LONG WALL MINING AND ITS MERITS.

THE MERITS AND DEMERITS OF THE LONG WALL SYSTEM OF MINING, WITH A BRIEF INTRODUCTION CONCERNING ITS ORIGIN.

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Mr. President and Gentlemen:

The long wall system of mining is frequently termed a new, or modern system; but history shows that it has been in vogue for more than a century. It also shows the circumstances of its origin. It was during the latter part of the eighteenth century, when pits were sunk somewhat haphazard; that is, they were sunk without conclusive evidence of the presence of coal. In those days, if the surface indicated the carboniferous formation, prospecting in the shape of drilling was seldom resorted to in order to ascertain the presence and nature of coal in the neighborhood of the proposed sinkings. It was at this period and with this information only, that in the South of England pits were sunk to a depth of from 500 to 1,000 feet, only to find very thin veins of coal. In some of these sinkings eight or ten veins were cut, the thickest not exceeding three feet, the thinnest being one foot. It was here that "necessity, the mother of invention," compelled the officials of these mines to adopt some mode different from what they had been accustomed to in working thicker veins; otherwise, they would have to abandon the idea of realizing any revenue from the investment. Hence the long wall in its crude form was conceived to be the only method of working such thin veins at a profit, and a small profit at that.

About two years ago we made an effort to try the long wall at the Allen Coal Company's mine at Dell Roy, Ohio. The vein in which we tried it is known as No. 6, cut by a shaft at a depth of eighty feet; this vein being also known to contain a large quantity of sulphur, and like in all shallow mines we had a copious supply of water to deal with. These two things together made it very unpleasant to the miner, insomuch that we realized trouble in keeping sufficient miners to supply the demands of trade.

At this period we found it required one keg of powder for seventeen tons of screened coal. As a result we had trouble in getting coal in a marketable condition, the coal being shattered and wet, made it quite a task to clean it. It occured to us that in the case of a large output the consumption of powder would be such that we should have to make special provisions for diluting and conveying away the gases generated by so much powder, which must inevitably render the atmosphere of the mine almost unbearable. It also occurred to us that the large quantity of water we had to deal with would be very expensive if we still maintained the double entry system of working, because we had to pump from nearly two thirds of the places. The dips and swamps being numerous, and the bottom impervious, compelled us to do so. Then, under these circumstances we thuoght we could, by adopting the long wall, modify these disadvantages considerably. In the first place, we though it was possible to obviate so much blasting and have a better system of ventilation with less motive power. We also thought the coal would not require so much blasting, which would be one way of getting the coal in better condition. Then we thought we could concentrate the water to the lowest point in the district, which would undoubtedly give us more dry places, consequently more men would be enabled to clean their coal. The fact is, that we considered the long wall to be the only remedy for dirty coal, so long as we had so much water to cope with. The district selected was not one of the best for the experiment. The roof was not as favorable as in other portions of the mine, it being a bastard sandstone, very hard to drill and fractured by numerous water cracks, or natural breaks, which gave off large quantities of water both in the room and entries prior to adopting the long wall.

Our mode of procedure was as follows: From a pair of butt entries we converted the lowest one into a heading, or level, by opening out sufficient coal on each side to put in pack-walls nine feet wide and still leave space for men to work at the coal behind these packs when a gateway was turned off this heading. This means that the heading was driven from thirty-five to forty feet wide, and after advancing the headway twenty feet we turned a gateway off the heading at an angle of approximately eighty degrees with the heading, and then advanced the heading forty feet farther before turning another gateway parallel to the first one; thus allowing forty feet between gateways, which was turned on both sides of the heading. To produce height for roads, etc., we took down from two to three feet of top. This with the refuse of the mine itself gave us nearly sufficient material to construct the pack walls, the packs being nine feet at least in the heading and eight feet wide in the gateways. This size of pack was sufficient to resist the pressure of the superincumbent strata and have a good margin of safety, as the cover does not exceed one hundred and fifty feet. The gateways we calculated to go one hundred and sixty feet, but in order to win the block of coal between the heading and the next pair of butt entries, we had to drive one hundred and eighty feet; otherwise, we should have to drive the rooms coming to meet these gateways over their distance (viz., one hundred and fifty feet).

We are now enabled to say that the long wall affords the several advantages we anticipated, both to the miner and operator. Some of these benefits we will now enumerate. In the first place, we find the average tons of coal per keg of powder is about twenty-seven from the long wall places. This is a direct advance for the miner. And then, he can get these twenty-seven tons with about the same labor as he could twenty tons from a room, because he can make his shots to a better advantage in a place forty-eight feet wide with only one cutting side—the other side being a loose end—than he can in a room twenty-two feet wide and two cutting sides. He can also prepare more coal on idle days, or when the turn runs slow.

Another point of minor importance is that he does not have to load so many cars for the same quantity of coal as he would in a room, because we find the cars from the long wall will average four hundred weight more per car than from the rooms. This denotes a saving in the haulage by about one-fourth, which deserves consideration whether the hauling be long or short, as it goes to show that the output may be increased one-fourth, in some cases especially.

The long wall method of mining also affords facilities, unequaled by any other system of mining, regarding the ventilation. It affords the opportunity of conveying the air current along the face of the workings, thus diluting and rendering harmless the noxious gases generated by the use of explosives, etc., where in room and entry work the resultant gases become a positive nuisance to the miner, if explosives are used frequently and in large quantities. We admit it is possible to dilute the gases even in rooms and entries, but yet it is impossible to maintain a thorough system of ventilation and still be competitors in the same market as those that are indifferent to the miner's health. It has been said "the better the ventilation, the better the results." This means that a miner can perform his duties better and with less danger in a comparatively pure atmosphere than he can in a dark and contaminated atmosphere.

We now come to another important point which ought to command serious attention; that is, the high percentage of coal lost in mining by the double entry system. We have realized that, at Dell Roy, about 25 per cent. of the vein is lost in the shape of room pillars, and judging from this we are justified in saying that the aggregate loss will amount to nearly 30 per cent, when we consider that 2 per cent. is blown into the gob by the heavy charges of powder, and make an allowance for the entry pillars.

We will now consider the relative cost of the long wall and double entry systems of mining; although we must bear in mind that it is somewhat intricate to give the theoretical cost exactly, yet we can come near enough the mark for our present purpose. Then suppose we take a block of coal three hundred by thrre hundren and forty-six feet, and by the double entry system of working this block will require one pair of entries three hundred feet long, or six hundred feet of entry in all. This requires about five breakthroughs and at thirty feet each it means one hundred and fifty feet in all. This will win ten rooms on each entry, twenty in all, and each room requires two breakthroughs about six feet each, or twelve feet per room, two hundred and forty feet in all. Now the cubic contents of this block (four feet vein) equals four hundred and fifteen thousand two hundred cubic feet, and assuming thirty-five cubic feet equals one ton, we have eleven thousand eight hundred and sixty-three tons of coal; and for our purpose—which will be seen later on—we will take lump and nut and slack, to be in the ratio of six and four. This will yield theoretically seven thousand nine hundred and eight tons of lump coal. Now then, six hundred feet of entry at $1.75 per yard equals $350.00; one hundred and fifty feet of breakthrough at $1.25 per yard equals $62.50; twenty rooms turned at $2.75 each equals $55.00; two hundred and forty feet of room breakthrough at 60 cents per yard equals $48.00; the bottom cutting and track laying in the rooms cost 4 cents per ton, or $474.52 for this block. Total cost for these items alone equals $989.00, or a little over 8¼ cents per ton of mine run coal. Now the cost to win a similar block of coal by the long wall method is not quite as large as that above. As we have already stated, we allow forty feet between gateways. Then if we say that for each road shot the linear distance of coal exceeds forty-six feet, and each road costs $1.25 per yard to take down the top and build the pack-walls, thus we see it costs $1.25 for every five hundred and fifty-two cubic feet of coal ($46 \times 3 \times 4 = 552$).

Now we have shown that the cubic contents of the block of coal in question equals four hundred and fifteen thousand two hundred cubic feet. Then if we divide the cubic contents of the block by five hundred and fifty-two, it will give us seven hundred and fifty-two, or the number of yards of top to be shot to extract the whole block by the long wall; and at $1.25 per yard it equals $940.00, or about $7\frac{3}{4}$ cents per ton, showing a saving of only $\frac{1}{2}$ cent per ton, providing all the coal is extracted by both methods of mining. But as we have already stated that 25 per cent. of this block, at least, is lost if mined on the double entry system, so that, to make a true comparison we must subtract this 25 per cent., which leaves us eight thousand eight hundred and ninety-eight tons available by the doube enltry method; and at a cost of $989.00 it equals 10 cents per ton, thus showing a difference of $2\frac{3}{4}$ cents per ton in favor of the long wall. Even this is worth saving, but the difference is still more appreciable in favor of the long wall when we consider that the cost of draining the long wall workings is less, and the cost of track laying is decreased by more than half. We might convey the idea of this latter remark better if we gave a practical illustration as it occurred in our case. That is, at one time when we had about ninety miners, employed, ten of which were working long wall requiring only five roads, the remaining eighty miners requiring nearly fifty roads in the shape of rooms and entries. Now, we found that these ten men, or one-ninth of the total number, gave about one-fifth of the output for several weeks. This concludes what we have termed the theoretical comparison between the double entry and long wall modes of working. We will now give the actual comparison of cost.

From the introduction of long wall up to the month of August, 1894, we found from keen observation the difference to be 4 cents per ton,—that is, the long wall was cheaper by 4 cents per ton. Then we find it possible to extract all the coal; hence the lifetime of the mine is prolonged in the same proportion as that of the percentage of coal lost, which in our case would be at least one-fourth.

The principal disadvantages of the long wall are: First, a vein exceeding four and one-half feet in thickness requires larger pack-walls than we have quoted, hence the cost is increased. Second, a vein with a hard sandstone roof is not only expensive to blast for the roads, but it does not bend and break off at the timber like a slate top, but usually overrides the timber, thus throwing the weight onto the coal face, as well as having a tendency to swing the pack-walls. Third, if the royalty is intersected by numerous faults, it is a disadvantage. Fourth, if the bottom be soft and liable to heave.

Our only trouble at Dell Roy is that the miners are sceptical as to the safety of the long wall, while we consider it to be equally as safe as any other method, and according to statistics it is more so. (Applause.)

PRESIDENT ORTON: It is with a great deal of pleasure that I see a paper on long wall mining brought forward which is a record of actual trial in this State. I have been present at meetings of this Institute when the subject has received a great deal of attention. A great many friends and enemies of the system have been here from time to time and have given us extensive treatises of how the system would affect us in Ohio, and at last we have a case in point brought forward by Mr. West of a trial of the system in Ohio, and I am glad to note the conclusions he arrives at. Are there any who would like to discuss the subject?

PROFESSOR RAY: I would like to ask a question of Mr. West. You speak of the yield per keg of powder as seventeen tons in double entry. How did the yield compare in long wall?

MR. WEST: Twenty-seven tons per keg, I quoted, by the long wall system.

MR. KANE: What is the size of the cars referred to?

MR. WEST: Average about thirteen hundred pounds lump.

MR. KANE: What is the average run of the mine?

MR. WEST: I could not say that.

PRESIDENT ORTON: This is the first time, I think, that the subject of long wall mining has failed to extract a full expression of opinion from the members. Are there any further remarks?

MR. LOVE: I had a paper on that subject once myself, and as you say it brought forth a good many enemies and some few friends, but no one seemed to know much about it. It was like the fellow who said he had heard of London city, but because he had not seen it he didn't believe there was such a place—they haven't seen it worked and don't believe in it. I have heard men talk who have tried it, and am here to say that I have seen it tried.

The mine is in my district, and I want to say that in my opinion that mine was unfavorable for long wall mining. There is a sandstone roof in this section where it was tried, and the miners wanted to discourage it as much as possible, feeling that it was not a safe system, and there were other disadvantages. In the double entry system they must leave very large pillars, and yet a squeeze will come on, and in this system the bottom does not heave at all, and in the whole section you can't see a place where the track has heaved like in the entry system. This may seem remarkable, but it is true. The rooms with pillars seven and eight feet has brought on a squeeze, where the long wall has not.

MR. DALRYMPLE: I want to ask Mr. West one question; that is, the distance the mine has extended from the place where they commenced to work by long wall?

MR. WEST: The age of the mine is about three years, and about six hundred feet from the shaft where it was opened out.

MR. DALRYMPLE: What I want to show by that is that if you mine the coal properly you don't need any powder. If built regularly and in good shape, the weight will gradually come on and split out the coal. If the miner understands long wall mining, he can handle the coal in that condition and don't need any powder, after the workings are opened up properly. I understood you to say you were using so many kegs of powder to so many tons of coal by the long wall and also by the double entry system?

MR. LOVE: As I understand it, that depends altogether on circumstances. Mr. Dalrymple may have seen where the weight would mine the coal, but I don't think it could be in a seam like No. 6.

MR. WEST: I would say that our friend's theory is quite correct in that respect. The weight does assist the miner considerably in bringing the coal down, but we have been placed here in an unfortunate position. The stagnation throughout the country resulted in the mine being closed, and we couldn't get the men to fill the places up in proper line, and the consequence was one would cave in advance of the other. We intended when we commenced to keep all the face all through, but as I said, they allowed one gateway to advance in advance of another, so the weight hadn't a fair chance.

MR. DALRYMPLE: This system of mining don't depend on circumstances at all. It has been practically demonstrated that the proper way to work long wall is by bringing sufficient weight to bear to bring the coal down.

PROFESSOR RAY: I wish to ask Mr. West if the shape of the working face in the mine was straight or a curved line.

MR. WEST: I have a small pencil sketch which is too small for all to see, but it will give you an idea. (Handing paper to Professor Ray.)

PROFESSOR RAY: Is this long wall better than that formed by wheels or circles? There are several long walls in the West that invariably approximate a wheel, the shaft making the hub and the working face the felloe, and there the weight brings down the coal without blasting.

MR. KANE: I would like to ask Mr. West what is the reason they don't mine the coal, what the causes are for not mining it?

MR. WEST: It is a seam that has a sulphur band immediately on the bottom, and the miner cannot carry in sufficient picks to mine it, and the result is at least two-thirds is blasted. In reply to the professor here, I might say that if he will examine that sketch he will find we have there a semi-circle of long wall, if we had sufficient miners to clean it out.

PRESIDENT ORTON: As I understand it, if your system were carried out it would be the same as Mr. Ray's system?

MR. WEST: Yes, sir.

MR. KANE: Mr. Dalrymple, you don't mean to say that the long wall system will result in breaking the coal down without mining?

MR. DALRYMPLE: I mean to say that there is weight enough to burst the coal out, but it will not result in good round coal for the market.

MR. KANE: Would it not depend upon the depth of the mine or the thickness of the immediate strata above it?

MR. DALRYMPLE: It will take in any of our mines in Ohio.

MR. LOVE: If the material that underlies the coal seam is hard, then it will burst the coal off solid and break it down. But this has a very soft bottom and a very strong sulphur band so that the miner cannot make wages in mining and so lifts it out with powder.

MR. DALRYMPLE: If Mr. West had practical long wall miners, they could bring it out of there better than by blasting.

MR. WEST: I might say, in reply to our friend, that a good deal depends on the judgment used in shooting. It can be arranged so the weight will aid the miner better in some respects than in others, and can get practically all nut or practically all lump, as desired.

PRESIDENT ORTON: I am sorry to say that we have not heard from Mr. Keighley, and will defer his paper for the present. I will therefore call for the next paper, "Spontaneous Combustion in Mines," by Mr. John P. Jones, District Mine Inspector, North Lawrence, Ohio.