. The first one turned out was tried in the Bunker Hill Mine where Harrison machines were being operated, and it was a great success. We could cut rings around the other machines. The other nine were about completed when Richards was shot and killed by the editor of a local paper. It developed that the mayor's supposedly great wealth was not his but belonged to his ward, and our machine business fell flat.

Out went the puncher

We attempted to sell the patent, which Frank and Wright had taken out jointly, to the Sullivan Machinery Company. J. W. Mitchell, at that time a leading expert in mining machine circles and, by the way, an uncle of Mike Mitchell, now in charge of the Sullivan Company's St. Louis office, was sent to look it over. He told us that his company had been experimenting for over two years with an improved puncher, and, while ours had merit, they could not afford to scrap what they had and take up ours. Shortly thereafter, the well-known Sullivan puncher machine was marketed and proved a great success. But the popularity of the "puncher" type of machine was to be short, as there was soon to appear the "chain breast" undercutters operated by electricity. Our ten machines are still rusting somewhere at Bunker Hill, so far as I know.

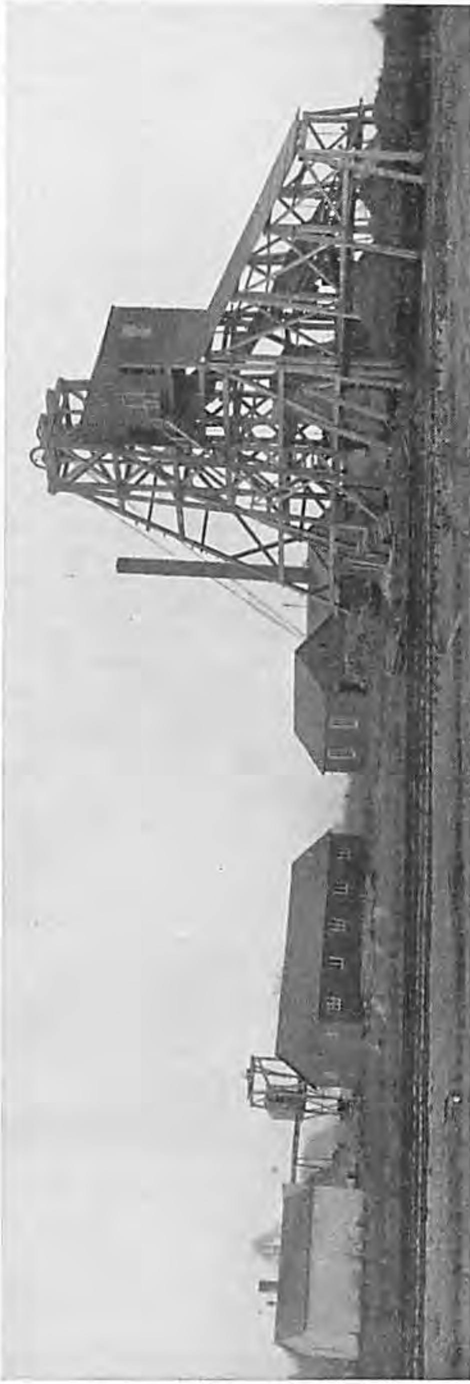
When the mine examiner resigned, the local miners' organization recommended me to the general superintendent, J. P. Hebenstreit, for the place. I was accepted and served for fourteen months.

Mr. Hebenstreit was a man of remarkable energy and ability. He remained with the Consolidated a number of years, later going with Rutledge and Taylor to Livingston and from there to their Nokomis Mine, where he died. His sons are still at Livingston where one of them is general superintendent.

Silas Shaeffer, an operator at Assumption, became interested with others in a new mine at Johnston City. He had been a schoolmate and lifelong friend of my mother; had taught school; went into mining; and was then, and is yet, one of the best-known men in the industry. I applied for the job of mine manager and got it. This was my first position as manager of a large operation, but before saying farewell to Gillespie for good, I wish to relate an incident which goes to show what bull-dog tenacity of purpose can accomplish.

When I first saw Gillespie, it was a small village of about six hundred population. The streets were "paved" with cinders hauled from the mine, and all the sidewalks were made of boards laid lengthwise. These walks were known to the citizenry as Two-plank, Three-plank, and Four-plank, depending on the number of planks the walk was in width. Four-plank extended through Main Street to the cemetery a half mile south of town and was the favorite promenade for the town's lovers. I had early fallen in love with a charming girl whom I later married, the daughter of a physician, Dr. T. W. Floyd, and dear to our hearts even yet are the fond memories brought to mind when we think of our Four-plank and the happy hours we spent upon it. The modern Gillespie is a thriving city with four large mines, paved streets concrete walks, electric lighting, and other conveniences, and but few of its citizens can recall to mind its former state.

But to get back to what I started to tell about "tenacity of purpose": The old mine had been owned and operated by S. H. Dorsey, who through



The New Virginia Coal Company, Johnston City, Illinois, of which Mr. Cartlidge became manager in 1900.

some cause, lost control of it. Mr. Dorsey conceived the idea of taking options on the surrounding acreage and promoting another large operation. He secured options on a large tract for a year but failed in his objective. He was well known to all the farmers thereabouts and periodically would again go out after options, which they would grant without any down payment. Shreve would fail in his attempt and again would renew his options.

This optioner won

He kept this up, off and on, for nearly twenty years, until it became the standing joke of the community. But finally he got in touch with Marvin Hewitt, president of the Northwestern Railroad, and sold to his company somewhere around 40,000 acres at a fine profit. When the farmers were notified to deliver their abstracts to the local bank and get their money, not one of them would believe it. Finally, a German farmer shuffled shamefacedly up to the bank window and asked the cashier if Dorsey did really have any money on deposit there for the purpose stated. He almost expired when told "Yes," and that started a stampede right.

to Johnston City as manager of the New Virginia Coal Company so had no part in this development.

Johnston City was a small hamlet of about five hundred inhabitants, and was called Lake Creek by the postoffice department. It was divided into east and west sides by the creek, the principal business houses fronting one street on the east side, with the better residential section on the west. It formerly had the reputation of being the toughest town in Illinois, but when I went there in 1900 there could have been no better behaved place.

As I have already stated, the New Virginia mine was owned by the Assumption people. The coal was 7 ft. thick and had a soft draw slate 2 ft. to 4 ft. thick between it and the sandstone, making it a difficult roof to control. It was also a very wet mine. It was a hard customer for a new man to make good with, but I pitched in with the vigor of youth and inexperience and did well. J. M. Seymour, now a well-known and highly respected operator in the Franklin County field, was superintendent. Mr. Seymour had laid off the bottom plan before I took charge. It was the typical southern Illinois layout which provided for cag-

A puncher of the type described by the author. The drift pin on the board was used for loosening the pick.

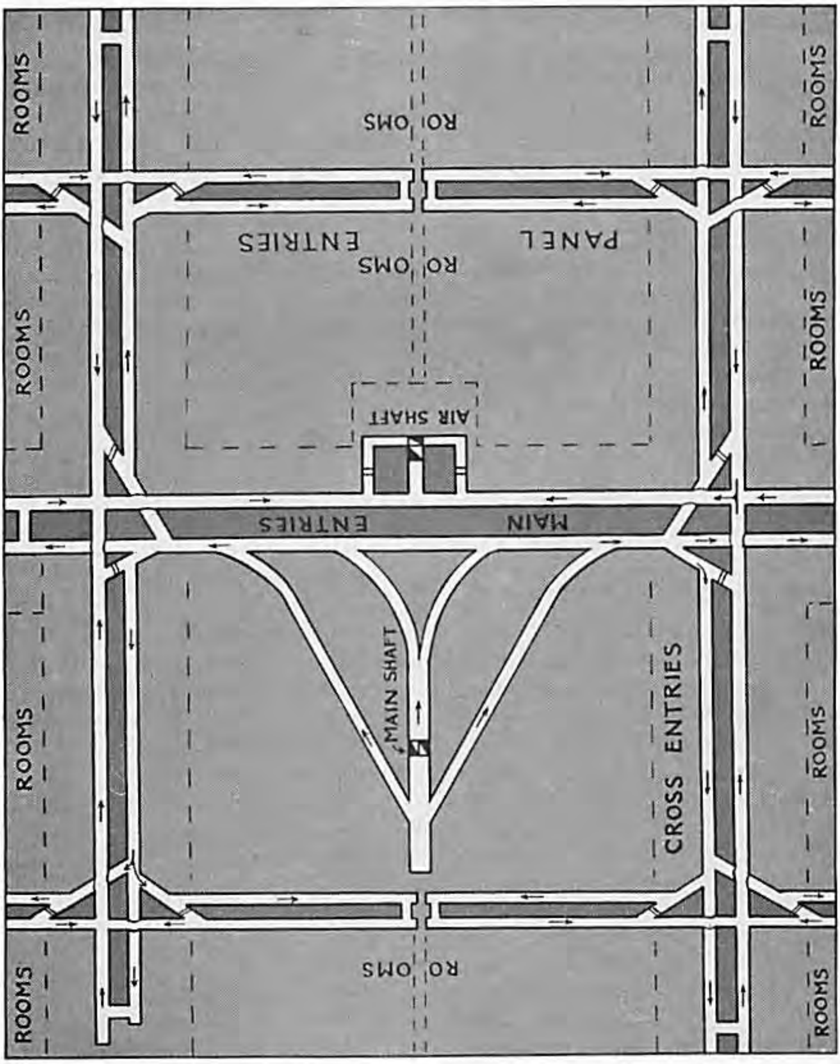
This unchanging purpose of Mr. Dorsey's resulted in a new Gillespie; four mines with a daily output of 20,000 tons; the building of the city of Benld and several smaller places; and made Dorsey a rich man. But I had gone

ing the loads on one side only, the empty cars being butted off the cage by the loaded ones, and gravitating by a back switch arrangement to side wings connecting with the main entries, where the mules picked them up to be taken into the working places.

It was a rapid and cheap system for use with self-dumping cages. I do not give it as authoritative, but it is commonly conceded that the credit for this invention belongs to "Uncle" Walton Rutledge.

Later developments improved this bottom plan until it finally reached the point where increased caging speed demanded mechanical means for moving the empty cars fast enough to clear each other, and this was met by the Holmes device, produced by Holmes Brothers, Danville, Illinois. This new device lifted the cars straight up by compressed air and sped them down a steep incline to the gathering points in the wings.

Caging cars by hand, also, became too slow, and there came into use in the larger mines a device known as



A semi-panel system with "Y" bottom, such as was used at New Virginia mine. The loaded cars came to one side of the shaft and the empty cars gravitated to the wings on either side.

the "Nolen Cager." This machine released a car by the action of the descending cage, and caused the loaded car to push off the empty one, while, at the same time, another load was advanced and held ready for the next cage.

To cage 6,000 or 8,000 tons in an 8-hr. shift meant three or four cars a minute, and the bottom cager would ring off quite often before the load was on the cage. Sometimes the hoisting engineer would be too quick for him, and the car would be caught under the bottom bulkhead, in which event it would be demolished. However, it was considered better to have an occasional wreck than to lose caging time. The larger mines, also, employed a double crew of hoisting engineers during caging time. One man would hoist an hour and then be relieved for the next by his buddy. No one man could be trusted safely to stand the strain of a straight 8-hr. shift at the throttle; neither could he maintain the necessary speed. Practically all hoists were operated by steam, of which the Litchfield and Danville, named after the cities where they were built, were the best known, although the Ottumwa, also, was fairly well established.

When railroad cars were scarce

The old-timers will recall the system of allocating cars then in general use by the railroads and can believe that this one job alone was enough to keep any man's time well occupied.

Our railroad had a car distributor at Marion, and every mine in the district had to call him each evening by telephone, saying how many cars were needed for the next day's run and giving the number loaded during the day and the number left over. Since one could not say how many loads he had until after the day's run, telephoning did not start until about five o'clock. Everybody was in the same notion at the same time, and unless one happened to be lucky his turn might not come before midnight; also, he never knew what he was going to get the next day, for the man who "stood in" best with the distributor got first choice. It was the operator's policy to treat them the best they knew how.

Coal cars were not the monsters of one hundred or more tons capacity we see on our railroads now. Forty tons was the maximum, and even as late as 1900 we had some ten-tonners, while twenty-ton cars were common. Open cars were scarce, so a large number of box cars were loaded. Nearly every mine of any consequence had a box-car loader of some kind, but all of them were far from perfect and did much damage to the coal. The Christie and the Ottumwa were the leaders at that time. It is interesting to note the improvements box-car manufacturers have made since then to keep abreast of the general progress in mining.

During my management of the New Virginia, some Chicago men bought a tract of land west of Johnston City and started to sink a mine. The president of this company, the Johnston City Coal and Coke Company, was George Brennan, who later in life became the Democratic boss of Illinois and of the nation. The secretary-treasurer was P. H. Holland, a chap about my own age and one of the finest men God ever made. The general manager was Edward Anderson, an experienced coal man and a noble fellow.

Great difficulty was experienced by these men in sinking, there being 20 ft. of quicksand to pass through, about 40 ft. below the surface. It was at this shaft that "Z" bars were used for sinking through the sand. They interlocked all around the shaft rectangle and were driven with a pile-driver 3 ft. or 4 ft. into the shale below the sand. It took thirty days to place the bars, but the sand was loaded out in two days after this had been accomplished.

I was boarding at a private home where Messrs. Holland and Anderson lived, and Holland and I became great friends. He had been observing my work at the New Virginia, and after their shaft had reached the coal he made me a proposal to go with them in charge of the underground development with Fred Baumer, a big German from the northern longwall field. I accepted and took up my new work under very favorable conditions.

My new job

Holland was taking care of the clerical work, and Mr. Anderson was in general charge but mostly was occupied with details of organization of the sales end of the business. This later, also, took up more and more of Holland's time until I was finally doing most of the work at the mine. I projected the mine plans; did my own engineering, setting sights, making maps, and the like; kept the books; made up the semi-monthly payrolls; acted as paymaster; ordered cars for the next day's loading; and billed out the coal until the output reached 750 tons a day. When I contemplate such a record now, I wonder how I ever did it. And yet, I did not seem to be overworked, for I recall having time to do considerable playing on the side. It goes to show what one man can do when he is interested heart and soul in his work.

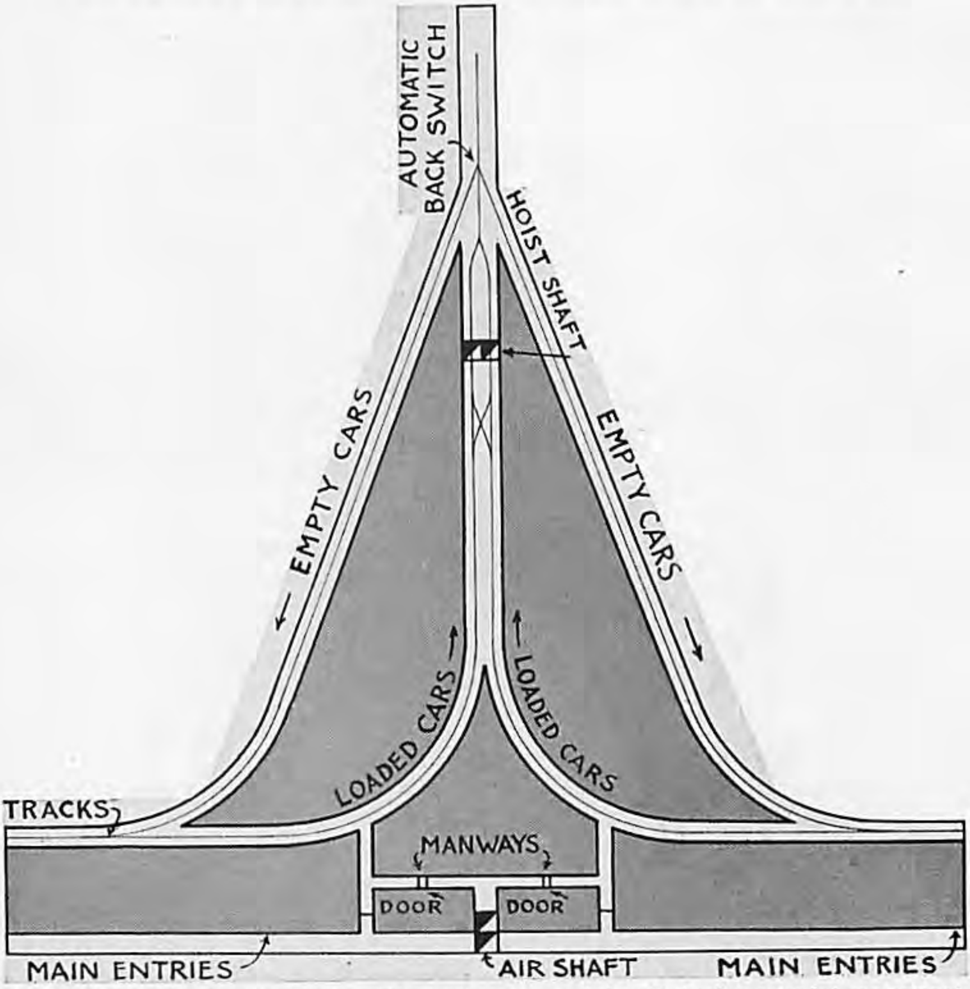
While I was in charge of the Holland Mine, I experienced my first explosion. I was attended with phenomena that to me have never been explained by any process of logic, and illustrates how dangerous a mine is even when every precaution is taken and when all conditions appear favorable.

As I have said, the mine was new. Main entries, north and south, had been driven past the point where cross-panel entries, east and west, had been turned on either side of the shaft bottom. The first and second east-panel entries on the south side were in about 300 ft. from the main. Undercutting was done by compressed air machines of the "puncher" type. The mine generated considerable gas, and shotfires were employed on the night shift to load and shoot the holes that the loaders on the day shift had drilled. It was the rule to drill three holes in a 9 ft. entry—one in the middle below the vertical center, as a "buster," and the other two were placed near the top and 12 in. from the ribs. The "buster" was fired first, after which came the rib shots, one at a time.

The air passage between the main and escapement shafts had not been completed, and air for the mine was taken down one side of the main shaft and through the entries by means of board partitions erected in the center. Ventilation, as evidenced by the fact that the shotfires were working with open lights, was adequate to clear away the gases. Both shotfires were men with years of experience in shooting "puncher" mined coal. On the night in question, they had gone into the first and second east on the south side to start. As stated before, they were in about 300 ft. Both places were about even, and an open crosscut was 20 ft. back from the face.

The shotfires went into the back entry, charged and tamped the three holes, lighted a squib in the "buster," and retired through the crosscut to the face of the first entry. When the shot went off, it sounded natural, so the two men, after waiting a few minutes for the smoke to abate, returned to touch off the other two shots. A mine car had been left on the track in the back entry just opposite the crosscut, and when they got to this point they observed that it was turned upside down. It then began to appear somewhat warm, and they concluded to go to the shaft bottom. They had not gone far until signs of destruction began to appear, and the farther they went, the worse it was. Mine cars were turned over; the board partition through the shaft center and the down main entry was demolished; and the cage which had been suspended in the shaft at the top landing was hanging in the tipple above the dumping point.

The explosion occurred about 10:30 P. M. I was staying at a place fully a mile away and had gone to bed but I heard the sound distinctly, as did nearly everybody in the village. Hurriedly throwing on my clothes, I rushed to the mine, and, on shouting down the shaft, which was only 200 ft. deep, you can imagine my relief when the men below answered with the assurance that they were both all right. We speedily improvised a cage and brought them to the surface, none



The New Virginia "Y" Shaft bottom. The tracks were graded so that when a loaded car bumped an empty off the cage the empty gravitated to the side wings to be picked up by the motors and again taken into the mine. Mules were used instead of motors.

the worse for their experience. It was really a miracle that no one was killed or seriously injured.

No answer for the blast

Early the next morning, the mine inspector, Mr. Evan Johns, and I examined the mine. We found the "buster" shot had done its work perfectly. The two rib shots were tamped but had not been fired. The inside of the mine everywhere showed signs of violence, but no burned particles of any kind were visible.

Now here was an extremely violent explosion with a detonation loud enough to be heard for more than a mile, and yet the shot had been properly drilled, charged, tamped, and fired, and it had performed its work as anticipated. The shotfires were not over 70 ft. away in the next entry yet they neither saw nor felt anything unusual. Their lamps were not even extinguished. Undoubtedly, it was a "windy" shot, for no flame or evidence of flame was seen either at the time or afterward.

It has been nearly twenty-five years since this occurred, and I have observed thousands of shots of various kinds since, but just what happened is as much a mystery to me now as it was then. The shotfires declared they had only 16 in. of powder in the hole, and from the size of the lumps produced it was evident the shot was not over-powered.

PART IV

During the time I was with the Johnston City Company, the New Virginia Company had several men in the place I had vacated, and the owners tried to induce me to return. Finally they offered me a substantial increase in salary over what I was getting, and the title of general manager. I eventually accepted, but was there only about a year when I was offered a place as general superintendent of the Egyptian Coal Company at Harrisburg. Since it was a still better job than the one I had, I went there.

This company had two good mines and had exceptionally fine-appearing prospects, but I had not been in charge very long before I found that there were two factions opposing each other.

They say "opportunity knocks but once," but in reviewing my past life, I can see at least three or four outstanding chances which I missed. One of them was offered at this time.

The control in the Egyptian Company was held by local bankers and merchants, but about 40 per cent of the stock was owned by "Jack" Davenport. He was an old Englishman who had come up from the ranks and, at that time and for several years preceding, was the leading operator in Saline County. He could neither read nor write, but he was the possessor of unusual business sagacity which had made him the virtual dictator of the coal business in that county and he had accumulated a fortune reputed to be over a million dollars. Everybody either knew him or had heard of him, and he was taken into the Egyptian Coal Company.

An opportunity turned away

I had been there about a year when Davenport dropped in to see me one day. He made to me the astounding declaration that he would secure control of the mines and offered to give me ten thousand dollars worth of the stock if I would remain and take charge of the mines as general manager, both of the Egyptian and his own operations. J. M. Seymour had left the New Virginia and was now superintendent of the Benton Coal Company at Benton, Franklin County. I had been given to understand that I was wanted there, so I begged Davenport for a couple of weeks in which to think it over. I finally made up my mind that it would be impossible for him ever to get the property. I was also very much afraid that, because of his physical condition, the situation would be reversed and he would lose out entirely. He had told me that there was soon to be a wonderful change in Saline County and that the stock he was offering to me would be worth two to three hundred dollars a share. The mines on that jerkwater line, a branch of the Big Four, were idle most of the time for lack of cars, and the stock was worth practically nothing. I couldn't figure where there could be any immediate improvement, so I turned down the proposition and accepted the Benton job, going there as general underground manager.

A few months later, the Big Four began to rebuild its tracks; the O'Gara Coal Company bought up all the principal mines, which Davenport had secured under option, including the Egyptian operations, and he was more firmly intrenched as the boss of Saline County than ever before.

Davenport offered me $10,000 worth of stock if I would take charge of the mines as general manager.

To the young and ambitious chap I would say this friendly word: If the "big boss" shows interest enough in you to offer you a job, it is certain evidence that he likes you and your work, or he would not do it; and if he is unlettered and looks to be "all in," don't be too sure of it. Judge a man by what he has done rather than by the way he looks. In my youthful ignorance, I failed to realize this and missed a golden opportunity.

Saline County mines operate in the No. 5 coal seam. It is from 42 in. to 9 ft. thick. In the northern part around Eldorado, it is thin and thickens toward the south where it averages 5 ft. to 7 ft. I have seen 9 ft. of clean coal in O'Gara No. 9 Mine at Ledford.

All underground workings in the '80's were double entry, with rooms about 25 ft. wide on 40-ft. centers. I planned the Egyptian shaft bottoms after that of the New Virginia and started development along accepted lines.

Colonel Roberts' first tipple

The tipples were of yellow pine, three tracks, with shaking screens. It will interest the reader, I am sure, to know that the erection of these two tipples was the first job ever completed by Roberts & Schaeffer Company. Colonel Roberts—at that time plain Mister—devoted much attention to his job. The result was a substantial piece of equipment of which he was quite proud and which, for that day, was very up-to-date, although I surmise that there comes a smile to his lips now when he thinks of the first-born of his brain as compared to some of the elaborate steel structures with Marcus screens and Arms air cleaners which his firm erects today.

From this small beginning arose a vast business which now extends to practically every mining country of the globe. His business increased rapidly, for it was but a few years until there was an R. & S. four-track steel tipple with electric hoist at Buckner, Franklin County, which was a far cry in design from his first effort. Mr. Roberts and I collaborated in writing a description of this mine and plant for *Mines and Minerals*, or then it may have been called *The Colliery Engineer*.

The Buckner Mine was opened by the United Coal Mining Company with C. M. Moderwell, president; A. S. Allais, vice-president; and Frank Urbain, general manager. This company also had a mine just east of Christopher, and the men interested had operated previously near Brazil, Indiana. Some years later they sold out to Old Ben. Mr. Moderwell interested himself in several properties in Illinois and West Virginia; Mr. Allais organized the Columbus Mining Company, with several operations in Eastern Kentucky; and Mr. Urbain returned to France, where he died.

About the time I left Saline County, another man, who later became one of the prominent men in the industry, was opening a mine midway between Eldorado and Harrisburg. This was C. M. Wasson. He is still operating two properties in the county, known as No. 1 and No. 2 of the Wasson Coal Company.

When I went to Harrisburg, the town was just entering on a "boom." I had been married about a year, and we could find no house in which to live. The two small hotels were full, and likewise every boarding house. Finally, we secured one room from a widow named Rice and we were able to get our meals at a rooming house across the street. Conditions were so crowded that several young couples we knew were forced to club together by renting a house and doing their own cooking. The streets were unpaved, and in the winter they were practically impassable. I have seen the mud so deep in the Court House Square that it took a four-horse team to pull a wagon through it.

Meals—$15 a month

However, the "boom" had not yet affected the cost of living to any extent. Our room cost us $8.00 a month, and our meals cost $30.00 for two! This was quite different from the Harrisburg of today with its paved streets, beautiful residences, and hotel rates of $5.00 and $6.00 a day.

When I went to Benton, Mr. Seymour, who was one of the best shaft sinkers of his day, had just reached the coal. The shaft was 9 ft. by 13 ft. in the clear, timbered with 3-in. by 12-in. yellow pine, and 630 ft. deep. The coal was No. 6 and measured over 9 ft. thick. With the exception of the "blue band," characteristic of the seam, it was clean. The roof was the usual gray shale, which "weathered" rapidly when exposed to the atmosphere. By leaving from 12 in. to 18 in. of the top coal, we had an excellent roof. The coal was practically level and the mine was dry. Underneath was a rather soft fire clay which was from 2 ft. to 10 ft. thick and which was to prove troublesome to the future operators in the field, as it had to be reckoned with in figuring the necessary pillar width to avoid their sinking through it.

The Benton Coal Company was owned by local capital, with Judge William H. Hart, president; Walter W. Williams, vice-president; and J. M. Seymour, general manager. The law firm of Hart & Williams was the most prominent in Franklin County, and perhaps is to this day. The judge was quite a character. He was the leading Democrat in the county and mentally was as "keen as a brier." Outspoken, warm-hearted, generous—he was liked by everybody.

Meeting Carl Scholz

I had been in charge of the work but a few months when there came a visit from a fine-looking young German, one year younger than I. The main entries at our new mine were 16 ft. wide, with double tracks, and the fame of the timbering job I was doing had spread abroad, so this man came to look it over. Men and materials were being handled in the buckets, which Mr. Seymour had used to sink with, as our cages were not yet installed. We got into a bucket and began the descent to look over the timbering job. When we had gone down about 500 ft., a small stone was knocked into the opening, striking my visitor, and cutting a gash in the back of his hand, the scar of which he still carries.

This was my first introduction to Carl Scholz. At that meeting began a friendship which threw us together frequently in the following years and which has lasted to this day. At that time, Mr. Scholz had just begun his long service as chief engineer of the Rock Island's coal properties. His company owned a large tract of coal land just north of Benton, and there was talk of sinking a shaft to open it up. Mr. Scholz suggested that I take charge if they should decide to operate, but for some reason the mine was never developed, so that job did not materialize. Anyhow, I appreciated the compliment conveyed by the offer.

A wild bucket ride

It was while we were still using the sinking buckets that a laughable, yet quite serious, incident took place. Charley Veatch, known in later years to every coal man in the Middle West was "Uncle Charley," of the Ohio Brass Company, came to see us. Charley was at that time selling Norfolk air compressors.

He got into the bucket with me, and we started down. We had no guides, and to one unaccustomed to riding in a sinking bucket, it is a worse experience than the first airplane trip. If left to its own devices, the bucket will spin around at a lively rate and, to prevent this, the occupants reach out and touch the walls with their hands as they descend. Unless it is done properly the bucket will swing from side to side with increasing momentum until it finally becomes unmanageable and extremely dangerous to its occupants.

Well, Charley and I went along comfortably until we got down about half way when the engineer suddenly put on speed, and we could not touch the walls. The old bucket began to swing and whirl and was soon pounding against the walls in lively fashion. I became alarmed for my visitor, so I shouted to the engineer to "go slow," whereupon Charley, who was "scared stiff," shouted with all his might and main, "Yes, go slow, very slow!" with the accent decidedly on a prolonged VERY.

This heartfelt plea, made 400 ft. or 500 ft. below the surface, and to an engineer above, who, in common with his kind, took extreme delight in getting a greenhorn in the bucket and "cutting the rope," so amused me that I could hardly do anything. I finally got him to crouch down inside the bucket with me, and we hung on for dear life until we reached the bottom.

Charley got over his fright, but if I live forever, I will not forget the wonderful lung power he wasted on that trip into the bowels of the earth.

The mine at Benton was the second one to be opened in the County of Franklin, Mr. L. Z. Leiter having preceded us about two years with a shaft at Zeigler, of which more will be mentioned later.

There had been talk of sinking a shaft at Benton some twenty years before, but some interested parties had drilled for coal to the then unheard-of depth of 600 ft., and had failed to find it. So it became an accepted fact that the thick seam that was being worked in Williamson County, to the south, did not extend as far north as Benton. Our shaft was 630 ft. deep to the top of a seam of 9 ft. The drillers had quit 30 ft. too soon.

Unfamiliar mining problems

I laid out the underground workings on the semi-panel system, with rooms

The old bucket began to swing and whirl and was soon pounding against the walls.

24 ft. wide on 45-ft. centers. This was the deepest shaft I had yet to deal with and I had many unfamiliar problems to meet and conquer, such as the thickness of the pillars to be left around the shaft bottom for safety; the width of rooms and thickness of the pillars between them; the thickness to give the pillars between entries; the depth to which rooms could be driven; the kind

of timbering that was essential; and many, many other problems for the solving of which I had no precedent to guide me.

Help from J. T. Beard

In the case of uncertainty on my part as to the practicability of any plan I was considering, I always had one unfailing friend to whom I could go. That was J. T. Beard, who had but recently given up the management of mines in Iowa and accepted a position with *The Colliery Engineer*, published at Scranton, Pennsylvania. He conducted a "Questions and Answers" column in the magazine, which was very popular. Whenever I got into a jam, all I had to do was to write to Mr. Beard, explaining my predicament, and a full and complete solution would come in a few days in the mail. Mr. Beard's unselfish gift of his time and unusual talents through a long professional career is almost unprecedented, and only God knows the good he has done in this world. I am sure he has no conception of it himself. Many times he has earned my eternal gratitude in days of inexperience and uncertainty. Mr. Beard has had a long and honorable connection with *The Colliery Engineer*, the International Correspondence Schools, *Mines and Minerals*, and *Coal Age*, and is now enjoying himself in retirement from business at Danbury, Connecticut. I don't know if he has ever met the "Mad Hatter," but if he has, he has done him some "good turn," you can safely bet.

CONSTITUTION AND BY-LAWS

Adopted June 21, 1913.
Amended Nov. 12, 1926.
Amended No. 8, 1929.

ARTICLE I.

NAME AND PURPOSE

The Illinois Mining Institute has for its objects the advancement of the mining industry, by encouraging and promoting the study and investigation of mining problems, by encouraging education in practical and scientific mining, and by diffusing information in regard to mining that would be of benefit to its members.

ARTICLE II.

MEMBERSHIP

Section 1. Any person directly engaged or interested in any branch of mining, mining supplies, mining appliances, or mining machinery may become an active member of the Institute. Any person desiring to become a member of the Institute shall fill out a blank for that purpose, giving his name, residence, age, and occupation. This application shall be accompanied by one year's dues of $3.00. Each application for membership shall be submitted to the Executive Board, who shall make an investigation as to the qualifications of the applicant, and shall be authorized to elect to membership and issue a certificate of membership to such applicant subject to the ratification of the next regular meeting of the Institute.

Section 2. Any person of distinction in mining may be elected an honorary member of the Institute by two-thirds vote of the members present at any regular meeting. Any member who has been an active member of the Institute and shall have retired from active business in mining may become an honorary member.

Section 3. The annual dues for active members shall be $3.00 and any person in arrears on August 1, of the current year, after having been sent two notifications of dues, to be dropped from membership. Members in arrears for dues will not receive the printed proceedings of the Institute.

Section 4. Any active member may become a life member by the payment of $50.00. Funds received from life members are to be invested and only the income from these funds may be used in the regular operation of the institute.

ARTICLE III.

OFFICERS

Section 1. The officers shall consist of a President, Vice-President, Secretary-Treasurer and twelve Executive Board members. The services of all officers shall be without compensation.

Section 2. Nominations for officers and the executive board shall be made by nominating committee of three (3) appointed by the President at least thirty days before the Annual November meeting, provided that anyone can be nominated on the floor of the meeting for any office for which an election is being held.

Section 3. The 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, act as program committee for each meeting, determine what is to be published in the proceedings and shall perform such other duties as may be referred to them by a 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

LIFE MEMBERS

BROOKS, C. W. .... 1629 Monadnock Block, Chicago, Ill.
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HARRINGTON, GEO. B., President ....
Chicago, Wilmington & Franklin Coal Co., Chicago, Ill.
JENKINS, S. T. .... Goodman Mfg. Co., St. Louis, Mo.
JONES, JOHN E. .... Old Ben Coal Corp., West Frankfort, Ill.
JOYCE, A. R., Vice President .... Joyce-Watkins Co., Chicago, Ill.
LEACH, B. K. Vice President .... Egyptian Tie & Timber Co., St. Louis, Mo.
McFADDEN, GEO. C., Asst. Vice Pres. .... Peabody Coal Company, Chicago, Ill.
PELTIER, M. F., Vice President .... Peabody Coal Co., Chicago, Ill.
RYAN, JOHN T., V.-P. & G. M. .... Mine Safety Appliances Co., Pittsburgh, Pa.
†SAYERS, A. J., Engr. .... Link-Belt Company, Chicago, Ill.
SCHONTHAL, B. E., Pres. .... B. E. Schonthal & Co., Inc., Chicago, Ill.
SCHONTHAL, D. C., Pres. .... West Virginia Rail Co., Huntington, W. Va.
TAYLOR, H. H., Jr. .... Franklin County Coal Co., Chicago, Ill.
THOMAS, T. J., Pres. .... Valier Coal Co., Chicago, Ill.
THOMPSON, J. I., Vice-Pres. .... Koppers Rheolaveur Co., Pittsburgh, Pa.
WEIR, PAUL, Vice-Pres. .... Bell & Zoller Coal & Mining Co., Centralia, Ill.
ZELLER, HARRY, Vice-Pres. .... West Virginia Rail Co., Huntington, W. Va.
ZOOK, JOS. D., Pres. .... Illinois Coal Operators' Assn., Chicago, Ill.

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MURRAY, HUGH .... Equality, Ill.
ROLLO, JOHN .... Murphysboro, Ill.
TIRRE, FRANK .... 7126 Northmoor Drive, St. Louis, Mo.

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ADAMS, WILLARD C. ....
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ANDERSON, A. R. .... The Jeffrey Mfg. Co., Columbus, Ohio
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ANDERSON, WALTER .... Mine Rescue Station, Benton, Ill.
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ARNOLD, MARK R. ....
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BEAN, F. M. .... Murphysboro, Ill.
BEDA, P. W., Vice-Pres. .... Old Ben Coal Corp., 230 S. Clark St., Chicago, Ill.
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BIGGER, I. S. .... 514 South Blvd., Cape Girardeau, Mo.
BILBY, S. A. .... Vacuum Oil Co., St. Louis, Mo.
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CECIL, C. H. .... 1921 Peoples Gas Bldg., Bethlehem Steel Co., Chicago, Ill.
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CHAMBERLIN, W. M. .... 521 Black Ave., Springfield, Ill.
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CLARKSON, JOHN L. .... Nashville, Ill.
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CLUSKER, JAS. .... Mine Rescue Station, Springfield, Ill.
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COOLEY, H. B. .... 332 S. Michigan Ave., Allen & Garcia Co., Chicago, Ill.
COULEHAN, T. E. .... Old Ben Coal Corp., Johnston City, Ill.
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DUNCAN, GEO. D. .... Duncan Fdry. & Machine Co., Alton, Ill.
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DUNCAN, W. M. .... Duncan Fdry. & Machine Co., Alton, Ill.
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DUNN, THOS. J. .... Old Ben Coal Corp., Christopher, Ill.
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EDGAR, R. L. .... Watt Car & Wheel Co., Barnesville, Ohio
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GRISSOM, FRANK Alcoa Ore Co., Belleville, Ill.
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HAYWOOD, W. T. Witt, Ill.
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MILLER, FRED .... Franklin County Coal Co., Herrin, Ill.
MILLER, JAS. B. .... 1946 N. Broadway, St. Louis, Mo.
MILLER, RICE, V.-P. .... Hillsboro Coal Co., Hillsboro, Ill. X
MILLER, RICE W., Secy. .... Hillsboro Coal Co., Hillsboro, Ill.
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MITCHELL, M. C. .... Franklin Hotel, Benton, Ill.
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MORRIS, NELSON .... Harrisburg, Ill.
MORRISON, GEO. F. .... 624 Washington Ave., Evansville, Ind.
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MOSES, THOS., Pres. ....
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MULLINS, T. C., Pres. ....
Northern Illinois Coal Corp., 310 S. Michigan Ave., Chicago, Ill.
MUNRO, CHAS. .... 574 Monroe St., National Armature Co., Gary, Ind.
MURRAY, ED. .... U. S. Fuel Co., Westville, Ill.

*MURRAY, HUGH........Equality, Ill.
McARTOR, GEO........Herrin, Ill.
McAULIFFE, EUGENE, Pres........
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McCLEISH, W. J........Harrisburg, Ill.
McCLOUD, DON B........Duquoin, Ill.
McCOLLOUGH, F. R........C. I. P. S. Co., Marion, Ill.
McCRINDLE, D........344 Tenth St., La Salle, Ill.
McCULLOCH, LAWRENCE........429 S. Tenth St., Vincennes, Ind.
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McELHATTAN, D. F., Safety Engr........Peabody Coal Company, Duquoin, Ill.
**McFADDEN, GEO., A. V.-P.....Peabody Coal Co., 20 N. Wacker Dr., Chicago, Ill.
McFADDEN, JOS., Supt........Peabody Coal Co., Mine No. 24, Danville, Ill.
McFADDEN, NAT., Div. Engr........Peabody Coal Co., Taylorville, Ill.
McGURK, SAM,........Mt. Olive & Staunton Coal Co., Staunton, Ill.
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McKENNA, THOS........U. S. Fuel Co., Danville, Ill.
McKORKLE, PAUL........Fairmont, W. Va.
McLAREN, A. B........Marion, Ill.
McNAIL, O. D........Truax-Traer Coal Co., Elkville, Ill.
McREAKEN, C. W., Div. Supt........Peabody Coal Co., Marion, Ill.
NEAL, DAVE........Consolidated Coal Co. of St. Louis, Mt. Olive, Ill.
NELSON, I. C........Beall Bros. Supply Co., Marion, Ill.
NEWDICK, N. A........568 N. Fourth St., Columbus, Ohio
NICHOLSON, HUGH P........Urbana, Ill.
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NOE, A. C........Geological Dept., U. of C., 57th St., Chicago, Ill.
NORRIS, G. B........Jeffrey Mfg. Co., Columbus, Ohio
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ZIMMERMAN, L. D. .... C. I. P. S. Co., Marion, Ill.
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S. W. FARNHAM	March 12, 1931
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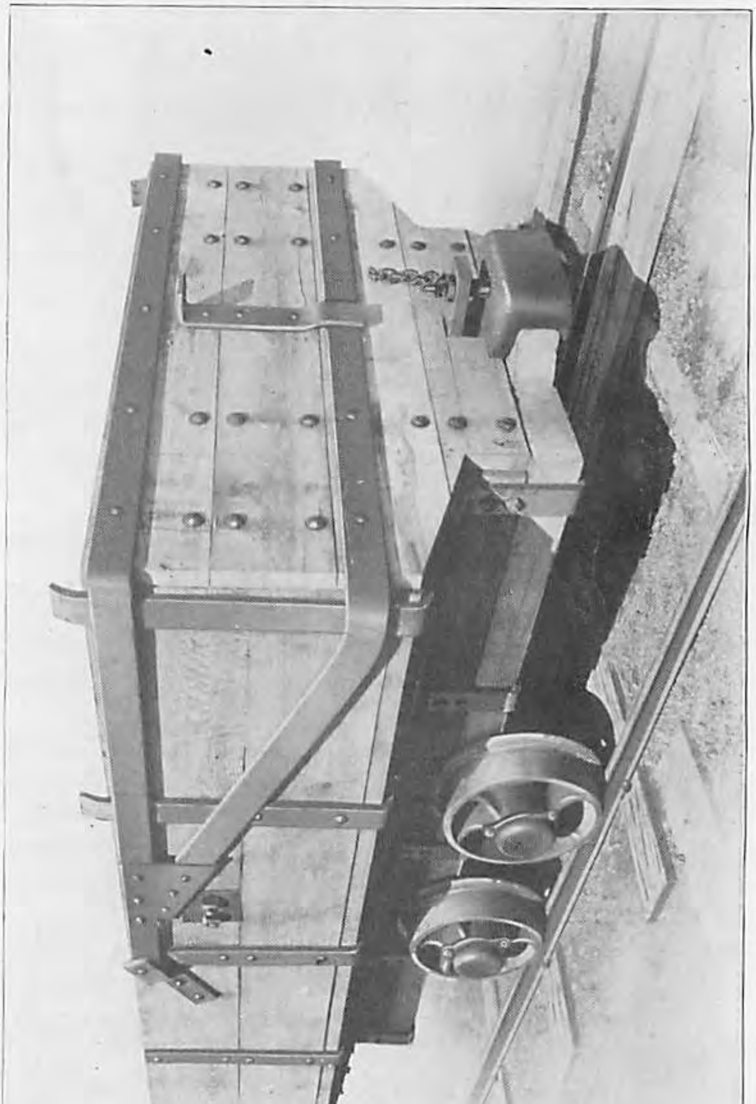

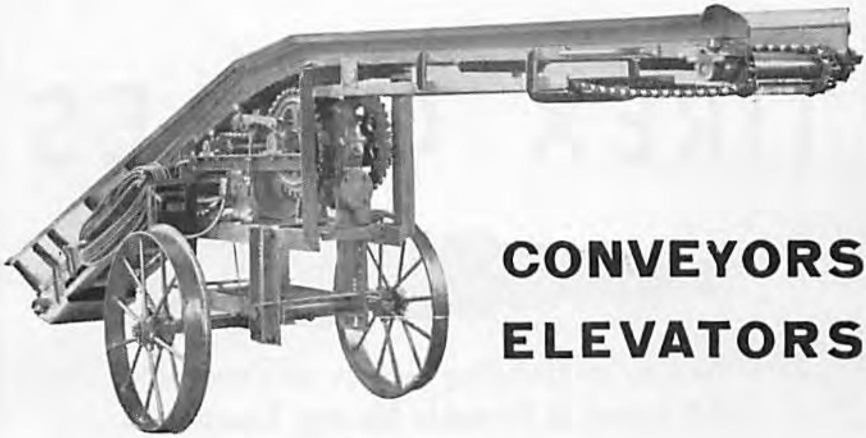

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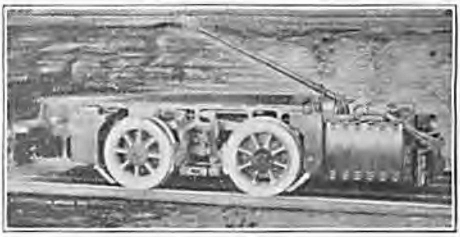

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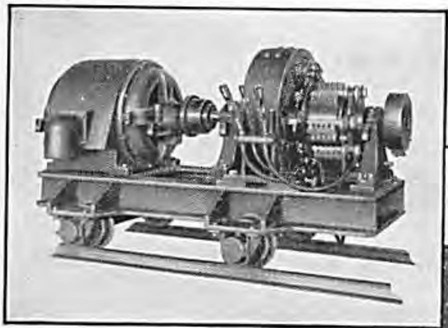

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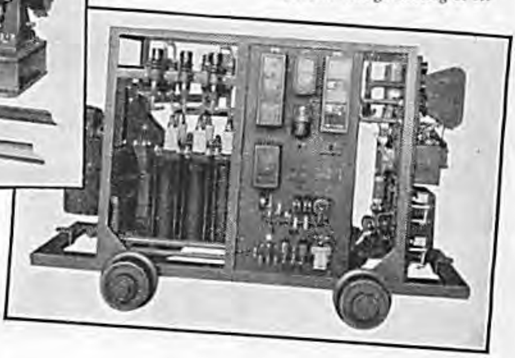

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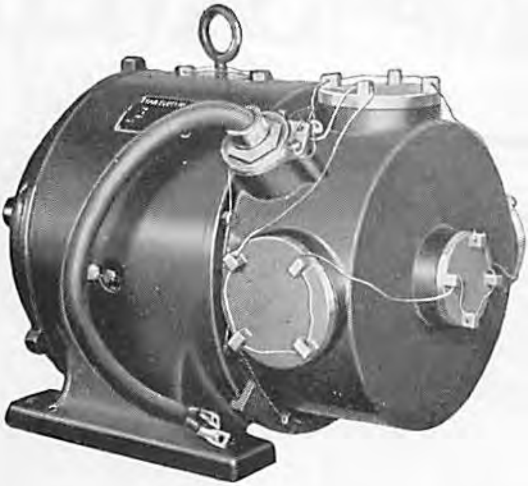

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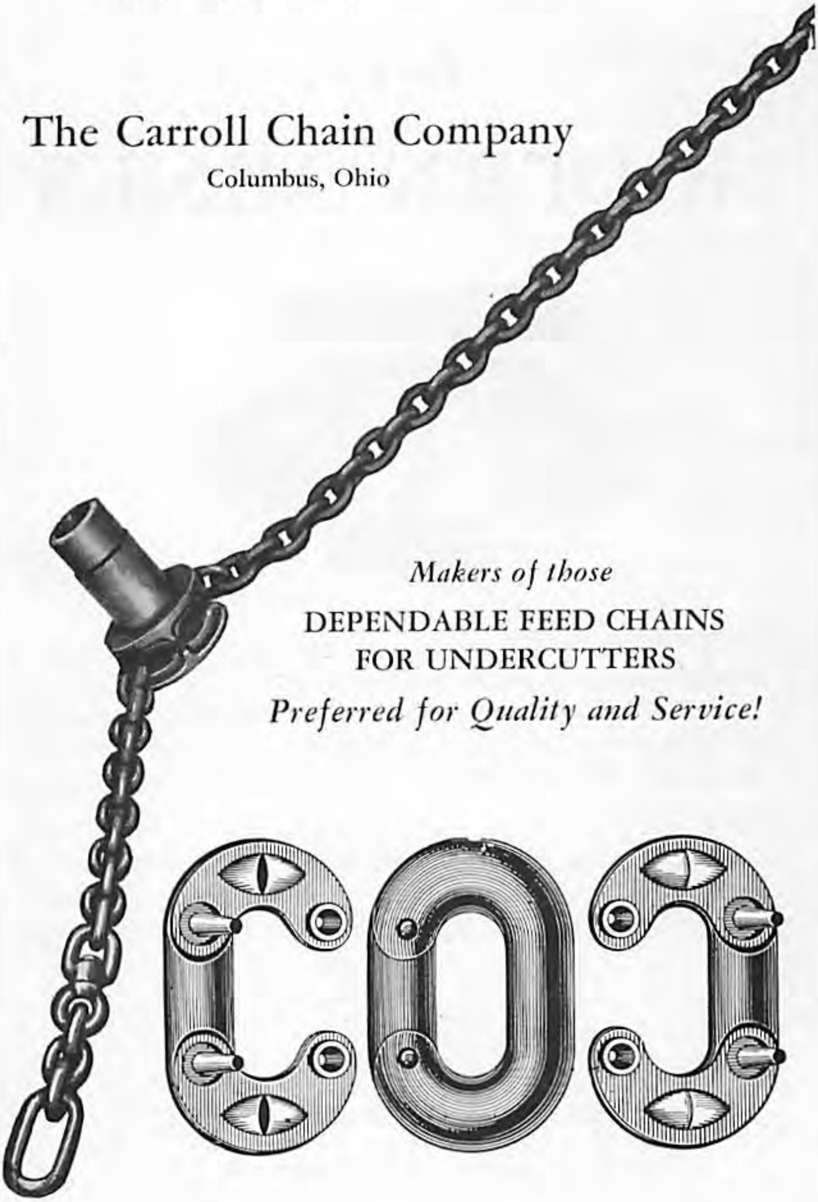

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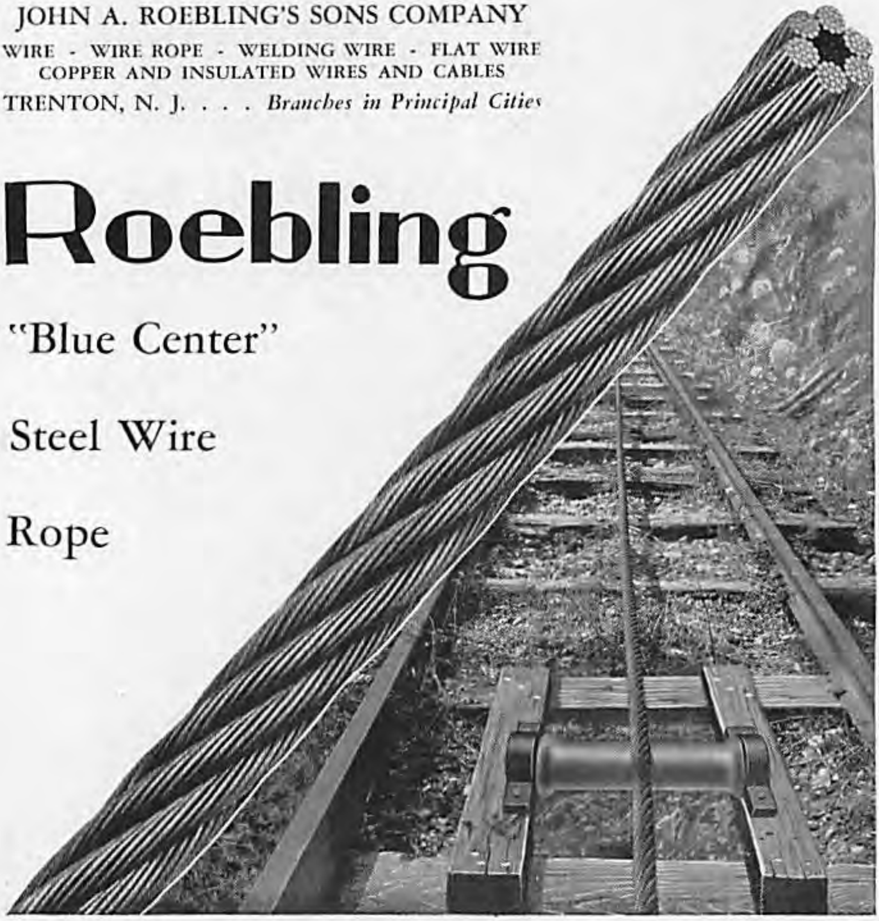

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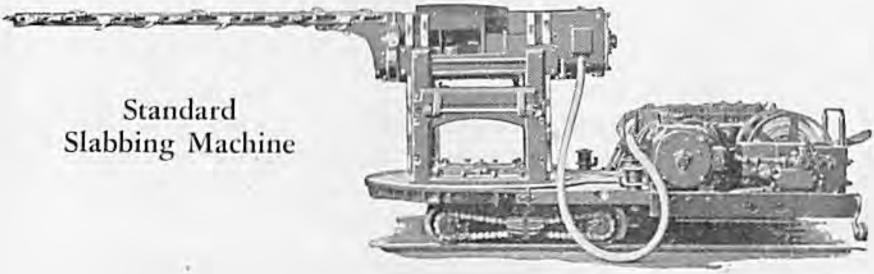

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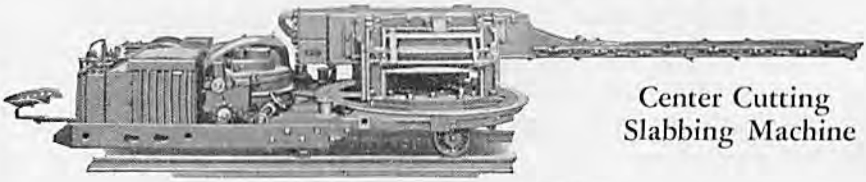

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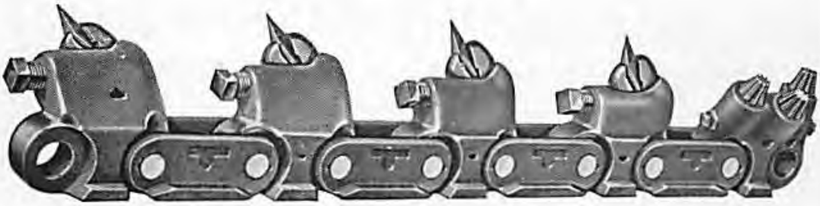

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The old style bit when new weighs half a pound. The Bowdil bit when new weighs one and one half ounces.

Average Bowdil superiority over old style bits in 53 tests in all kinds of cutting from clean coal to rock tunnel work.

Number of square feet cut per minute	36%
Number of tons cut per bit point	501%
Bit setting time per ton	547%
Bits broken and lost per ton	783%
Average power demand K. W.	37%
Average power per square foot, K. W. H.	81%
Average saving in bits, power, cutting and bit setting time, upkeep of machines, and depreciation per ton	$.05036

No sharpening of bits. No collecting or distributing of bits, as the machine man can carry enough in his pocket to last a shift.

The greatest saving is in upkeep of machines by running with less power.

In ordering chains specify make and type of machine, length of cutter bar and number of bit blocks.

Describe cutting fully, especially character of impurities encountered.

Prices net F. O. B. Bowdil, Ohio

Chains $4.40 per bit block including straps, set screws, core breakers, and 100 bits. A few extra parts at additional cost sent with the first chain to any operation.

Holders	$ .15 each
Wedges	.10 each
Bushings	.05 each
Screw pins	.05 each
Core breaker burrs	.20 each
Set screws	.15 each
Bits per M	50.00 net
Bit blocks	3.40 each
Straps	.50 each

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Annual Boat Trip

and

Summer Meeting

ILLINOIS MINING INSTITUTE

JUNE 10-12, 1932

S. S. CAPE GIRARDEAU

Leave St. Louis 11 p. m. June 10
Arrive St. Louis 10 a. m. June 12

A splendid program is being arranged.
Make your reservations early.

B. E. SCHONTHAL, *Secretary*
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