LIGHTNING IN THE PIT AT TANFIELD MOOR COLLIERY.

It having come to the notice of several members of the Institute that lightning had been stated to have entered Tanfield Moor Colliery on Monday, July 12th, 1880, and traversed the workings in several directions, Mr. William Joicey kindly gave them permission to examine the witnesses of the occurrence and the workings of the colliery so that a complete and accurate report could be drawn up of the circumstance; and, on the 30th July, 1880, Mr. C. Berkley, Mr. J. B. Simpson, Mr. W. H. Hedley, and the Secretary went out to the colliery and were met by Mr. W. Joicey, one of the owners, Mr. Pringle the viewer, and Mr. Arkless the resident viewer; and the following statement is a record of the information then obtained:

The top of the working shaft at this Colliery is 36 fathoms from the Shield Row Seam, and Plate VIII. shows the arrangements at the bottom of the shaft; Fig. 1, Plate IX., shows the plan of the workings; and Fig. 2 shows a section through the north incline way and the south engine way; both plates show the position of the different witnesses at the time of the appearance of the lightning; and Plate X. shows the position of the pipes, ropes, and signal wires in the shaft. It will be seen by these plans that the Incline Bank leads northwards from the working shaft and ultimately reaches the day by a drift at X, and a little to the south of this is an up-cast shaft. The Engine way leads south from the working shaft, and goes in-bye to the goaf at Y. It will be remarked that between this goaf and the working shaft there are two down-cast shafts, one of which is to the south of the furthest witness at this part of the pit. From what can be gathered, the lightning passed down the working shaft and struck the flat-sheets and then divided itself into two parts, one of which went north up the Incline way and probably passed out to the day at X, where it is supposed to have left traces of its exit in marks upon a bank of rubbish near by. The other part went south, along the Engine way, but after passing the point B, where it was noticed, its further course is not known; the thill of the seam is composed of soft sagger and the roof of strong post, both of which would offer great obstruction to the absorption of the
electric fluid, and the probability is, that this portion of the fluid had been
dissipated in the goaf, or had forced an exit by way of the down-east
shaft, No. 2.

The following evidence was taken:—

JOSEPH KIRTLEY, back overman, said, that on Monday, the 12th
July, about 3 o'clock p.m., he was on the north side of the shaft, about six
yards from it. A light, distinct but not very bright, fell and struck the
flat-sheets, and split up into several lights like a lot of lighted matches.
He could only see the light for a moment among the tub wheels. It struck
the puller-out William Watson, who said, "Man, something struck me on
the arm;" he complained that his arm was numb. The onsetter, James
Offord; H. McGie and Wilfred Reay, drivers; and John Burdis, who
minds the drags, also saw it. Watson told Kirtley afterwards that when
he got home his left arm from the wrist to the elbow was quite yellow.
Kirtley said, "That's lightning;" and the onsetter said the same. A
heavy peal of thunder was heard very distinctly almost at the same
moment. No injury was done either in the shaft or on the road where
the lightning was said to have passed. He could liken it to nothing better
than a box of matches all struck at once.

JAMES OFFORD, onsetter, said that on Monday, the 12th of July,
about a quarter or half-past three, he was at the shaft bottom on the
north side. He had just sent the west cage away and had his back to
the pit, perhaps two or three yards from it, taking hold of a tub to be
ready to set it on in the next cage, when he heard a crack like the
report of a small pistol, and saw a light close to his feet. He was on the
north side of the pit. William Watson was standing on the opposite side
of the pit, and saw the fire strike the flat-sheets and make its way
towards the North Incline. He also felt another part go past him to the
south. He heard a heavy peal of thunder almost immediately on the
light being seen; did not recollect ever hearing such a heavy peal; he
never noticed lightning come down the pit before. The slides in the pit
are all of wood. There are two sets of steam pipes; they come from bank
under the heap-stead and down the pit, and go into the south side just
over the head of the puller-out.

WILLIAM WATSON, 24 years of age, puller-out at bottom of pit, said
that on Monday, a fortnight past, he was standing with his left hand on
the empty tub that he had pulled out. He saw a flash of light come
down and heard a noise like a gun; he would be two and a half yards
from the pit. It struck on the plate, or flat-sheet, to the north of the
side he was standing on. He felt something strike him on the arm, and saw the light divide when it struck. His arm was numbed for a time after, which made him think that part went past him. He had the numbness all the afternoon; he felt something go all over him. When he went home and got washed, his arm was yellow from the wrist to the elbow. His sister, Ann Watson, who is about 21 years of age, saw the arm was yellow, but no one else. He had no pain in it afterwards. He heard a heavy peal of thunder immediately after the light fell. The light, when it struck, seemed very bright, but he did not notice it brighten up the place to any distance.

The evidence of the five following witnesses relates to the portion of electric fluid which was observed to go up the North Incline:—

**Thomas Crisp** said, he was a deputy, and on the afternoon of July 12th, the Monday previous to the Rises explosion (which occurred on Thursday, July 15th), he was on the north side of the pit, about 20 or 30 yards from the top of the Incline bank, in company with John Greener. (C, Plate IX.) They were bringing down a tram used for carrying timber when the electric fluid passed. Greener had his hand on the tram but he had not. He (Crisp) saw something like a lot of fire flying, and he thought the tram had cut the joint. It was like as though a person had trodden upon matches and they had gone off. Greener saw it as well as he. They then thought there had been a fall upon the rails, but as they proceeded down the bank no fall was to be seen. The fire came right up to the inclined plane; it seemed a little larger than the light of a candle, and came close by the tram where he was standing. To the best of his judgment it came along the metals.

**John Greener** said, that when going down the Incline with Crisp, and having hold of the tram, he saw a light on the rail about twenty yards off, about the size of a candle, flickering, not steady. It appeared to travel along the rail, and as it passed the tram it made a noise like the crack of a pistol, which he thought proceeded from matches or something on the way that was cracking. He saw it first fifty or sixty yards before it came to where he was standing. They were not far from a guiding-wheel which changed the direction of the rope, and there were men working at the wheel both east and west in a new place recently commenced. He had no idea that it was lightning as it flashed past; they had never seen such an appearance before.

In answer to some remarks from the visitors it was elicited that the rails were fished; that it was not noticed if the lightning came down
the rails or the rope; that it was a self-acting incline; it was a flickering unsteady light that Greener saw which was past in a second; there was a noise as it came to the tram as of a pistol or gun shot; it was not very loud, and a similar noise was heard as it left the tram; the metallic contact might have been broken by a fish plate being off. Crisp said that he did not think of its being lightning, but supposed that matches had been dropped which crackled as they went off.

Nicholson Watson said, he was going up the Incline bank and met Crisp and Greener, his feet were on the rail, and he saw a light go close past them, which seemed to numb them for a short time; as it passed it was like the spark and noise from the cap of a pistol when exploded. There was a wheel near and two men hewing close to it; he went to the men, who said they had heard a great noise, which they thought had been caused by the electric light being tried at bank. Two hewers at the bank-head, William Athey and John Brown, told him they had heard a report going off like a gun, and he remarked to them, "They are trying the electric lights from bank," but he did not think of its being lightning till he got to the shaft.

John Hagan, a patter, said, he saw lightning come along the plates. (D, Plate IX.) It caught him as it passed, giving him a sort of queer feeling in the legs; it made a sharp cracking noise in the plates, like a gun; it passed him as he was going down with his pony. He had seen matches put on the rails to be exploded by the trams passing over them—and the appearance was like that caused by the trams going over the matches. He thought it was lightning at first, before any one had time to tell him, because of the feeling about his legs. Where he was standing the rails were about 4 feet long, not fished, and with a good space between them.

Thomas Spring said, he was a hewer on the north side, and was working about fifty yards from the bank-head. (D, Plate IX.) He heard the noise and went a few steps back from where he was working. He asked the lad, John Hagan, what it was, and he replied it was lightning. He thought it was a fall of stone at the bank-head, and to be sure that there was no one hurt he went out to see.

The statements of the four following witnesses relate to the portion on the south side of the shaft.

George Crisp said, he was a siding minder, and was about fifty yards from the shaft. (A, Plate IX.) He heard a cracking noise, and saw a bright light and flash of fire against the big binding sheave (two feet
It is new light, the noise. The possibility of lightning penetrating into the workings of collieries. All further observations, which can only be based on conjecture, it is considered had better be made during the discussion after the communication has been read, which it is hoped will be taken up by some of the members of the Institute who have made electricity their special study.

The President said, this was an inquiry of very great interest. It was not entirely a new one, because suggestions had been made long since as to the possibility of lightning producing explosions. The question came before a Select Committee of the House of Commons on
Accidents in Mines, on the 26th of June, 1835, when evidence was taken upon the point. Mr. George Stephenson, in answers 1705 to 1733, gave his views at great length, and doubted the possibility of gas exploding underground by lightning. Mr. J. Buddle was then examined in answers 2191 to 2211, and said, amongst other evidence; that “the Lawson Main Pit was exploded by the lightning. The pit was upwards of 70 fathoms deep, and was not particularly fiery. The explosion took place at or above the surface. I happened to be near the pit during the thunder-storm. A flash of lightning exploded the gas, and a very heavy explosion immediately ensued. I cannot state the interval between the flash and the gas being perceived to be ignited, but I understood it to be instantaneous. I know a fact, recorded by my father, of the engine pump having acted as a conductor and carried the electric fluid to the bottom of the pit; but I do not know it of my own knowledge. My father saw it.” The meeting would be exceedingly glad if any gentleman would be kind enough to favour them with any opinion on the matter, or with any facts which had come before them.

Mr. A. L. Steavenson said, he remembered hearing about ten years ago of a circumstance of a similar kind. It was told to him that the boys at the siding about a mile in-by at the Page Bank Pit had seen lightning running along the rails at the time a heavy thunder-storm raged on the surface; but it seemed so entirely unlikely that he took very little notice of it at the time and made no inquiry. When he saw the notice of the Committee’s report upon the agenda paper, however, the circumstance immediately recurred to him, and he would take the opportunity of trying to get some evidence on the subject. The difficulty which occurred to his mind at the time was, that the lightning should run along the rails and do no harm.

Mr. May said, he had had a little experience connected with the action of the electric fluid underground, which might be interesting to the members. In this particular case, at Tanfield, it was stated that the lightning went down the pit and went along the rails or along the rope; but the difficulty was to know what became of it. At Boldon Colliery they fitted up some electric bells about a mile from the shaft, and the electricity could not be got rid of after it had been used for the working of the bells, the bells themselves ceasing to work in consequence. Ultimately they tried to get rid of it by fastening one of the wires to the rails and thus endeavour to take the electricity out-by again, but to no purpose, until it was discovered that about 200 yards of the way was not fished; and it was this break in the rails which prevented the bells working. As soon
as a small piece of wire was attached on the 200 yards to couple up the lengths that were not fished, the bells went to work at once. Seeing the difficulty of getting rid of the small quantity of electricity required for the bells, he was led to ask how the much larger quantity that went down the Tanfield pit was got rid of. At Harton Colliery, during the late severe storms, the lightning struck some wires which were used for connecting the electric bells at the bottom of the pit with the engine house at the surface, and it passed along into the engine house and fused all the small wires upon a telephone, and so passed to the earth. The lightning did not go down the pit at all, as the resistance through the telephone on the surface in the engine house was very much lighter than that which it would have encountered in having to go down the pit.

Professor Herschel said, the question which seemed to be a very important one was, what became of the lightning when it entered a pit? And it was in a great measure answered by the very excellent paper which they had heard read, and which he thought contained more abundant information on a particular point of a very interesting character than he had met with for some time, or had ever been able to fall in with. The paper showed quite clearly what was the nature of the occurrence which took place in the passage of the fluid and certainly described a clear case of lightning stroke. It had been a matter of deliberation with him for a long time whether accidents of this kind, where injuries were done to instruments, might be produced without the actual stroke of the lightning, by what was called the return stroke. A flash of lightning which took place in the clouds never reached the earth at all. There was a great relief, not only of the strain on the clouds themselves, but of that on the earth which had sympathised with it; and the rush of the fluid which streamed through the earth might be of such magnitude as to do these injuries. If the water pipes and gas pipes of a town were connected together, by telegraph wire for example, the largeness of the area covered by the water pipes, and that covered by the gas pipes, might be very different; and under the attractions of electricity in the clouds, there might be an electricity of one kind accumulated in the large area of the water pipes, and of the other kind accumulated by influence, or induction, on the area of the gas pipes. When the relief takes place in the clouds these two electricities unite themselves on the earth, and the passage through the telegraph circuits which used these earths might be severe and injurious. He had often questioned whether there might be sufficient strength in these return strokes, as they are called, to do these injuries. He doubted it now; and this history which they
had heard especially convinced him that the accidents which occur are really strokes of lightning—of electricities coming from the clouds to the earth. Then the question arose, where does the electricity go to? And the fact just described by Mr. May that the bells would not work at the bottom of a pit because no good earth could be found there, was a fact which he could confirm by experience. He had had to put up bells in this house, and had taken the earth wire to almost every accessible piece of metal-work in the building, and finally even to the lead and gutters of the roof, without being able to find earth sufficient to work the bells, until he tried the water pipes, and in joining the wire up to the water pipes it found good earth. Laboratory electricity, however, differs altogether from lightning electricity; not, as was supposed by Mr. May, in the quantity of the fluid which had to be got rid of, for the difference was just the opposite. In the laboratory there was a great quantity of electricity to be got rid of, but it was of very low tension, and it would not overcome resistance. A passage to the earth that was unsuitable for a bell was quite suitable for a lightning stroke; and the lightning would spring from wires to the earth, and make its escape where laboratory electricity could not follow. The quantity of lightning electricity was very small; but coupled with its high tension where it passes, it does a work far exceeding what a current of less stress would do, and it would melt the wires which it was able to traverse on account of its intensity or strength; it melted thin wires of great resistance, like those of telephone coils.

In a case like this, where a real stroke of lightning had, he believed, come down the steam pipe, and thus descended the shaft to a certain depth, it found there rails spread over a large surface of earth. This probably was a very dry pit, and it might very reasonably be asked how the electricity found its way from these rails? It would not do any harm in passing along the rail, but in jumping across from one to the other, the flash and the heat produced there would be dangerous to a colliery by the risk of firing explosive gases. If a safe earth for the lightning at the bottom of the pit could be insured, there would be no injury from it underground. The facts which were learnt in the present case were, that the lightning on reaching the bottom of the steam pipe, not having any chance of escaping into a sump full of water as might have been the case had the pipe gone to the bottom of the shaft, sprung down to the plates, and from the plates to the rails, and found its way along the tram roads. The pit must have been very dry, for the lightning did not escape to the earth as readily as lightning from a lightning conductor is supposed to do; but having entered the rails,
spread along them, seeking the earth at every foot or yard it ran in that way; and the fact, for instance, that at 700 yards from the shaft the sound was heard and no light seen, showed that the lightning had diminished in power by the time it arrived there; it had partly escaped into the earth. 400 and 500 yards from the shaft there was still much left; but he thought it would be found from the workmen's accounts, who were in the inclined way, that they spoke of considerably less light and less noise appearing between the breaks of the rails than the setter-on and the pusher-out at the bottom of the shaft mentioned, where the character of the flash as it fell upon the plates was like that of a gun, and the lightning struck with a light upon the plates which alarmed them all. There could be no doubt that the lightning did make a great flash just there, and passed on into the rails, and there it diminished its strength as it reached to greater distances. All that was perfectly in harmony with what would be understood from lightning leaking out of the rails as fast as it could all along the earth-way. The rails afforded a tolerable earth for the lightning. He thought it was of importance, however, to learn in such cases what took place above ground. There was a thunderstorm, and a thunderclap was heard at the same time. It would be well to know whether on every such occurrence as this it could be ascertained that a lightning flash was seen at the top of the pit. If this proved to have been the case, pits were in need of lightning conductors as much and more than ordinary buildings; just as a powder magazine should be protected by a good lightning conductor, so also should be a pit; and the nature of that lightning conductor should, he thought, occupy the attention of mining engineers and students, and of those who are acquainted with electrical science, and particularly of electrical engineers, of whom he hoped there might be some present who would give some information on the subject. The narrative which they had just heard, showed that rails, extensive as they were, and far as they might lead away lightning, are yet scarcely a better earth than short steam pipes, and that although the rails laid down in a pit do conduct to carrying away electricity, they yet retain the flash for long distances. On the other hand, this flash might probably be avoided by pointed conductors on the surface, which was the only way in which a lightning flash would ever be effectually prevented.

He had thought it might interest the members of the Institute to show them an instrument which he brought from Paris the other day; it was intended to serve as an electric light for the dark places in the pit. It was a gas-vacuum tube, through which a discharge of elec-
tricity passing produces a useful light. He would not wish to work by it, and as the sellers of the instrument said to him, he thought it was an instrument for amateurs, and not for practical use; because there was danger of the electrical spark passing between unprotected portions of the wires connected with the instrument. The instrument, therefore, was one of a dangerous nature; and he thought it should be borne in mind in reference to the use of electricity underground, and especially in very fiery pits, that there was always risk of a spark becoming sufficiently strong in the case of breakages of the circuit to have dangerous effects. The experience of George Stephenson on the subject, viz., that electricity seldom fires gas, and is probably not dangerous on that account, had no doubt a great deal of weight, and he (the Professor) thought it might be true that, as ordinary electric sparks have not nearly the body which a candle flame has, such small electrical sparks as are likely to occur in the bell circuits which are now frequently being put up would not be of any serious risk. But should it come to a question of using electricity for mechanical working underground, he thought the risk of inflammation occurring from the use of the electrical current might be a very serious one. In the examples which the members had had brought before them to-day, the discharges had been of a very much more violent character, and he would like to know how far the experience of telegraph engineers, on their lines where the instruments are sometimes destroyed even where lightning guards are used, led them to think that the destruction was likewise produced by the lightning stroke itself, and whether pointed conductors would avoid the occurrence of this damage?

The President asked, how the steam pipes going down this shaft were supported?

Mr. Pringle—They were supported by wood. (See Plate X.)

Professor Herschel said, he had not before thought of the circumstance, but the lightning in this case made its way along C and D, Plate IX., to the open mouth of a drift, and from what had been described it may have passed out of the drift. On that the suggestion was made by Mr. Bunning that the lightning tried to make its way out to the air again. It would, of course, naturally have been expected that it would try to make its way to the earth. But he thought it quite possible that the explanation suggested was true, and that in this case the lightning tried to make its way through the earth by another flash having taken place—one down the pit and one down the drift—the two flashes seeking to join each other through the best conductor they could find, which was along the waggonway.
Not enough is known as to where lightning goes after it has struck a conductor, and as to what earths are needed to get rid of it; that was a point upon which the experience of telegraph engineers was wanted. It might be that rails were very poor means for the discharge of the electricity, and that the thill or floor of the seam was often so dry as to be a retentive material, or very bad conductor, as seems in this instance to have been the case. It might, therefore, be a question for the miner to inquire what sort of earth he ought to provide for his lightning conductor, which should be adopted at every pit.

Mr. D. P. Morison said, a very curious case occurred near Acomb, Hexham, about six or seven years ago, in an old pit which had been totally disused for two years. It had been sunk, he believed, originally for a lead mine, but they found a small seam of coal; and they had worked a little coal out of that pit and then tried for lead afterwards. When the pit was closed, the wire-rope guides and the ropes were left in the shaft, and two years after the pit had been closed up, in a thunderstorm on a Sunday afternoon, the pit blew up. The cages were sent out of the shaft along with the ropes and other debris. Now, there was no chance whatever of there being any naked light down below, or near the top, which was railed off. The pit was altogether in private grounds; and, according to the account of a man who was walking in a field near the pit, the flash of lightning and the blowing up of the cage were simultaneous.

Professor Herschel said, he had not heard of the case, but should think there would be many such, and that the ironwork which was laid and left down a pit might afford an excellent earth for the lightning and prove a great attraction for it; and he should think that rails carefully fished over a large area might be the best earth which could possibly be used for providing lightning conductors with.

Mr. A. L. Steavenson thought it natural to suppose that the lightning would strike the pulleys, which are the most prominent object at the pit head, and then run down the rope into the pit, much more likely than to follow the steam pipes.

The President said, there was only this objection to that supposition, and that was, if the lightning did strike the pulleys, instead of going down the shaft it would go down to the engine house and get relief there.

Professor Herschel—Except for the attraction of the rails underground.

The President—Yes; but it would take the shortest way where there was less difficulty in passing to the earth, which would be through the means of the engine house to the earth rather than going down the shaft to the earth.
Professor Herschel.—The earth alone is not a good recipient.

Mr. Morison said, he would like to ask Professor Herschel whether lightning could light up gas underground unless it was in a thoroughly explosive condition?

Professor Herschel said, it would have to be highly inflammable. In the laboratory they found that electricity did not succeed in exploding mixtures which were only approximately inflammable. Sparks from lightning would be more intense than sparks given off in small experiments, and on that account they would very probably be more dangerous.

A Member said it had been mentioned that the Risca explosion occurred at about the same time, and there was a good deal of speculation as to whether that explosion was caused by electricity. As all life underground was destroyed, there was no evidence to show what did happen there; but the workings were very dry and dusty, and the result of the inquiry was, that the explosion had occurred in-bye, and that there had been an accumulation of gas, but there was no evidence to show how that gas had been exploded.

Mr. Ryder said, it had been mentioned that there were some traces of the lightning flash upon X at the daylight drift, Plate IX.; he would like to know of what character these traces were, and whether there was any damage done?

Mr. J. B. Simpson said, with respect to this question, there was no definite evidence as to its having gone out there. Some of the witnesses said there was a mark on the side of the drift which might have been caused by the lightning, but the Committee had no other evidence.

The President said, he would like to know whether any of the foreign engineers had made any statement as to their experience, or whether any member had any knowledge of anything having appeared in the Transactions of any of the Foreign Societies upon the subject?

Mr. Morison said that both in Belgium and Germany, as a rule, they had lightning conductors on the top of the pulleys.

Mr. Simpson asked whether that might not be to save the surface buildings, and not to prevent the lightning going down the shaft? The surface buildings in Belgium were very large.

Mr. Morison said, the conductors might not be put up to prevent the lightning going down the shaft, but would still have that effect.

Mr. Bunning said, he had noticed that the use of lightning conductors abroad was very much more general than in England.

Mr. Morison—It is very much more general.

Mr. May said, that at Harton Colliery, where they had two or three chimneys, and very high houses round about, they had them protected
To illustrate the paper "On particulars relative to the fact of Lightning having been seen in the Pit at Tanfield Moor Colliery."

**Shaft Bottom**

Scale


E. Position of the witness J. Offord.

F. ... do. do. W. Watson.

G. ... do. do. J. Kirkley.
To illustrate the paper "On particulars relative to the fact of Light"

**TANFIELD MOOR**

**PORTION OF WORKINGS**

**FIG. 2**

Incline Way Section same scale

**FIG.**

The Dotted Line shows course

A. Position of the wine.
B. do... do... do
C. do... do... do
D. do... do... do... do
Colliery,
Shield Row Seam.

Engine Way

taken by lightning.

G. Crisp
G. Nicholson and J. Pyle
T. Crisp and J. Greener
T. Spring and J. Bogan
To illustrate the paper "On particulars relative to the fact of Lightning having been seen in the Pit at Tanfield Moor Colliery."

**Willie Pit Shaft.**

**Tanfield Moor Colliery.**

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**Shield Row Seam:**

*Signal Wire*  
*Rope*  
*Steam Pipe to Underground Engine*  
*Exhaust Steam Pipe*  
*To underground Engine*
by lightning conductors; yet still the electric fluid struck the wires which are only about 10 or 12 feet from the ground.

The President said, the matter had now been very fairly discussed, and he hoped it would receive the attention of those gentlemen who were more conversant with electrical matters than many of the members, and that they would endeavour to let it be known whether there was any possibility of an accident happening from an explosion of gas by lightning passing underground, and if so, whether the danger could be met by finding earth, as Professor Herschel had put it, without the lightning going in-bye. Perhaps this subject might receive consideration, and the members would be very glad to hear of it if any gentleman arrived at any satisfactory proposition.

The Secretary said that an electric signal apparatus for use at pits was now being exhibited at Messrs. Mills and Co.'s, Forth Banks, and those gentlemen would be very happy to exhibit it to any member of the Institute who liked to go round and see it at the close of the meeting.

The President moved a vote of thanks to the Committee of Investigation for the most interesting paper they had given, and also to Mr. Kendall for his paper.

Mr. Steavenson had great pleasure in seconding the motion.

The votes of thanks were then carried by acclamation, and the meeting terminated.

Since the discussion took place the Secretary has received the following communication from Mr. Heaviside, the Superintendent Engineer, Post Office, Telegraph Department, Newcastle-upon-Tyne:

1, Grafton Road, Whitley, Newcastle-on-Tyne,
20th December 1880.

T. W. Bunning, Esq.

Dear Sir,—Mr. Ryder has been good enough to favour me with a perusal of the accompanying proofs, and I beg leave to offer the following observations thereon:

I have read the evidence and there can be no doubt that the pulleys, the steam pipe, and the signal wire were struck by lightning; and owing to the imperfect fishing of the rails, the charge, whilst in the act of dissipating itself over the various conductors which carried it to earth, experienced so much resistance in its course that heat and sparks were caused, accompanied by slight reports as described by the witnesses. I have no knowledge of the pit in question, but it almost follows that it must be a dry one, and also that the surface must have been dry at the time of the lightning discharge, otherwise the phenomenon would have taken place much more quietly.

Remarking upon Mr. May's observations. It is a law that all circuits must be complete within themselves for a current to flow, hence if the bells would not ring
there must have been a break in the circuit, and Mr. May points out where the break was; namely, in the earth connection; for as soon as that was made good by connecting the 200 yards of unfinished rails, the bells worked all right. Hence in the Harton pit also, if the earth connections at each end of the wire were perfectly made, there was no path, or a path of such very high resistance, owing to the dryness of the pit, that but a fraction of the current took the course intended for it, and that fraction was insufficient to work the bells. The whole question of the safety of the pit from being struck by lightning appears to depend upon the nature of the earth connections made on the surface. Now, with ordinary telegraph instruments, it is a well-known fact that where the earth is riddled with shafts and underground workings, or is artificially raised, as at the Ballast Hill at North Shields, a good earth connection is not obtainable. I can mention three cases in particular: Throckley, West Stanley, and the Ballast Hill at North Shields. At Throckley the “A B C” was fitted with a switch, so that each side of the line could be used independently of the other, but when the switch was turned to say line A, it was found that line B was also getting the message intended for A; what happened was this, owing to the imperfect earth connection, the current had three paths open to it, the one to line A, the other to the earth, and the last to line B, the current dividing inversely as the resistances of the three paths, probably the greater portion going by line A, and smaller portions by the earth and line B; this difficulty was got over by taking care to make the earth connection of large surface.

At West Stanley the wire was frequently being reported faulty and this was finally traced to a defective earth at West Stanley.

At the Ballast Hill, North Shields, the earth wire had to be carried down into the River Tyne, otherwise there was danger of failure of the Time Gun.

Mr. Steavenson’s remarks as to the lightning probably striking the pulleys is a most pertinent one, and though the lightning would take every path open to it, the pulleys being so prominent and the rope continuous, that path would probably have the largest share of the charge to dispose of.

With regard to the chimneys at Harton being protected with lightning conductors and yet the telegraph wires 10 or 12 feet from the ground being struck by lightning, this is probably explained by the fact that the wires in question extend over a large surface of country, and no matter where struck the charge would be felt at Harton.

The practical point is how to prevent lightning discharges entering pits, and being a source of danger, the extent of which is not well understood: obviously, to protect the mouth of the shaft efficiently, lightning conductors should be fixed to all lofty chimneys and buildings in the neighbourhood, the various points upon a building being connected to the main conductor, and this conductor must be continuous and make good earth. To effect the latter, should the surface and pit be dry, it must be taken to some point, no matter how distant, where a good earth can be obtained, and nothing is better than the bed of a stream or the water mains.

At most collieries I have observed a reservoir of water, and in many cases a stream of some volume due to pumping operations, and in those cases there can be no difficulty.

Then there is one other point, the conductor or conductors must be tested from time to time so that it may be ascertained that they are intact and making good earth.

I have not specially studied the subject of lightning conductors, but it is a pleasure to comment upon so interesting a topic.—I am, yours truly,

A. W. HEAVISIDE.