EXPERIENCE WITH MINES THAT GENERATE FIREDAMP IN THE CONNELLSVILLE COKE REGION.

BY FREDRICK C. KEIGHLEY.

By the term "Mines which generate Firedamp" I mean those mines containing light Carbonated Hydrogen Gas, no matter whether it may issue from the coal itself, the floor, the roof, from clay veins, from faults or by the reason of the presence of fissures in the strata. I do not wish to lead you to believe that mines containing fire-damp are more dangerous that other mines, for such is not necessarily the case. In fact I am going to try and demonstrate to you from my own experience and observations, that the known presence of fire-damp in a mine, is not so much to be feared as the apparent and oftentimes presumed absence of it. It is not so much a question of fire-damp as it is a question of conditions, and it is the failure to properly weigh these conditions and the inability or in some cases, the neglect to make timely and adequate provisions for them that brings disaster. Fire-damp of itself never caused an accident, but conditions neglected or conditions not forseen, in conjunction with fire-damp do at times result in the destruction of either life or property and often both. Allow me to use an observation of every day life for an illustration of the point I now wish to make and impress upon you. A month ago I was away on a business trip and I went part of the way by boat. Whilst on that boat I saw the usual notice that the owners of the boat had complied with the law. The boat, its machinery, its various attachments and appliances were of the kind and to all appearances just in the condition the law called for. I further read a certificate of inspection from which I learned that the boilers of the boat were allowed to carry a pressure of 160 pounds to the square inch. My state-room was right over those boilers. Right under me whilst I slept a terrible and deadly force was in existence, yet neither I or any other person could with reason say that that boat was dangerous or unsafe; on the other hand I was perfectly satisfied it was safe. Why? Because the conditions were such

that they made it safe. There was the guarantee of reasonable safety. Those boilers were of first-class workmanship. The material was the finest of steel 20.100 of an inch thick, rivet holes drilled, longitudinal seams double rivetted, flues properly spaced and designed, the diameter of the boilers in proper proportion and the boilers were furnished with safety valves of an area that was sufficient to carry off any excessive force or pressure and the whole was in charge of competent men. This is but one example of the numerous dangerous forces man makes his most powerful levers and best servants that the traveling public come in contact with every day and with all of them. there is a reasonable, though, perhaps not, an absolute assurance of safety. Now again let me take a figure for illustration (I am tempted to say a parallel case) a coal mine that I am perfectly familiar with. This is a shaft mine over four hundred feet in perpendicular depth. In that mine fire-damp made its appearance the second day after the coal was cut in turning off the first heading or entry and from that day until this fire-damp has incessantly issued from the coal; the roof and the floor. At times the fire-damp was so strong that the men were kept out until it could be controlled; at other times blowers were struck that roared and hissed like escaping steam from a boiler and at other times the fire-damp has silently filled up the headings in one hours time a distance of 500 feet horizontally. This mine has been opened up two years and produced 415,000 tons of coal and during those two years a terrific and deadly power has incessantly manifested itself, yet the first accident and first damage to life or property in that mine has yet to take place. With all this seeming evidence of safety and the non-appearance of disaster can we justly say that mine is a dangerous one? I say no. Not any more so than we could condemn that steamboat as dangerous and if I were to decide which was the best risk I would say that coal mine was a better risk than the boat. Now why has that mine been safe and why is it still safe? I say simply because the element of danger was known from the beginning and the conditions being known they were carefully weighed, understood and provided for. It is not the sand-bar marked with a bouy or the rock lying under the gleam of the lighthouse and designated on the chart that brings disaster and death to the mariner. but it is the unknown, the hidden rock that sinks his vessel before he even has time to recognize danger and lift a hand to port his helm.

So it is in the mines, the recognized dangers do not necessarily bring disaster, for they are accepted as the conditions to which that mine is subject and a competent, conscientious

management endeavors to anticipate these and when he or they once know them, they boldly and unhesitatingly grapple with them and strain every nerve to conquer and control them. Now I am not going to say that with proper care and skillful management accidents from fire-damp can be made impossible, for from the first breath we draw, we all know that death is ever ready to lay his clammy hand on us and there is no such a thing as perfect safety in this world, but I will say that many accidents could have been prevented and possible ones may yet be prevented.

I am not going to spin before you to-day any of those beautiful, glittering and startling theories that throw around the science of mining a halo of romance and mystery. I am going to give you good plain horse sense, or in other words, instead of theorizing it is my intention to reason—to endavor to deduce from what has actually occurred (in my own experience and under my own observation) in the mines I am familiar with; what could have been done and what it is reasonable to expect or presumed can be done.

The first accident I will cite was the explosion at the Uniondale Mine, Dunbar, Fayette County, Pa., some 9 or 10 years ago. Before I go any further let me say in this particular case my acquaintanceship did not begin until some 4 or 5 years after the accident, but that accident or explosion was the means of furnishing me with the biggest tussle I ever had with fire-damp in my life, and in that way I became quite familiar with that mine and the details and causes of the accident. I took out of the abandoned workings of that mine three and one-half million cubic feet of fire-damp, but as that proceeding would furnish abundant material for a paper of itself I must pass over it. The Uniondale Mine was opened up on the crude system or methods in vogue in the Connellsville Coke Region twenty years ago. This mine was not an extensive one, neither was it what might be termed a fiery one. It was a slope mine. The slope being driven on the dip of the coal and the tendency would be for that slope to drain off to a great extent, the little fire-damp in the coal, if there was any. Adjoining the Uniondale Mine was the very extensive mines of a well known Iron Company and large areas of waste workings from these mines existed about the Uniondale Mine boundaries. These waste workings were filled with fire-damp. It is said that one of the operators had trespassed or in other words had over-run the boundaries, which one, it is neither my promise or desire to decide or even intimate; however, let it be either one, the consequence of that trespass was that one day a miner in Uniondale Mine suddenly struck through into those waste workings. The hole was a small one

and the miner's naked lamp at that time gave no evidence of the presence of fire-damp. Without closing the hole thus made the miner left it to inform the mine boss of what had taken place, and I am informed that this man told the mine boss that there was no fire-damp there. The man and mine boss went down to the hole with naked lights and an explosion took place burning them both severely but not fatally. This explosion put out the lights of other miners working in other parts of the mine. After sometime one of the miners whose light had been thus extinquished became anxious to ascertain what had happened and he crawled in the dark out on to the slope and there struck a match and a violent explosion took place killing —— men and burning others. Now what was the cause of that accident? It is plain that fire-damp was the power that dealt the blow, but it was no more to blame for the accident than the pistol in the hands of an assassin. It was a clear case of conditions not anticipated or if anticipated that were not provided for. Now what have we? The following facts, viz: First, that one of the parties had trespassed. Second, that accurate surveys had not been made or if made, either the matter was kept secret or some one failed to notice that a trespass had been committed. This then was the real cause of the accident—unknown or neglected conditions. It is plain fire-damp was not guilty in this case. What could have been done? The party making the trespass could have had accurate surveys made and thus avoided a trespass, or if the trespass had been known to him or they, notice could and should have been given the other party of the danger. The party driving towards the abandoned workings could have kept bore holes in advance of him. He could have used safety lamps when he found that he was approaching waste workings. The miner should have immediately stopped up the hole he cut, with his hat, coat or shirt and not returned to the hole until notice had been given to the other miners. The mine boss should have scented danger when informed of the holing through and provided himself with a safety lamp before approaching the vicinity of the breach. Had any of these things been done the fire-damp would in all probability never have been ignited. The second accident I take up for illustration is the Hill Farm Mine disaster. This mine also was a slope opened up years ago (perhaps 20 years or more), when a hole in the ground and a pair of broken winded hoisting engines constituted a coal mine.

It, like other mines opened up in the Connellsville Coke Region 10, 15 and 20 years ago, was headed into the coal, (though occasionally t'other and went first) with nothing definite in view but the chopping out of coal in some way, cheap if possible, but

coal in some way, if not cheap. The only difference between headings and rooms was that one had an iron track in it sometimes and the other had a wooden one. This state of affairs existed for years and though at times some fire-damp had been seen, yet for sometime previous to the fire or so-called explosion, little if any had been detected in the workings—in short it was not considered a fiery mine and both naked lamps and safety lamps were in use. After this mine had been worked many years and became an elephant on the hands of the owners a change was made in the manangement. The new manager was an able man and quick to see that radical changes were necessary—too many to make in a short time; however, to my own knowledge, he took the matter up in good earnest and one of the first things done was to bore a hole to take care of the water with which the mine was greatly troubled and another hole was to have been bored (it has since been done) in order to get rid of the steam line on the slope. I will here state that I have known the temperature on that slope to reach 140° Fahrenheit whilst the steam line was in use, so you can readily understand why the new management commenced improvement in that direction first. When the first bore hole (or water hole) went down it struck a point in the coal seam 11 feet from the slope. The hole was completed on Friday, but not tapped until the following Monday.

At 11 o'clock of the morning of the fatal day, the miners pick struck into the hole and the water contained in the hole rushed out with terrific force and a loud roar. The man working there escaped and his naked light did not fire the gas. A few minutes later a boy some distance up the slope, with a naked light on his head heard the terrible uproar and laboring under the impression that water had broken into the mine rushed down the slope to warn the miners below. In passing the bore hole he ignited a blower of fire-damp that came out of the bore hole. This blower shot out a long finger of flame that reached out across the slope to the bratticing and that bratticing took fire. At this stage of the fire it might have easily been checked by the tearing down and trampling of the brattice cloth, but it was either not thought of or perhaps overlooked in the confusion and the flames at once began to play upon a trip of loaded cars standing on the slope. These cars were saturated with oil and standing right on the main air return they so constricted the air passage that a high velocity was reached and this fanned the flames with frightful vigor and in a very few minutes the whole of that part of the slope was a seething mass of flames and dense smoke. Twenty-nine men were cut off from retreat by that fiery

barrier and two more brave fellows lost their lives by attempting to force their way through the smoke to their comrades and if possible save them.

Thirty-one persons lost their lives by that fire, not by explosion as commonly reported at the time, but through their inability to pass that fiery barrier. They were hemmed in there until suffocated by the fumes. Now what are the facts in the case? Did fire-damp kill those men? I say no. It was the conditions prevailing at the time that did the work. Fire-damp was the arrow and conditions the bow that drove it forward on its deadly errand. Need that arrow to have left the bow? I say no, if the conditions had been anticipated and provided for. Could these conditions have been foreseen? Could the deadly combination of circumstances have been prevented? It would seem upon reflection that they could have been. The hole could have been tapped Saturday evening or Sunday. Failing to tap it then the men could have been withdrawn on Monday and kept out until the tapping had been done. It may have been tapped in working hours with a reasonable degree of safety if nothing but safety lamps had been used for lights and a small bore hole kept a short distance in advance of the workmen. If the mine had been properly opened up and had a manway on each side of the slope or a brick overcast had been built to connect both sides of the workings with the manway in existence at that time, the fire could have burned with the greatest violence and still not a man have been lost. It was not the fire of itself that killed the men, but the fact that the fire was in the only avenue of escape. It was a barrier with death on the one side and life on the other—those men were on the side of death. Years before that fire took place the death trap had been unconsciously set. It was the advance into the coal-field with no route for retreat. The bridge to carry them back in, and to safety was not destroyed. It was never built. Let every man to-day who is in the act of planning or opening up a new mine, long reflect and be sure that he is not setting a trap that will some day close its relentless jaws upon those who not only were not responsible for it, but who never suspected its existence. Opening up a new mine is a serious undertaking and the plans need to be skillfully drawn, deeply studied and carefully carried out if found to be drawn on safe and correct lines. The question will be asked. Why was that bore hole opened in the manner and at the time it was? To this I will say that I presume it was because the management anticipated no dangers as bore holes had been tapped in a similar manner before without mishap. I am satisfied that if the management installed shortly before the time of the accident had

had the planning and management 5 years prior to the date of accident, no such a deadly combination of conditions could have taken place for Mr. Hill would never have tolerated such slipshod work as that which ruined that mine. Mr. Hill was not captain until the ship was a dismasted hulk, with a demoralized crew, and he had to run before the gale not as he would but as he could.

Now I cannot tell you all my experiences in the coke region unless I monopolize the whole of the various sessions, so I will take up only one more mine that I know. That mine will be the Mammoth Mine. From what I experienced there I will conscientiously endeavor to point out the lessons to be learned from that terrible disaster. I say lesson because every accident reveals to all of us something we did not know or understand before and the mining law of the State of Pennsylvania has reached its present efficiency by the means of accidents, each of which traced with its bloody finger the deficient clauses. The "Mammoth Mine Disaster" was in all probability the result of the ignition of fire-damp by a naked light. This fire-damp suddenly and unexpectedly gathered in the rib or pillar workings and in all probability it issued immediately after the fire boss made his examination from the strata underlying the coal and not from overlying strata. Previous to the explosion the Mammoth Mines had always been remarkably free from fire-damp and open lights had always been used in all parts of the mines. I say mines because there were two openings—a slope and a shaft with hoisting engines at each opening. I had taken charge of the Mammoth Mine a little over two months before the explosion and up to the day of the explosion I never carried anything but a naked light, as all others did, with the exception of the fire bosses, who in their daily morning examinations, of course used the Davy Safety Lamp. I had traveled over the whole of that mine in company with the mine boss with nothing but naked lights, but of course never until after the fire bosses had made their morning examination. During that time I never either saw or heard of fire-damp being found. When I went there first I asked the mine boss, assistant mine boss and the fire boss if they had seen any fire-damp in those mines. They said not, with the exception of a couple of small blowers that were struck when the shaft was first opened up years before and which were long ago exhausted. The mine I had last had charge of, before going to the Mammoth, was a very fiery one and it was worked with safety lamps. Being accustomed to the use of safety lamps I looked upon naked lights at first with some distrust, but learning that naked lights had always been used there and being assured by all and by my own observations that fire-

damp did not exist in the workings and also knowing that the mine inspector had not said anything about exclusion naked lamps I saw no reason for comment on my part. My first intimation of danger was the explosion itself. On the morning of the disaster, not more than ten minutes before the blast came I went into the engine house and examined the fire bosses report and found it signed as usual, with no remarks on its face beyond that the mine had been examined at such an hour that morning and found to be safe. After reading the report I put it back in the desk and was about to ask the engineer for a cage when I learned from him that there had been a wreck on the trestle leading to the coke ovens. I at once went to see what had caused the wreck and whilst standing within twenty feet from the shaft I was startled by a rumbling noise and looked up in surprise, to see a vast cloud of smoke hanging over the derrick like a huge balloon. I at once got down off the trestle and ran to the fire-pump and got it started and the water turned down the shaft, expecting to see flames next, but none came, so in about 5 minutes we stopped the pump for no flames showed up. We next started the cages to running and two men and a boy came up. They could tell us nothing, though all were uninjured, so I at once called for volunteers and together with two others (all that answered the call) I went down the shaft and found all the stoppings and doors blown down. Could not find a soul, so went to the top of the shaft for more help and boards, nails, etc. In a few minutes I went down again with the mine boss and some others to start bratticing and exploring and a short distance from the bottom of the shaft we found six hungarians from the slope workings alive and uninjured. These we sent out and proceeded with the bratticing and exploring and from that time forward we found nothing but destruction and dead bodies. 109 men had died in a few minutes time for the want of air. Of the 46 bodies I personally helped to remove not one was mutilated and I understood from the other explorers that only two or three of the remaining 63 bodies were mutilated, so it would seem that all or nearly all died from the effects of after-damp. The cause for all this very great loss of life was undoubtedly the blowing away of the main door and stoppings. The air after the explosion simply went down one compartment of the shaft and up the other until the bratticing was replaced, which was of course the work of many hours time, although we did manage to reach the first bodies in less than three hours' time. Had the mine been properly laid out, without doors at the very base of the intake and been ventilated by means of split air currents and over-casts as it should have been and as I plan-

ned but the day before the explosion, very few, if any would have lost their lives. I had just completed a new ventilation plan for the mine the afternoon before the explosion. With the old system of ventilation the opening of one door near the foot of the shaft on the inclined plane where all our coal was hoisted to the foot of the shaft, cut off all air to the shaft mine workings. Of course that door was opened and shut for every trip of loaded cars hoisted and every trip of empties run down and in case of a wreck that door would have to remain open.

Now what do we learn from this outline of that accident? First we find as in the other cases cited that there was a sudden and unexpected influx of gases. Could this sudden influx have been foreseen? I think it is doubtful in this case for the reason that only since the few days following the accident (it is now three years since it happened) has fire-damp been detected in that mine and then it was a sudden out-burst lasting but a few hours This time no naked lights were in use, so it was not ignited. Could the ignition of fire-damp have been prevented? It could in all probability if naked lights had been excluded; however, it is a difficult matter to determine just where safety lamps should be installed and after my experience I would not wait for the appearance of fire-damp. I would favor the use of safety lamps from the beginning of the mine for it is an uphill business to introduce them and educate the miners after naked lights have once been used in a mine. This I know as I introduced or installed them at two mines and it was a bitter fight in each case. Even at Mammoth after all the loss of life it was no easy matter to get the men to look upon the safety lamp with favor.

A careful examination of the mine by many experts seemed to warrant the presumption that in this case the fire-damp came from the floor of the mine, which is a rather unusual circumstance in the Connellsville Coke Region, though I do know of another case where a sudden outburst of fire-damp came from the floor of one of the largest mines in the coke region, whilst the fire bosses were just completing their morning examination, preparatory to the lowering of the men into the mine. It was so sudden and of such violence that the fire bosses had to hasten to the top of the shaft by way of the cage and the fire-damp reached the surface as soon as they did. It took three days work with a constant supply of 100,000 cubic feet of air per minute in circulation to control that outburst. I will here say that there was some disposition on the part of the public to charge neglect on the part of the fire boss making the examination at the Mammoth Mines. Now I can hardly think that a

fire boss would deliberately report the mine safe if he found it otherwise, go out to breakfast, then return to the mine without saying a word, to face a violent death, which he did. The fire boss died at his post and met it in one of the most remote headings of the mine, the lowest flat heading below water level. I knew the man intimately and I never met a more able man in his line or calling, in fact I had such a high opinion of him that I intended to make a mine boss of him at my first opportunity.

In the Mammoth Mine disaster you again see the dreadful consequences of unforeseen conditions and the appalling results from the faulty planning and opening up of a mine. You will ask why did not the owners of the mine see that the mine was properly opened up? Let me say that the owners at the time of the accident were not responsible for its faulty development. They bought the mine years after it was opened and from the day they bought it until this very day it has been a continual succession of improvements. I was only there myself 11 months, yet during that short time I used over 200,000 red brick for overcasts and stoppings alone. A mine spoiled in the beginning is a ticklish thing to handle and it takes years of incessant study, labor and expense to right its wrongs and in the case of some mines I know the damage from poor planning and working is absolutely impossible. Such mines as those wear out the very soul of the man in charge and an ordinary man can fight but one such battle in his lifetime, for by the time he gets a wrecked mine in shape he has become a wreck himself. Again let me say to those opening up or about to open up new mines, be careful and plan with skill for as the twig is bent, the tree will grow.

Perhaps some of you would like to know what kind of a mine I would like to handle. I will tell you. I will take the gaseous mine everytime. I want no more of your presumed absolutely non-gaseous mines. With the gaseous mine I know the danger and I know how to fight it. The miners know the danger and they are observant, careful and ever keenly alive to the existence and treachery of the enemy and it never catches them sleeping in fancied security. With the non-gaseous—that is the presumed non-gaseous mines—everything is happy go lucky, the naked light hob-nobs with the flaming petroleum torch and the overflowing odoriferous petroleum can kick up its heels and follows in the procession that revels in the very presence of death, and lights the ghastly, horrifying pyre. The new mining law of Pennsylvania sets down heavily on the funeral torch that feeds on petroleum, and I am glad that it does, for of all the

fights I ever had in my life, the fight against petroleum in the mines was the most bitter and hard.

I suppose that as I have expressed my desire for a Fiery mine, you will next ask how I would open up my Fiery pet. In answer I will say with three shafts, and with two, three, four and five headings, as the circumstances and conditions might demand or make justifiable. With heavy shaft and heading pillars, the division of the mine into sections—each section protected with heavy barrier pillars; no cut throughs in the barrier pillars excepting at section intersections; with split air currents; the exclusion of naked lights; fans in the duplicate; one shaft for return exclusively; shafts sunk as far apart as possible under the circumstances; concentration of working forces; drive the entries or headings away ahead of immediate requirements; adopt rope haulage and aim for a large output.

My paper is now ended and before you for discussion. If my statements and suggestions are worthy of criticism, or contrary to your opinions, I am ready to further support the points I have taken.

THE CHAIR: Gentlemen, I think I will express the sentiment of the Institute in tendering our most earnest thanks to Mr. Keighley for his extremely able and interesting paper. We have heard a paper from a man whom it is a privilege to listen to. There are not many opportunities for hearing a man discuss the question of accidents from fire-damp who is as intimately acquainted with the subject from experience as Mr. Keighley. A man who has seen, as he has, the detailed characteristics of some of the most extensive accidents in Pennsylvania, certainly is one whom no person can fail to appreciate the value of hearing. He has asked for discussion of his paper. I am sure there are members of the Institute here—numbers of them—who will accept this opportunity. The paper is now before you for discussion.

MR. HIBBS: A little over a year ago, friends, I had a little experience as Mr. Keighley has had, and I wish to say that I believe just as he does, that it requires certain conditions for explosion, and sometimes the conditions themselves will not bring about an explosion without a little awkwardness to begin with. I had a little experience myself. I was fortunate enough to be away, just far enough away not to be hurt, but this was a

new mine, not very far advanced in headings, about eight or nine hundred feet from the pit mouth. The conditions were that three men were driving a heading. One was foreman and the other two assistants. The day it happened the foreman was away. The two assistants drilled a hole straight into the solid against the butts, I think about six feet deep. They put in a charge of powder, a heavy charge undoubtedly, and sometimes it happens, and frequently, too, that there would occur what we call a windy shot. Of course all miners know what that is. Well, there was a can of powder about twenty-five feet away, open. A little further on there was another, and several others containing more of this powder in the gang-way. These were the conditions. All it needed was the miners pick to start it off. Well, of course it is not necessary to tell you that the fire was driven into the powder from the blowout shot or windy shot. The powder was like the charge of a gun. It hurt quite a number, and killed one by the force, suffocated two more, and one died afterwards from being burned. These were the conditions, and of course the newspaper reporters came around the shaft and seeing the smoke coming from the shaft, the report went out that the mine was on fire, and similar exaggerations of course were printed. Well, mining men came there, and some of them, the miners of experience and mine inspectors. The old men shook their heads and said there must have been some gas. The mine inspectors said it was coal dust principally. Well I admit that coal dust burned. The mine was not the dryest, yet it was dry and undoubtedly some coal dust burned, but instead of being the cause, it was powder, and yet gas had to bear the blame of being the force to do the destruction, but awkwardness was the starting.

MR. EDE: I think there is some things he desires to impress upon us about opening up our mines in the commencement that can be overcome. One of these things that struck me very forcibly, and with which I have had considerable acquaintance, and that is that in these fiery mines it is the unexpected that happens. Some of our most calamitous disasters in England have come from seams that were supposed to be non-gaseous. There is the Jackson No. 2. For twenty years it was not sup-

posed it had any gas, but some of the mines that have been opened have shown that there is gas. And there are some gentlemen here who, I believe, would be very well able to follow that paper up and give us a little of their experience on what they have met with. There is no question but these are the points we have come here for. It is the experience we gain in our work and brought out in discussion in this manner that makes this thing helpful. It is here that the educational part of it comes in. We can help one another and raise up the standard of mining engineers and miners generally by our experience, and I would like to hear this subject discussed a little more about this matter in other seams, where it is possible this danger may come in.

MR. HIBBS: I wish to make an additional statement which I forgot. I might be considered as casting some reflections. This accident did not occur in Ohio.

THE CHAIR: Mr. Ede's statement that some of our Ohio mines are developing fire damp is certainly one that should provoke discussion. I think the point is very interesting that has been made as showing how fire damp accidents are most frequent in non-fiery mines. It is where it is not expected that it does the most damage, and if there are gentlemen here who are acquainted with these facts that Mr. Ede has suggested, I hope they will furnish them.

MR. LOVE: I want to say, Mr. President, that I heartily endorse the statements of the paper read by Mr. Keighley. I was with him part of the time after that explosion, and I hope he will not think that I am trying to flatter him when I say that in my experience I never met as brave a man in fire damp. He certainly does understand it fairly. A man that would go ahead of all others and look after his dead men and risk his life a thousand times as he did there, that I know of, certainly is worthy of all praise, not only by the Ohio Mining Engineers, but those of his own State. But what I want to say in particular, and want Mr. Keighley to explain is that the majority of the experts in that disaster claimed, I believe, and the legislative

committee in their examination claimed that coal dust was the leading factor in the explosion, and that in fact it bore the heaviest force in the explosion.

MR. KEIGHLEY: I would say that I did not, in writing that paper, want to say anything about coal dust, for the reason that everybody in our country there, thinks, when we talk about anything outside of fire damp, that we are trying to blame something else for it. But the facts are, that there was no great volume of gas there, but the location of the explosion was demonstrated by the presence of two fires which was discovered on the second day, showing that the gas came from the bottom in the No. 3 flat heading. I have a plan in that bundle that I can locate the point on the plan if anyone wishes to see it. It seems there was a crack in that part of the mine. It had been opened a good many years, but no pillars drawn in that part of the mine. We started to mine that pillar coal and had been mining but a short time before the bottom began to come up. That part of the mine was a very dry part of the mine and had a great deal of dust in it, and I think that when the bottom had stood all the pressure it could, that it cracked and let out this gas, this fire damp, and there being so much dust around there, there is no doubt that it reinforced the fire damp and was the real cause of the violence of the explosion.

Another reason of thinking that, was this: I sought for damp there—I speak in a general way—but we met with carbonic oxide principally, and we found the dust of it over the mine, sticking to the coal, charred right on the coal, coked all over the mine. That thing we never brought into prominence for the reason that we thought that they would think we were trying to put it on the coal dust. Now my opinion about the way the fire damp was ignited was this: that perhaps some road men were tearing up old tracks in this place and for some reason or other they went back in this squeezed portion. I don't know what they went for, but sometimes they do go, sometimes for curiosity and sometimes something else. I think one of these men went in there and ignited these blowers from the bottom. We found them on fire there and put them out. That showed it came from

the bottom and, as Mr. Love says, I think coal dust was the great factor there. I would further say that I have the report of the commission on the Mammoth Mine disaster with me, so that you can get all you wish as to what the commission determined. There was a pamphlet published on it and I have it with me.

THE CHAIR: I would suggest that during the meeting that Mr. Keighley's plans be placed here on exhibition. I think we can arrange them and I think they are matters that the Institute would be glad to see and should see. Is there any further discussion of this paper. I think it would be interesting to hear some facts in regard to the recent occurrence of fire damp in Mr. Ede's district. I would like to hear something from that. Mr. Harry is here. Couldn't he give us some points in regard to that?

Mr. EDE: I was expecting somebody else who is more familiar with the subject to rise up. I noticed, however, in No. 3 mine—I went in one day there—and in that mine gas accumulates in considerable quantities. I went in there once and there was an explosion, not very serious, but we got down. I had an instrument in my hand, but I let that go. I wanted to get down. I noticed it there in sinking the shaft. That was from a blower there. There was a regular blower from the bottom. Of course this gas accumulates on top of these structural arrangements. I have only noticed it in that particular place and I know there are gentlemen in the room who have followed this matter a great deal further and more closely than I have.

MR. TURNER: I would like to ask a couple of questions of Mr. Keighley. Was there any air current passing through this abandoned portion of the mine?

MR. KEIGHLEY: There was air passing up the flathead and air passing up the butthead. There was a current passed up each butt.

MR. TURNER: Did your fire bosses examine the abandoned portion of the mine?

MR. KEIGHLEY: They examined every working place in the mine. To examine every part of that mine was impossible, because, as the plan will show, it covered too much ground, and at that time the mining law of Pennsylvania did not call for every place being examined, but only the working parts. But the probability is that he did not examine that part of the mine. I cannot say. I know the man was capable. The mine boss and Mr. ——— were in that part of the mine the evening before the explosion with naked lamps on their heads. That you will find in the testimony. Now that is the testimony, that he was there the evening before.

MR. JONES: As I understand our brother there, did he indicate that that mine was located in the gaseous region?

MR. KEIGHLEY: I guess they consider the Connelsville region all gaseous now, but it is no uncommon thing to find three or four mines worked with naked lamps and the next worked with safety lights. It seems to be local. Safety lamps are not used all over the region to this day, and the mining law don't require it, so that if you go into the Connelsville Coke region you will still find naked lamps in the mines.

MR. JONES: I was going to say, Mr. President, that as a precautionary measure it might have been well to have made an examination of that part of that department or locality of the mine, in view of the fact that notwithstanding there was no gas found to be present, that inasmuch as the mine was located in a gaseous region, it might have been a precautionary measure and no doubt would have been if a diligent examination of that part of the abandoned mine had been made. I have also been very deeply interested in the paper that the gentleman has read; but I have noticed some parts and things in that paper that are not applicable, in my judgment, in every coal region, at least in Ohio. That part of it that sets forth that there should be three shafts sunk, will not, in my opinion, be justified in certain coal deposits that we have throughout the State of Ohio. It is all right, I believe, where there is a good and sufficient deposit of coal to

justify the expenditure, but I submit that it is not practicable in a coal basin like we have in the regions of Stark County known as the Massillon district. I submit that the amount of coal that can be extracted from one of these basins will not justify any company in going to the necessary expense of sinking three shafts before they get any return for their money.

MR. KEIGHLEY: Mr. President, I am afraid that Mr. Jones thinks I am trying to apply this generally. Now this paper is written only for the coke region. It is my experience in the coke region and not my experience anywhere else. You will recollect that I said I will tap two, three, four or five headings, as the conditions might require or make justifiable. Conditions are what we have to consider. We are not to adopt a plan because it is a good plan, but we have to look at it this way: will that plan satisfy our requirements and conditions? As to the examination of that mine, I would say that Mr. Eaton testifies that in company with the fire boss, on the evening of the 26th, he was in that place. Now as to what that fire boss did, I cannot say, nor anyone else, because the man was killed, but this I do know, that William Snedden came from C. M. Colliery, in England, was one of the men that cleaned out that colliery after an explosion, and also at the ———, two of the greatest explosions that ever occurred. He was fully sixty years of age and I never met a man that knew so much, but there was just one thing wrong with him, he could not pass an examination, and he was a very rough, broad, outspoken Scotchman, and he offended many people. He went in that morning, went through that mine, went out and got his breakfast and went back in that mine and died. Now do you think any man who had the least idea that there was danger in that mine, would go out and get his breakfast and go back to his death? Now do you think that? I don't. That is one reason that makes me think that Mr. Snedden did his duty. I know I got the report. I went to the desk in the engine house. I was going down the shaft myself. In five minutes more I would have been down. I went to the desk, read the report, put it back and asked the engineer for the cage. Just after that accident happened I recollected that fact, that that fire boss' report

was in the desk, and as soon as I could, I went to the desk and put that report in my pocket and carried it in my pocket for several days. I am very glad that I did, for the report in that other mine did not turn up for ten days. The fire boss' report was the only ground we had to sustain us all the way through. The fact that the report was there. The man was gone.

MR. HAUGHEE: I think, like our Pennsylvania friend, that precaution is the greatest safeguard in working a mine, for the reason that mines that generate gas—you may search the works to-day, and you won't find anything at all, but to-morrow or day after to-morrow, the conditions may change. A door may be broken down, a brattice plank be knocked off, or something that will change the conditions of ventillation to a great extent and then you may go over the same ground you had been over a day or two before, where you found no gas and find a great volume of it. That has been my experience. For instance, in No. 4 mine, I used to occasionally make a habit of searching the old workings for gas, because it generated gas, but the old workings were kept ventilated. We nevor found any standing gas, but one day, especially, in passing an entry which had been abandoned for quite a while, I said to the fire boss who was with me, "we will go down through here." He says: "That entry is not working, it has not been worked for quite a while." I says, "I know that, but we will go through here anyhow." So, after we had proceeded a short distance we came to a trap door that turned the current into these old workings and it was standing half open. I asked about it and he said it was new to him. So we found that a track layer had drawn a hinge and the next person that went through found it did not work easily and left it standing open. So that was the condition. I says, "Now I will take a stroll up through the old workings, and you may stay here." So I left the naked lamp and lit the safety, and I didn't go forty feet until I found a great volume of gas within a few feet of the floor. Now that was caused as the gentlemen says, by carelessness. I believe there was gas enough in there, if I had gone in there with a naked lamp, to have blown the hoppers off. Our protection was to put up danger signals.

I did not want to stop the men. I will not mention the fire boss' name at all, but he was an old and experienced man. As soon as we found that, he went to shut that door. What would have been the result. That gas would have been carried into the other entry and an explosion would have occurred, so I told him not to do it and we went and notified the men not to go into the west third entry where this gas was, because there was a large volume in there, and that night we turned the air in there and cleaned that out.

MR. KEIGHLEY: I would say that about a year ago we had in our Oliver No. 1 Mine an outburst of gas at half past nine o'clock in the morning. Perhaps I can show it on this plan. (The speaker here explained the situation from his diagram.) About half past nine on the morning of this day, the mine boss was there and noticed nothing unusual. He went towards the No. 2 shaft in his regular round and he said for some reason, and he never knew what, but he had a strong impulse to go back of the shaft head and in one hour's time he went back there and when he got there the lamps were all filled with fire-damp, every lamp. The men were coming back with their lamps all full of fire-damp. He at once withdrew the men and he found that in one hour's time that heading had filled back 500 feet. Now that gas did not come from the coal. While it seemed to come from the coal, it came from this drift fault that overlies it. For 400 feet that is filled with not exactly drift but a mixture of shales, fire-clay, etc., and it appears that that fault has gathered the gas. On the south side of the fault we have never found any gas. Particularly the No. 2 has never given an indication of fire-damp and we think that fault has drained that section of the mine. Now there is a case where no one on earth could have foreseen a case of that kind.

Now there is another matter about fire-damp. When we know we have it, you say we can put in air and take it out. Now that is not true, I know that.

(At this point Mr. Keighley explained from his diagram in detail the plan of a mine which he had charge of.)

Now here was about five acres of waste workings and it was

all full of gas and it came right out of that heading. We were afraid that a driver would some day break his lamp or drop it or, coming down at an unusual speed, pass the flame through his lamp. We thought we could get that out by turning the air through there. We thought we could drive that fire-damp out. We got a cross cut right through there, right opposite this place and turned the whole current of the air through there. Now, we thought, we are going to clean it out. We put a door on temporarily and left it until the next morning so that that air passed through those five acres. When we went there the next morning there was as much fire-damp in those rooms as ever. So we came to this conclusion, that the air just simply board a hole through the gas and left it or passed through the gas and took some, but the great bulk remained there untouched. That thing was a terrible weight on all of us. We knew the rock had not broken. We had got the first fall and we knew we were within a very few feet of the 40 foot sand rock. That rock is very massive and it takes a great space to break it. We were afraid that rock would break and drive the gas through the mine and in spite of the safety lamps that it would ignite. We tried everything we could think of. I spoke to the company about it and I said I would like to try an experiment if they would pay for it. They asked me what it was and I told them and they said go ahead. I bored a hole 300 feet down from the surface. It proved to be a success, because the moment that hole struck the gas came out and we have never found any gas there since. The present mine inspector was there previous to the boring of the hole and he came there afterwards and he made his way up 40 feet in the fall. It was not safe to go that far, but he said he was determined to find out the effect of that. He said that at 40 feet above the level of the floor he found no gas and that hole is giving off gas to this day. It is no new idea. I thought it was at the time, but I got a book the other day and in reading that book I found that it has been a common practice in a certain district in England where they have two seems. The lower one is very gaseous and the upper one is not gaseous and it has been a practice with them for a number of years to bore a hole down

from the upper to the lower and tap the gas. So there are two instances where a hole bored down has taken out the fire-damp. You can talk as you please, but there are conditions where you cannot take out gas with air.

CAPTAIN MORRIS: When Mr. Keighley was speaking about that hole, I was reminded that that has been practiced for a good many years. Almost 40 years ago, when I was a boy, in our country in Wales, one of the most gaseous mines that was in Glenmorganshire, could not in any shape or form be ventilated so that they could, at that time, use the Davy lamp. It was so strong that they had to stop it. The gas was so strong it would heat the gauzes until they were red hot. So they came to the conclusion to do as Mr. Keighley did. They bored a hole down to the workings. It was an eight inch hole and they tubed it right to the bottom and when everything was finished they put a light to it and that light is burning to-day and it drained that mine of gas so that they could work there with safety lamps. So it has been practiced you can see for a long time in that little Welsh country.

I was in a rolling mill shaft one day some years ago in Steubenville and going through the mines. The mine was clear of gas, that was, the workings. The gentleman who was at that time superintendent said to me "Captain, wouldn't you like to go down through our old workings. It is nice and clear there and I want to show you that we don't keep a standing gas in the mine." I said "Yes sir" and we took a trip through the old workings. There were acres and acres of it. Probably Mr. Roy here knows about it. I wanted to know how he ventilated that. "Well", he says, "the pumps down in the old shaft keeps this going." Well, we went through and we didn't find a lamp full of gas in any place. The next day we went in again. It was necessary to take two days to inspect that mine, it was so large, so far in, and on our way in there was a door going to the old workings and I said "let's go in to-day and see how everything is to-day." We had our safety lamps and we hadn't gone 25 feet from that door until our lamps were full. Now the next thing was to find out what was the reason of that. We could not

determine at all. We knew that the gas was there. We went out. I knew it was getting pretty close then. Within 25 feet of the main hallway of the rolling mill shaft. We came to the conclusion that it was better to stop the men and fetch them out until we investigated the matter. We did so and when we went to the top of the shaft again there was a man had come up and said that the pumps had stopped since midnight, that the pump was broke and the water had risen within six inches of the top of the entry. It was evident there was the reason of it. Now there are so many different conditions that can generate gas in our workings that we have got to be very careful and always on the alert as to the reason of these things and the best way to get away with them. The only way to get away with that was to get that pump to going as quick as possible. We got it going that day and the next morning at nine o'clock there was not a bit of gas there. The conditions are so different that we can hardly at all times determine what is the matter until an investigation is made.

MR. KEIGHLEY: I would like to say a word about that bore hole. While it was good for us, I would not recommend you to put it down because we did. We have certain conditions at our place. Mr. Duncan, our ex-mine inspector, my successor and predecessor to the present mine inspector and myself talked together a great deal about that matter and he says "I don't think you had better undertake that bore hole." He says "You want to remember at the Hill Farm the bore hole took the gas and that is what made the disaster," and he says, "I am going to go around for your benefit and mine to all the bore holes I can reach and note whether the flow is down or up;" and he went to five different bore holes and in every case he found there were intakes instead of outtakes. Now I do not know the conditions that existed at those holes, but I can imagine the condition. Now I can imagine conditions at our works where that bore hole would have brought disaster, because 70 or 80 feet above the Connellsville coke coal is a little seam of coal about two feet thick and that generates fire-damp and that bore hole going through that, if it been an intake instead of an outtake, instead

of taking the gas out it would have added more to it. In boring that hole, we took the precaution to case the hole. Now if that bore hole of ours had not been cased and the hole had gone down—there is a vast amount of water in that hole and water would have run down and in spite of our fans it would have taken that gas in, like an inspirator taking water into a steam boiler, but we cased it off tight and I could see no reason why going into a bell-shaped cavity, it should not drain off the gas. I thought that it could not be otherwise than successful. But with all that, we took precaution. The first precaution was to remove the boiler from the hole. After the hole was started down to the rock and they had got into the rock, I went to the contractor and said "you will have to move that boiler." He says "we can't do it, we can't drill." I says "you don't drill another foot with that boiler there, because, if you strike gas the gas will ignite and it may go down as easy as up." He studied about the matter. I says "it is a matter for your own safety as well as ours, because your men may be burned." So he moved his boiler and carried his steam 500 feet to his engine. In that way we bored a hole, but we did not bore the hole in working hours. We only allowed them to bore that hole on notice from the mine boss. We placed that matter entirely in the hands of the mine boss and he notified them when to start to work and when to stop. We put the whole responsibility on him and he took charge of that and they didn't bore any while we were working, but in spite of all our precautions and even after we had put the standpipe on it, some person came along and ignited it. Whether it was done playfully by boys or designedly I do not know. I am inclined to think some boys did it, but the gas burned and it did not go down to the mine. There were some men in the mine at the time There was a great deal of excitement for a little while until they got the gas out, but you can see how that might have resulted in a great disaster. So, before starting to bore a hole, you want to study your conditions pretty well.

THE CHAIR: Gentlemen, the morning is going very rapidly and we have a very long programme, and we have another paper following which bears upon this matter more or less by Mr. Hibbs, of Scio.