SCENES AND INCIDENTS

FROM THE

LIFE OF A PRACTICAL MINER,

WITH

A TREATISE

ON THE

VENTILATION OF COAL MINES.

BY ROBERT SCOTT,

LATE CHIEF OF THE VENTILATING DEPARTMENT AT COXLODGE COLLIERY.

THRILLING SCENE SEE PAGE 32.

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[SECOND EDITION.]

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TO THE MINERS OF THE UNITED KINGDOM.

FELLOW WORKMEN,—

To you I address myself in these pages, giving advice if you will listen thereto; reproof if, appreciating my motive, you will receive it; correction, if you will take it in the same kind and friendly spirit as that in which it is given. I am on old miner, and have gone through all the varied grades of labour, just as you are now doing. I have spent the best part of my life underground, and I know as well as any man your circumstances, your wants and wishes, your desires and necessities, your failings and your virtues. Give me, then, your attention for a few minutes, while I place before you my views upon a subject that intimately concerns you.

In doing so, let me beg of you each individually to divest your mind of every prejudice. As soon as you take up this volume and begin to make yourselves acquainted with its contents, you will be liable to rush into hasty conclusions, and either give yourselves, without reflection, altogether up to the teaching of the writer, or fall into the opposite extreme of treating all that he has written with contempt. Let me beg of you to guard against both these errors, to read dispassionately the facts and opinions I here place before you, and to form, each of you for himself, a sober and thoughtful judgment; unbiassed by feeling, free from caprice or whim, and unaffected by any preconceived ideas of your own. Were I writing to you alone, I could do so without diffidence, conscious we would understand each other; but, perchance, these pages may stray into a higher sphere of learning, and there meet with a cool reception; yet, if its vein be good, as I believe it is, then under a due consideration critics may prove lenient, and admirers generous. This is the earnest wish of your humble and obedient servant,

THE WRITER.

VENTILATION OF COAL MINES.

THE terrible accident at New Hartley has awakened public sympathy on behalf of the miner, and the wants of the sufferers by that calamity have been provided for with a generosity unparalleled in the history of mining disasters. Let not the lesson read to the mining interest by that sad catastrophe be suffered to pass unheeded. Accidents will occur, but how many that have happened in our pits might have been prevented either by foresight and a trifling expenditure on the part of the masters, or by care and attention to the pit rules on the part of the men. A great defect at Hartley (apart from the absence of a second outlet) was the non-walling of the shaft where the stratafication was known to be bad, an oversight that is now visible to the unfortunate owners, who, in their sad reverses of fortune, have my profound sympathy. But, taking all the circumstances of the case into consideration, I think none of us will be inclined to pass heavy censure upon these gentlemen, who worked their pit on the same principle as many others are being wrought, and apprehended no unusual danger.

But in the Burradon case things wore a totally different aspect. That accident, I venture to assert, might have been prevented, as might almost every other pit accident caused by an explosion of gas. You will remember that the officials at that colliery gave positive proof to the world of their incompetency to manage the important departments entrusted to their care. You will remember, too, the absence from the coroner's inquiry of a very important person, the master wasteman. He appeared to be a sort of sleeping partner in the firm, instead of having faithfully represented the state of the return to those responsible for the daily operations in the pit, and, if necessity required it, to the chief agent himself. If he had done this, which was his duty, it might have saved Mr. C. Carr many a sad and bitter thought. He would have told them, for instance, that they had lost the return on the north side of the straight-up travelling board, by the pressure or creep from the large 22 acre goaf to the north, which had destroyed every visible passage for the air; and that it was necessary for them to immediately provide another, which could have been done by converting the straight-up board into a return passage, by building up the scale, and doubling the doors at the foot of the board, knocking out the stopping to the north, in the inbye side of the inner door, and taking the air through again into its original passage to north and west. I think this is what the two officials ought to have done on that day when Dryden and poor Carr were leaving their work. Dryden and Carr saw danger imminent, so much so that it

was with reluctance they went back to point out where the danger was, motioning to a north holeing five pillar back from the face of the whole working places; one of them stepped in, and as he proceeded towards the door his lamp filled with the flame of hydrogen gas. Now, to a man possessed of scientific knowledge in the system of mining, this was positive proof that there was *no* return passage for the air to the north and west of this holeing, for Nature never erred; and if there had been any, there would have been a continual pressure on the south side of this door from the scale at the foot, and when the door itself was open at the bottom, as it frequently would be, then such would be the increased pressure on the south side of the door in this north holeing, with the passage open and free, that every one acquainted with the system of mining, even slightly, must see the impossibility of hydrogen gas lodging there. But the utility of this return passage being destroyed, then this north holeing became a vent, an outlet from the large goaf, and this was the cause of the explosion, which did not occur until some weeks after this visit of inspection by the two officials, and yet there had been nothing done to remove the danger or protect the men and secure their safety.

But I have often said, many years ago, that all explosions of gas in coal mines can be prevented, and you will ask me to prove my assertion. Fellow workmen: the laws of Nature are my authority; twenty years' practice in coal mines afforded me an opportunity of endeavouring to understand them, and my success in dealing with cases of frightful difficulty and danger have given me confidence to speak to you so positively; I therefore formally assert that no explosion could occur in a pit constructed with two separate shafts whose ventilation I should myself superintend. When an accident occurs, many of you conclude immediately that the owners and chief agent are to blame for the consequences; this, in my opinion, ought not to be, as the person to blame is frequently one who has sprung from your own body of workmen. I will show you how: Suppose an overman or master wasteman dies, or loses his situation, you know how the men flock to the chief agent, each professing to be sufficiently conversant with the science, and in every way qualified for the undertaking. The chief agent has a choice of perhaps a dozen or more; he fixes on one, appoints him, and confides in his man; and if he prove to be one of the right sort, then all is well; but if not, who is to blame—the master or the man? Now, I say the man, because he has imposed on the master by false pretensions. And this principle is very common with you, arising from a spirit of envy. You cannot endure the idea of your neighbour's preferment, yet you know as well as I do that there is not more than one common coal hewer in a hundred that possesses the necessary qualifications for those highly responsible situations. Yet how ready men are to accept them at all risks, regardless of the future and consequent results in thus perilling the safety of their fellow workmen in the mine. To guard against evils such as these, I would particularly recommend all aspirants, young in years, to gather honey in the summer of life, for it is not enough to wish for knowledge without due application to its resources, nor for perfection without practice and experience.

I may here introduce a particular incident that occurred to myself when life was young. I was requested by the overman to go and hole another man's wall, on the pay-Friday night, as the authorities wanted to change the air on the Saturday morning. Well, I was about a mile and three-quarters inbye from the shaft, and not a living soul in this district but myself; my only companion was my standing lowe, *i. e.*, a candle beyond the reach of accident; but it so happened that when I had nearly done my work, I neglected this candle, and by chance put my own out, and here I was left in the dark at that vast distance from the outlet. Being so situated my attention was particularly attracted to a variety of sounds issuing from the neighbouring strata. I listened in silence to the discordant music, and, groping my way to some of the loudest-toned of these whistling sounds, I found that all of them were fissures giving out their native gas, which I felt distinctly on my face and the back of my hand. Now, said I to myself, what can all this be? What a lesson of instruction is here to a contemplative mind! And need I tell you, fellow workmen, that I owe all the little I know to that peculiar incident. It was the means of unfolding to my view the true principle of ventilating a coal mine. In the first place, I communicated my ideas to an intelligent schoolmaster, and engaged him to get me the best works on Chemistry, Geology, and Mineralogy—determined to find out the secrets of these singing fissures, and, after three years' reading and observation, I satisfied myself that the earth and all Nature is composed of gases in varied proportion. And I found, too, that the gas liberated in a coal mine materially adds to the bulk of the general current of air, if extra and ample provision be not made for its progressive route through the mine, and back to the furnace and up-cast pit. Our common atmosphere is composed of 21 parts oxygen and 79 parts nitrogen, and it descends the down-cast pit with all its vitality and elasticity. But, consider what it has to encounter before it ascends again to unite with the atmosphere. First, you will observe that its passages are excavated drifts, containing four sides of strata, all of which, in certain places, give out their native gas. Suppose one cubic foot is evolved in 40 yards, you then find at that ratio that at the end of one mile 44 cubic feet in volume is added to the general current of air, and so on increasing at a similar ratio throughout the whole zig-zag windings of an extensive mine. To meet this condition of things, which you will see is a natural process, you must adopt a progressive principle also, by increasing in bulk the area of the air passages. You will see the necessity of this, as in it lies the secret of successful ventilation. For be it understood your current of air in the interior of the mine is not that susceptible body it was. It has been in a great measure deprived of its vitality, and at the same time has partially lost its, elasticity; and this may easily be tested by this simple experiment:—Measure your air, and you will find so many thousand cubic feet per minute passing. Now, come to one pillar from the down-cast pit, and put in a stopping, leaving an aperture of 144 square inches. Again you measure your air as before, and you will find no diminution whatever. Now take out the stopping, and put it in at one pillar from the furnace; and again measure your air at the same place, and you will find you have not one-third of the quantity. Now

you that are practising in the capacity of master wastemen, at once commence to increase the area of your air-returning passages, and you will daily increase the volume or quantity of air. I need not attempt to give you the relative measurements for the ingoing and the return passages, as in an extensive mine they are variable; but I tell you this, that if your drift at the down-cast pit be 40 feet, the united measurement of your passages approaching the furnace should not be less than 100 feet.

By way of illustration, I will relate circumstances that occured at the colliery with which I was connected. Some years previous to my taking charge of the ventilation, it so happened that the parties then concerned aired two districts with one volume or division of air, taking it first into the innermost part of the mine, where whole working places only were in operation, and as it returned from this district it was taken into the other, where both whole and broken, or pillar workings, were in process; but such was the vitiated state of the air when it returned from this first district, that it was frightful to look at, so much so that the master appointed three men of experience to watch it night and day, stopping eight hours each. Notwithstanding this precaution, such was the dread of danger that the men occasionally refused to work, and so perniciously did it operate on the health and constitutions of individual men that they were obliged to quit the colliery and go elsewhere to work. And, as if no improvement whatever could be made, the men and boys had to work with the safety lamp in this unwholsome atmosphere.

I found the evil sprung from the corrupt state of the return passages, several of which were little better than a mass of rat-holes, men crawling on their bellies to get through. The incident of being left in the dark occurred to my memory, and furnished me with the material of improvement. I instantly began to enlarge the return passages, taking the worst parts first, and as we progressed with the work we got an increase of air, which was our object. We persevered in improving the old, and paid due attention to the formation of the new, and in two years we could congratulate ourselves upon a sufficiency of air for any emergency, with not the slightest symptom of approaching danger.

Now you will learn from this, that all the magic necessary to be used is to form your passages for the air in unison with the laws of Nature. What you have to do is to make ample provision for conducting the air back to the furnace, and when there, it meets with a fresh impulse in the restoration of its former elasticity by the agency of caloric, and all is safe.

Having said this much for quantity, let me now speak of mechanical application, and in the absence of perfect plans of our principal explosions, it will be necessary to show you a district section of a plan, so that you may be able to follow the instructions, and the more clearly see the utility of my scheme. First, we will take the plan of Burradon, as presented to the public by the authorities of that colliery, and I wish it to be understood that I do this with no intention to offend; and if any man feels aggrieved at what I say, I ask him to remember that individual interest must sometimes be set aside for the general good; while it must be admitted that none is so able to instruct others as one who, for himself and by his own almost unaided efforts, has learnt to grapple with and overcome difficulties

Plan of

WORKINGS & VENTILATION

AT

BURRADON COLLIERY.

REFERENCE.

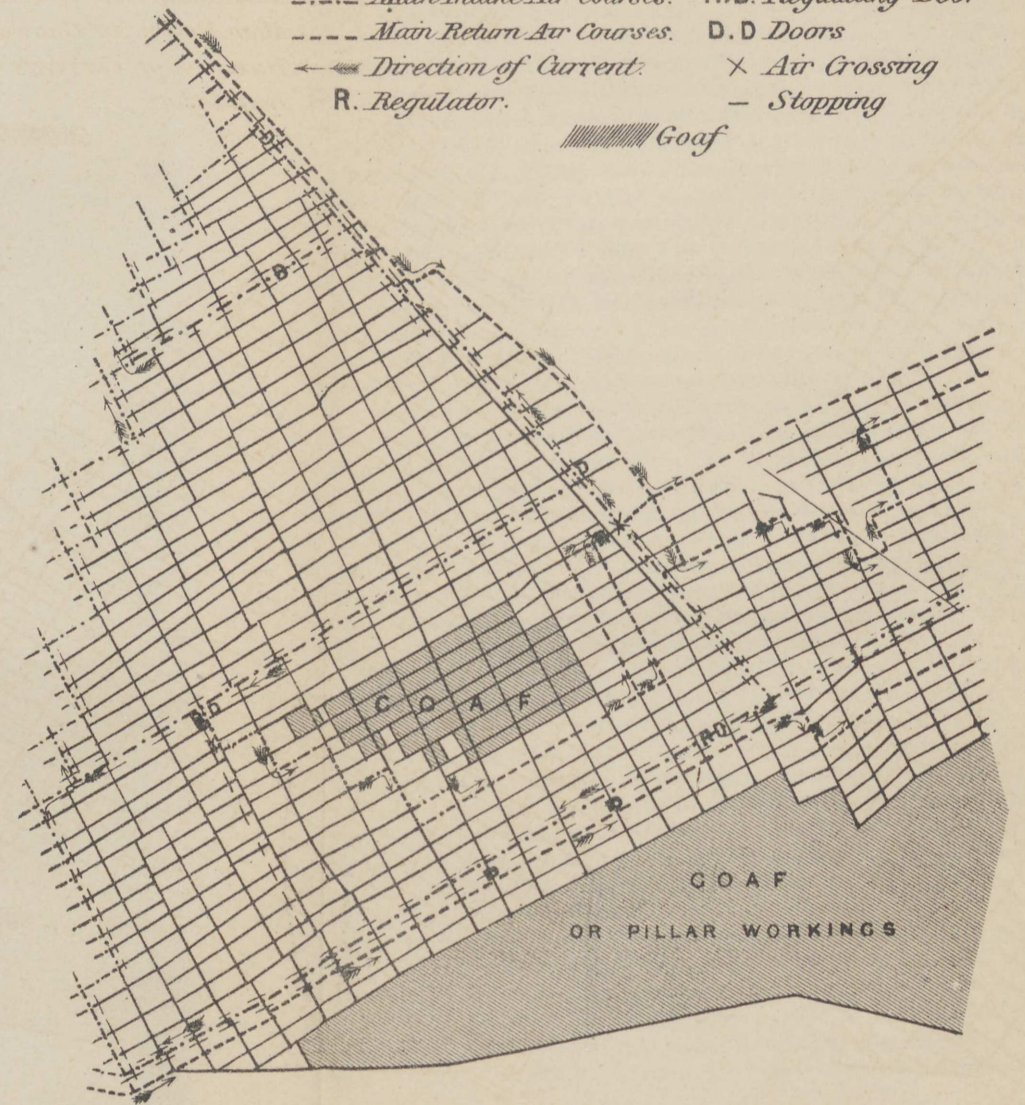
Main Intake Air Courses. R.D. Regulating Door

Main Return Air Courses. D.D Doors

Direction of Current. × Air Crossing

R. Regulator. — Stopping

Goaf



Plan of

WORKINGS & VENTILATION

AT

BURRADON COLLIERY,

ON AN IMPROVED PRINCIPLE OF VENTILATION.

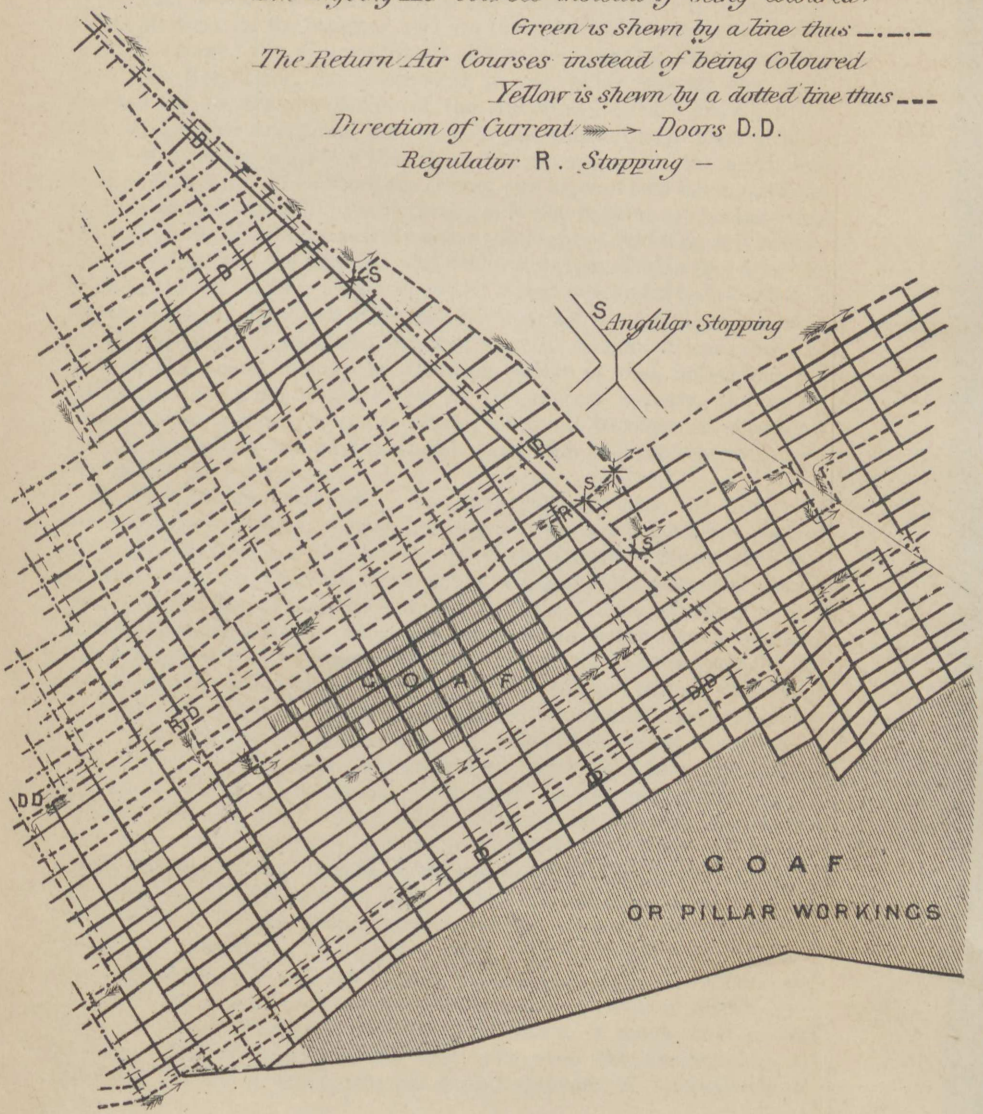
REFERENCE

The Ingoing Air Courses instead of being Coloured Green is shewn by a line thus —·—·—

The Return Air Courses instead of being Coloured Yellow is shewn by a dotted line thus ---

Direction of Current ⟹ *Doors* D.D.

Regulator R. *Stopping* —



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of every description incident to mining. In referring you to the plans, therefore, let us take our stand at the top of the incline bank, the foot of the straight-up travelling board, and the end of the south crescent. There on the spot, I would ask any man to point out to me the utility of that Regulated Scale in ventilating the workings, even with the admission of returns; but, as I know there was no return to the north, then that scale became the subtle deceiver of its inventor, and must appear to every man of scientific knowledge to have been an ingenious promoter of the explosion; as, for instance, you see the goaf before you, twenty-two acres in extent; you also see fifteen pillars in a parallel line, extending from the Regulating Scale, eastward to one pillar beyond the door, marked red, on the north side of the travelling board. On the south side of that door was found inflammable gas, which I have marked blue. You will now see distinctly that there was no return to the north and west of that door. Then there are twenty-two acres of coal taken out from beneath stratification 200 yards thick; is it not natural to conclude that this mighty incumbent mass will become solid again; and if so, is it reasonable to think that the pressure will act in a perpendicular line from the surface, through a vast variety of strata, laid in horizontal beds? Or is it not more reasonable to conclude that it would act in an oblique direction by the leverage of each stratum, and thereby include at least three or four of the board rooms, and standing pillars of coal, imbedding the pillars in the under stratum; or, as the process appears, the under stratum rises to meet the upper strata, when all becomes as close as a box, so that no air can pass through? And such was the case at Burradon before the explosion.

So much for the north side. You may suppose those red marks on the south side as inlets, or open headways to the lesser goaf, and each of them furnished with a door for the use of the putters. Now, when any of these doors were opened, there would be a gentle movement of the air round by the face of the whole of the working places, returning to and passing through the open door, and away to the south return crossing; there would also be a pressure on the scale at the bottom, escaping by the same channel, and when the door was shut, a partial stagnation would be felt at the face of the workings with a counter rebound in the air. The hydrogen gas from the north holeing, ever ready to extend its bulk, would expand into the straight-up board, and from its natural gravity would ascend by stealthy pace up to the flat, and there come in contact with the boy's naked light. This, in my opinion, caused the first explosion. And now, picture to yourself, this volume of inflammable gas lighted up in solid flame, and expanding in the twinkling of an eye into 1,300 times its bulk. Thus the explosive blast, and the destruction of the air, form a vacuum on the adjacent goaves, drawing forth their contents to fill up the vacuity with hydrogen gas, which, in its pure state, will not ignite, nor support combustion. Again, the air takes its course, rushing onward to some convenient return (perhaps to one fresh made), and as it advances, it meets this direful volume. The hydrogen spreads and rolls over the atmospheric air, like the billows of the ocean, for a pint measure of atmospheric air

weighs nearly nine grains, whereas a pint of hydrogen gas weighs little more than half a grain. By this curious process, it easily unites with the oxygen, and in a short period of time we have again a large field of inflammable gas ready for the match. Some one hurrying on in his homeward path, with light in hand, from the southern district, or up the bank to find the cause, arrives at the cross cut end, and top of the bank; his light fires the gas, and in a moment the explosive blast occurs. This, in my opinion, caused the second explosion. And the same cause and a similar process prepared the district, ready charged, for the third, as was seen by the exploring parties, when in search for the men.

Now, the closing up of that return passage would be a slow process, and the indications clearly given at the face of the whole working places daily, ought to have been observed by the officials in their examinations.

Some may say, of what use is it now to write anything about that, the men are gone, and what better can we make of it? True, the men are gone, but it is for the future I write; and as I myself know for a certainty that the present system of ventilating coal mines can be improved, I am induced to endeavour, if possible, to develop the principles on which I, with such great success, for a number of years practised; and as our subject is the Burradon pit, I will adopt it on the plan as it is. Beginning at the incline bank top (the air coming direct from the shaft up to this point), you will observe two doors marked red, at the bottom of the straight-up travelling board, they are a sufficient distance from each other, so as to admit the set to pass through the one before the other is required to be opened, and each of these doors is to be perfectly air tight with proper snecks affixed, so that they cannot be opened by accident, and with boys of proper years put to keep them. You now follow the current of air along the south cross cut (which I have marked green, so that you may distinctly understand its course) up to the middle travelling board, where it is divided, and regulated according to circumstances. We will now take the northern division first, following it up this middle board direct into the whole working places. You now see there is not a door nor any other obstruction in the whole distance, from the down cast shaft to a man working in the first board. You see the common pressure of the atmosphere on each man as you proceed north from board to board, and find it carried along by stoppings in the back board ends, until it arrives at the northernmost board, and begins to return. In returning, it passes through a slide regulator, which is the usual mechanism in colliery ventilation. When thus returning, you will see the necessity of this current of air being applied to the large 22 acre goaf, skirting down by the borders as near as may be, so as to prevent any accumulation of gas. The straight-up travelling board is the only visible passage for the air, until it comes to the foot or bottom, when you will observe it taken through a holeing on the in-bye side of the inner door to the north and west again. So much for the north division of air. Now, follow the green shaded darts from the middle travelling way, southward. Here, see this current of air arrive at the first man working in this district, and going from man to man northwards. But when it arrives at this third horseway, or travelling board, which I presume is a provision for the pillar working, with

the wall on each side of extra thickness and stoppings in them. If so, then it would be necessary to course the air through this little southern angle of waste, and when that is done proceed north and east from board to board, until you arrive at the middle travelling way again; there you will see double doors marked red in the wall north, dividing the northern division from the southern division, which doors must be perfectly air tight with snecks on each. Now, follow the yellow shade through a slide regulator in the northernmost of this sheth of boards, and so on through the waste until you come to a crossing marked red, taking the air over the south cross cut, and over the ingoing air to the west, and away north to another crossing marked red. At *S* put in an angular stopping, to take the current of air over the arch into the north side of the middle travelling way, in order to air the lesser goaf and pillar working. This will keep all safe, as you will see the air encircles the goaf and returns over a crossing into its original channel westward. It will be necessary to have a small sliding scale or regulator in the angular stopping, as at *S*, an indicator to show the master wasteman when it is necessary to take this division of air out of that district, which cannot be of long duration, for as these goaves advance on each other the incumbent mass of strata will exercise enormous pressure, imbedding and destroying several walls or standing pillars of coal between them, and which must be lost or only got with great difficulty and danger.

This illustration will at once show you the necessity of observing Nature's laws, inasmuch as all these accumulated difficulties—the dread of approaching danger, the awful explosion itself and its sad effects, destruction of property, loss of human life and sufferings—all originate in breaking into the upper strata, and forming this upper goaf in the centre of this great angle of pillars. Such a plan is wrong, and false in principle. The proper course would have been to work the pillars of the large goaf from north to south, by which means the goaf and pillar workings could have been ventilated with perfect safety, as additional returns could have been provided, ready to use when wanted, leaving a loose side open and free beyond the oblique pressure from the goaf of limited extent.

You will see that this principle of ventilation, which I recommend, is simple, safe, and easy in its application, and certain in its effects. It may be that from the imperfect state of this plan you may feel some inconvenience in the arrangement and coursing of the air, but, I hope by attending to the instructions, and following the shades as directed, you will discover the principle which I advocate, and you will see that no door, or stopping, can be injured so as to endanger the safety of the workmen in any part of the mine. Some may say, look at the expense of the board-end stoppings every time they advance—but the cost is not so great when the plan is duly examined, especially when you consider that very plan ensures safety, while under the other system, the mine, and the workmen in it, are always in jeopardy.

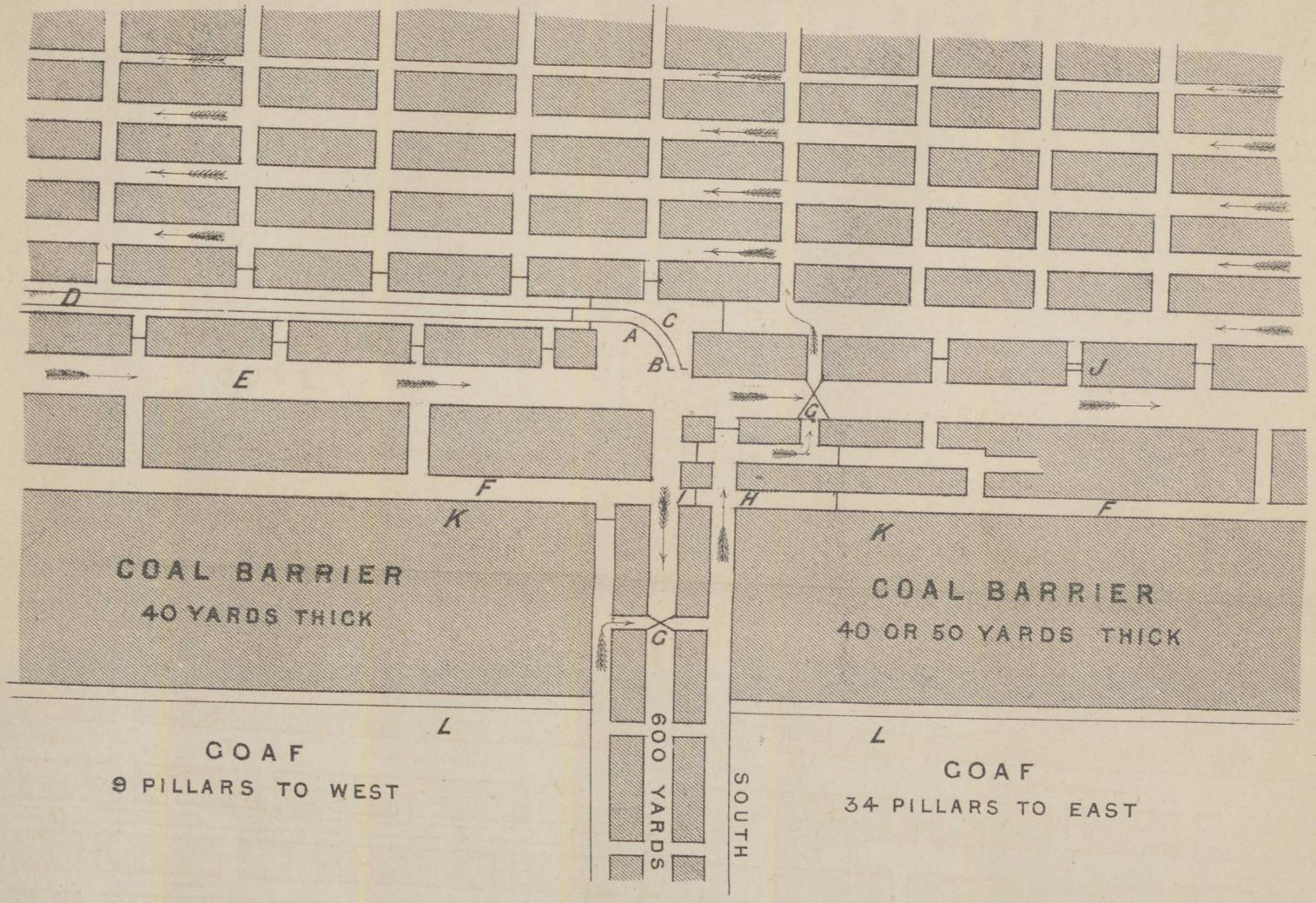
We will now quit Burradon, and take our course southwards, as far as Hetton Colliery, where there was an explosion in 1860, of a somewhat mysterious description. This colliery is under the care of one of the best

of men, and ablest of viewers, and the explosion is supposed to have originated in the flues leading from the engine down the pit. Now, whether the hydrogen did accumulate in the flues, or how the volume was ignited, I know not, but this I know, that it will accumulate in the flues when the fire is damped, and the damper, or ventilator, is nearly closed, if some other means be not applied to ventilate the flues; the vapour generated by the damp coals is hydrogen gas, and a slight escape of oxygen over the fire, will readily unite with the hydrogen, and of course fill the flues with inflammable gas. As the coals consume, this process diminishes, and the fire becomes of more intense heat, destroying the oxygen, and disengaging caloric in the shape of vapour; this advances on the volume and meets with a repulsive shock when the two come in contact, and by friction, or electricity, the hydrogen gas is ignited, hence the explosion in the flues. This phenomenon is exposed to the view of every inhabitant of the earth when they gaze on the vivid lightning's flash, and listen in silence to the awful grandeur of the loud-voiced thunder, bursting through the clouds of vapour, condensed in the upper regions of the atmosphere. The electric fluid converts the hydrogen and oxygen into water, and it pours down in torrents on the surface of the globe. As an author says:—"The atmosphere is a vast laboratory in which nature operates immense analysis, solutions, precipitations, and combinations; it is a grand receiver, in which all the attenuated and volatilised productions of terrestrial bodies are received, mingled, agitated, and separated. Notwithstanding this mixture, of which it seems impossible for us to ascertain the nature, atmospheric air is sensibly the same, with regard to its intimate qualities, wherever we examine it." Perhaps some one may say, as soon as he gets his head below the surface, and descends into the bowels of the earth, what now has Nature's law, or atmospheric air, to do with us? If there be such a man, I tell him he knows little about the ventilation of a coal mine, and the sooner he seeks information on this important subject, the better for himself, and for those who are working under his care. In my practice, I had one of these fire flues, 154 yards in length from the engine, built with bricks and lime, along the inside of our common drift, as a security against setting the seam of coal on fire. Yet, it was often on fire at the end of the flues, notwithstanding this precaution. Although we had a constant feeder of water running through the flues, yet there was always a quantity of soot covering the water, and whilst the brakesman was adding fuel to the fire, such was the heavy draft of air, that it bore the burning embers away, which lighted on the soot, and set fire to it; when the ordinary current of air was sufficient to bear it along in a body of fire to the end of the flues, where it spread out to a greater bulk, and came in contact with the coal. We, the wastemen, had to inspect this flue, up to its end, every Sunday morning, and to enable us to do so, we had an iron door in a frame, set on the top of the flues, 14 yards from the boiler, and 140 yards from the end of the flue, and such was the intense heat (under ordinary circumstances), that we were obliged to open this door and let the air press along, before we dared to attempt our passage. But when the soot was on fire, in the flue below us, or the coal at the end of

the flues, then such was the increased heat, that it was difficult, almost dangerous, to venture along; yet, it was an imperative duty on us to see the far end, and know that all was right before we left it. However, on a Sunday morning, when I myself, and another man, went to inspect it, we found the coal on fire to an enormous extent, one pillar, of 20 yards, being wholly lighted up, and in some parts burnt full three feet into the solid coal, which produced an awful sight, with little prospect of getting it put out. The excessive heat issuing from such a mass of fire, and operating on the upper strata, made it impossible to get near it for a time; we, and two of the deputies, went down the pit, at six a.m., and three men were down at work all night, which constituted the whole number down the pit at the time. I was obliged to stop them, as their assistance was necessary. I knocked out a stopping in the wall, between the horseway and the horizontal chimney, situated eight yards west of the flue end, and right in front of the fire; I also opened the iron door in the side of the flue, next to the damper. (*See* accompanying Plan. The letter *A* indicates the two iron doors, the one on the top, the other by the side of the flue.) So we now had a strong draft of air passing along under and also on the top of the flue, with this holeing open to the west of it, which increased the fire, but very materially reduced the heat, so that in a short time we were enabled to get to the flue end. We immediately put a dam in, to raise the water up to the fire, as the only antidote to the destructive element. I then took a man with me, and turned the Kenton feeder of water into the chimney, discharging 500 gallons per minute, which absolutely boiled for a time, as it arrived at, and rose upon the mass of fire, producing such a quantity of steam as made it insufferable, and compelled us to retire until the water got the ascendency over those difficulties we had to contend with. We then again advanced with the necessary implements, and by perseverance we succeeded in extinguishing the fire, and all got home by twelve o'clock. But although we had succeeded wonderfully with the fire, yet the flooding of the water washed away vast quantities of cinders, clay, &c., in and along the flue, which, if allowed to remain, would inevitably become, in a short time, a serious impediment; consequently, it was necessary for us to make all thoroughly clean and in a working state again, without delay. In describing the circumstances to the under-viewer, he thought it advisable to take some strong half-grown lads with me, to operate in the flues, in preference to men, and with what other hands I might deem necessary, to get all put right for the following day's work. We returned to it at six o'clock in the evening, and got everything put in order from end to end, by one o'clock, ready for the brakesman, &c. In order to ventilate this flue, when the damper was down, and the fire made large and damped through the night, we had a small iron door in a frame, four yards behind the damper, and when the brakesman let down the damper he opened this door a little, to send a draft of fresh air along the flue, to keep it right and clean until he came back to lift the damper, and shut the door. These were my instructions, and he was always careful to attend to them. In connection with this engine, I acquired a great deal of experience. I had heard it said that the safety lamp of Sir H. Davy was not safe in an

extraordinary current of air, and that when in an atmosphere of inflammable gas, the flame could be blown through the meshes of the gauze, and produce an explosion. Now this engine furnished us with a favourable opportunity of testing the truth of this assertion, as it had to pump the water out at nights, or when the pit was off, a distance of 600 yards. Thus, when commencing to pump, the water was generally down to the crank, and required a vast number of strokes before it reached the top or delivering channel, the space between the crank and the top of the pipes, or small pumps, was filled with hydrogen gas, and every stroke was a gust of hydrogen, until the water reached the top, when it was borne away by the current of air, diluted, and rendered harmless. At the end of these pipes we suspended a safety lamp, entire, which was soon filled with the flame, the next stroke of the engine blew the flame through the gauze, and we were nearly enveloped in the blast, but fortunately escaped injury.

This experiment told us that danger did exist, if the lamp was not used with caution and care in such an atmosphere. Indeed, it is then, and only then, that the Davy is truly a safety lamp. And how often have we been in an inflammable atmosphere with that lamp, under all circumstances, confident of our skill and judgment, even in the midst of danger. These pipes were laid down the east headways the distance of 600 yards, which was also the air's return passage; the workings in this district were not of great extent, being only thirty-four pillars east, at twenty-two yards, per pillar; and nine pillars to west, at twenty-two yards per pillar. Thus, giving us an area of about 54,400 yards of excavated drifts, two yards in breadth, and twenty apart, from north to south; and four and a-half yards in breadth, and eight yards apart from west to east. This is called a waste, which must be duly and properly ventilated, *i. e.*, the atmospheric current of air must pass through, and along every one of these drifts, so that they may be all kept clean and wholesome. Now, this is what might be considered the mechanical application of the air in the mine. When a district is brought to this point, the managers generally begin to work off the standing pillars of coal, which is (as the miners say) working in the broken. And, as this distance of 600 yards from north to south had declination of about five inches to the yard, you will see that the proper place to begin at (according to the law of gravitation), is the topmost part, or north-east corner, next the barrier and main horseway leading into the interior and vastly more extensive workings. Attention to this rule renders the ventilation easy, and free to compete with the hydrogen gas generated in the goaf. In course of time the whole of these pillars are brought off, and this vast district becomes a precarious goaf of about 100 acres in area, situated close by the main horseway, and only 400 yards from the downcast shaft. The governing authorities, in deliberating on the future, determined to bar it off with stoppings, and have nothing to do with it. I now show you the formation of these three headways, as the only drifts that penetrated this district. (*See* the Plan.) The centre one was four yards wide, and, as the darts indicate, was the ingoing drift for the air, the one that all the men and boys travelled in going to and from their work, and also up which the engine drew all the coals. The


D
C
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COAL BARRIER
40 YARDS THICK
COAL BARRIER
40 OR 50 YARDS THICK
L
GOAF
9 PILLARS TO WEST
GOAF
34 PILLARS TO EAST
600 YARDS
SOUTH

other two were only two yards wide, and were the air's return passages, as the red dart and crossing, one stenting down, show, and the crossing over the main horseway one pillar east of the engine. There is a barrier of coal left forty or fifty yards thick on the south side of the water level board, and running parallel therewith the full extent of the mine to south and east. It was the intention of the authorities to put these stoppings in the barrier below the water level board; and, on a day when the pit was off work (except the deputies and wastemen), the overmen set two of the deputies to cut out the ground work for the monster stopping in the centre drift. I had then no knowledge of this, but before the day was over I happened to go where the process was going on, and found the hands at work. I asked them what they were doing there? They told me all they knew. I then turned to the overman, and asked him if it was intended to stop off the goaf in that manner. He said, "I do not know, but I was ordered to set these men on, as you see them." "Well," I said, "its labour in vain, and you know it ought not to be done, and cannot be done; I would not continue in a pit with a goaf barred off, under any consideration." The following day, in a conversation with the under-viewer, I discovered that my remarks had been taken hold of, which gave us an opportunity to discuss the subject freely. I asked his permission to try the experiment, which he gave with a good grace. We then put a twenty inch stopping in the centre drift, as a necessity to its permanency, and the security of the goaf; but in the east headways we put only a ten inch stopping, at the same time making every other part safe against accident, &c. We now had this goaf stopped off, and it might continue to be so for months, it might be years. Yet still it was fraught with danger, as I will show you. (Consult the Plan.) A, is the two iron doors, one on the top, the other in the side of the flues; B, the boiler and machinery; C, the chimney, or flues; D, the flue end; E, the main horseway, leading into the interior workings; F, the water level board; G, the two crossings, marked red, for the returning air from the engine, bank workings, one at one stenting down south, and the other at one pillar east of the engine; H, the end of the pipes, discharging the water into the water level; I, a man door in the water level board, between the centre and east headways; J, two frame doors into the return board to north, indicated by the red darts; K, a barrier of coal, from 40 to 50 yards thick; L, the goaf. When the workings of this district were in full operation the machinery and all its requisites were in full play, according to their uses, but now the coal is all wrought off underneath strata 190 yards thick, to the extent of about 100 acres area. The authorities commenced to work off the pillars to the north; by doing so, the oblique pressure from the north goaf spread over several board rooms and standing pillars of coal, destroying the passages of the returning current of air, and injuring the crossing arch over the main horseway to such a degree that we had to take down the arch, build a twenty inch stopping on each side, and suspend a pipe from stopping to stopping, twelve feet long and six inches diameter; we had also to build a twenty inch stopping across where the engine stood, for stow boards, to enable us to keep a passage for the air. Now, these stoppings are put into the barrier, all is cleaned

away, the water level is laid on to the horseway as an in-going passage for the air. Time passes on, and the dread of danger, in illiterate minds, passes away too. But the contents of this goaf are carbonic acid, hydrogen, &c., and, as caloric in a latent state lies hid in all bodies, the falling of water on the strata disengages caloric in the form of sensible heat; and compression of the particles will throw it off. Accordingly, we now see this goaf charged to the vent with gases. A sudden change in the atmosphere now takes place, and now begins the elementary strife in the goaf, behind these stoppings; as in the case of a boiler overcharged with steam, something must give way, and, of course, the weakest part is one of these stoppings. Then comes rushing forth the gas from the goaf into the water level board, it is borne away by that portion of the air for several pillars, uniting with the oxygen, and forming an extensive field of inflammable gas. At length it ascends into the horseway, and there comes in contact with a naked light, and an explosion follows of the most disastrous description, for every man and boy employed in that pit at the time would inevitably be killed.

This, I wish you to understand, is, in all probability, what would have been the case if they had persisted in their design, and barred off this goaf; but I had permission to try an experiment, and such a catastrophe was averted.

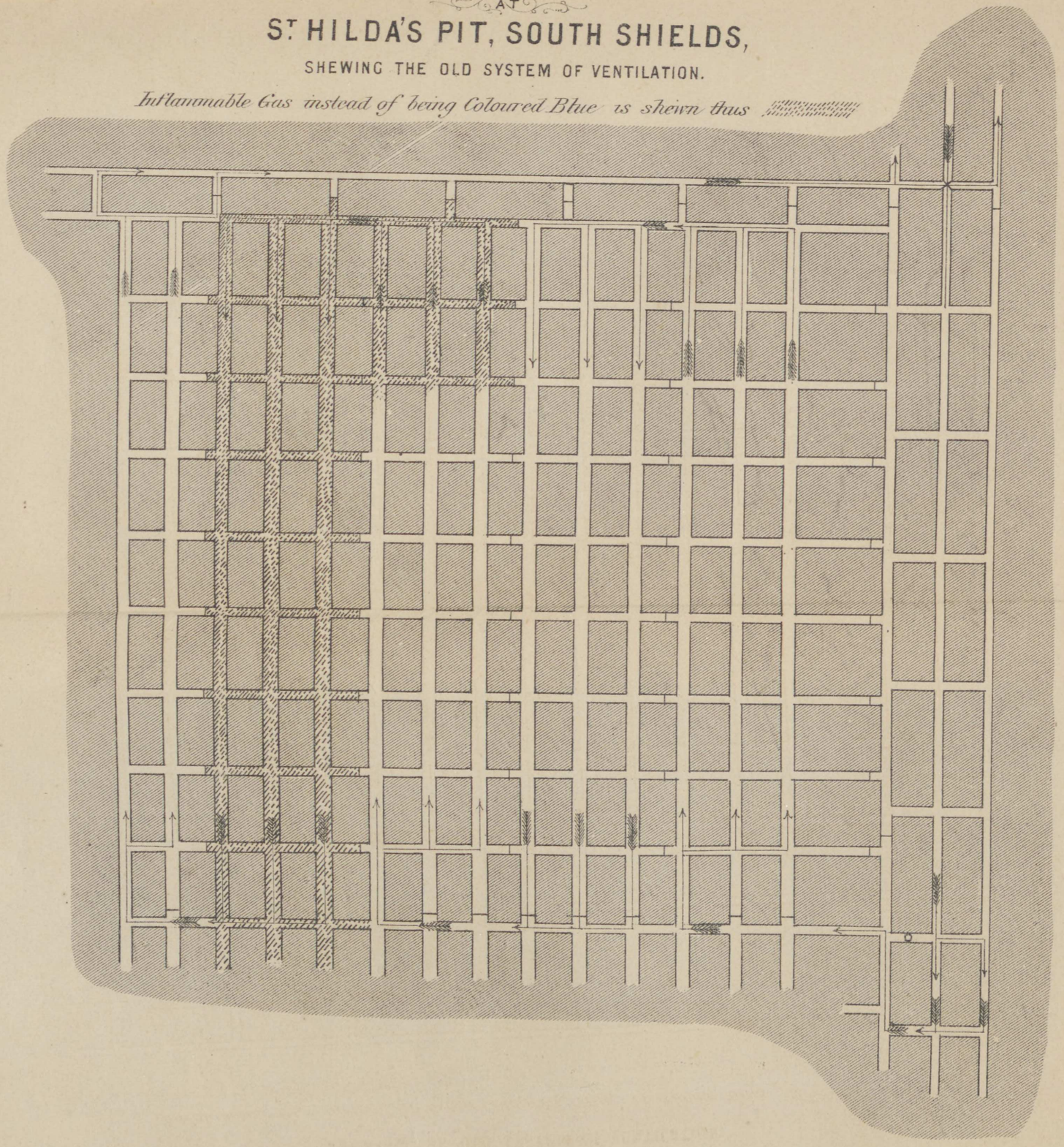
We now let several weeks pass over, and noticed many sudden changes of atmosphere, but without dreading any early outburst. It was, however, the autumnal part of the year, when goaves are most critical to deal with; and after eleven weeks had passed over I took the two men with me that were at the experiment on the lamp, and when I opened the door, behold a cloud as black as midnight enveloped us, and immediately put out the light in the lamp. I propped the door so far open, to admit a portion of fresh air, and took the men to the north and west side of the downcast pit, into the return passages, to ascertain its condition, as it advanced up to the furnace and up-cast pit. To our great satisfaction, not a particle of hydrogen gas was visible. We then returned to the door, and stopped, I opened the door to enable us to enter; when we found every brick constituting the stopping had been forced out of the headways as if by a blast, right across the four and-a-half yard board. Here, reader, you see my dreaded anticipations realised. We now let the goaf exhaust itself into the return for a few days; when, the security of this goaf being left entirely to myself, we again put a temporary deal stopping into the same headways end. We then pulled down the old injured arch and built a twenty inch stopping on each side of the horseways. Then I procured a pipe, twelve feet long and six inches in diameter, and extended this pipe from stopping to stopping, building it properly in each, above the reach of horse or man; I also made all the other stoppings good and safe. When that was done, I took out the deal stopping, and that pipe to this day operates as a safety valve for the goaf, which would appear as a phenomenon to those without scientific knowledge in the system of mining. It can be seen on any day at Coxlodge Colliery, in the Prince Regent Pit, 400 yards from the shaft; and I need only remind you, that if such a preventative had been applied in the Houghton Pit,

AT

St HILDA'S PIT, SOUTH SHIELDS,

SHEWING THE OLD SYSTEM OF VENTILATION.

Inflammable Gas instead of being Coloured Blue is shewn thus



in the County of Durham, there would have been no explosion there in 1850. Such is the deceptive and precarious state of goaves, that we should never conclude that because they are clean and safe to-day they must be so to-morrow. They are always subjected to changes of atmosphere, and must be ventilated by scientific skill. I may tell you, by the way, that the workings of the two pits at Coxlodge were of great extent, and abounded with hydrogen gas, which made them always critical and difficult to deal with. As a proof of this, it may be mentioned that when the general current of air returned to the furnace and up-cast pit, it was so seriously vitiated with poisonous ingredients, that five men in succession, employed as onsetters at the bottom of this pit, inhaling the pernicious atmosphere twelve hours each day, died from its effects, and became absolutely putrified before life was extinct. On one occasion, two men were engaged in examining and repairing the shaft, and so suddenly did it operate on them that one of them died in the cage, and the other was seriously affected, but recovered. The consequence was that we were obliged to bring a portion of fresh air direct on to the furnace to enable it to burn, and allow us to keep up an efficient state of ventilation.

Still further to illustrate the principle of ventilation that I recommend to your notice, I take next the explosion that occurred in the St. Hilda Pit at South Shields Colliery, in 1839. And here again, I wish it to be understood that my intention is not to cast a reflection upon any person whatever, but to hold up to your view a preventative system of ventilating a mine, whereby a similar occurrence, so dreadful to reflect on, may not take place again in the coal trade. You will see that neither agent nor officials were in the slightest degree culpable in that calamitous accident at St. Hilda's, as the system of coursing the air through the waste in conjunction with the whole working places, was prevalent throughout the coal trade at that time. Consequently, the same, or a similar catastrophe might have happened at any other colliery abounding with hydrogen gas. That system of air courses was false in principle; for Nature's laws are uniform, unalterable, inimitable, linked as it were by a vast chain of circumstances; and he that deviates from those laws, whatever link he strike, ten or ten-thousandth, as Pope says, breaks the chain alike. We will now take our stand at the south-east corner of the accompanying section, or supposed plan of the workings. You see a pair of winning headways going north, to the extent of a sheth of boards, fourteen in number, with nine pillars finished, and the tenth nearly so, to west. You also see three advance boards going west, the middle one being the horse and air-way. Now follow the darts as indicators of the air's course through the workings and waste. You will observe that the air goes up the south advance boards, and as it returns, passes through the barrier wall, thirty yards thick, as a provision for the pillar working. You will see that it airs the first three working boards to west first; and as it returns, it is borne down by a door in the wall, between the third and fourth boards. It passes by the end of a brattice in the third board (the other two having each a deal stopping in them), when it is again spread across the three by the wasteman, and conveyed down east to the

bottom of the waste and west winning headways. It then passes through the wall north, and returning up other three boards to west, back to the working headways; again passes by the brattice end of the fourth and southernmost board of these three, to air the face of the fourth board, &c. But as it was returning again from the working headways, down the next three boards, *i. e.*, the seventh, eighth, and ninth, I wish you to understand that at six pillars down, the upper strata had fallen and exposed one of these blowers of a dangerous magnitude, which the current of air is inadequate to dilute, but which it is sufficient only to convert into inflammable gas, as you see on the plan by the blue shaded atmosphere. Observe the three down-going boards, for three pillars in length, and the three up-going boards, nine pillars in length, are a solid mass of inflammable gas, ready for the match; and in this state it enters the working headways, when it comes in contact with a naked light and produces an explosion.

Now, let me show you my approved preventative system, when you will at once discover the impossibility of such an explosion taking place, or the health and safety of the workmen being exposed to serious danger. As the section or plan is the same as the other, I need not enter into detail, but merely show you the advantageous difference in the principle of ventilating a coal mine. The red dotted lines indicate the horseway up west, and tramway to north along the westernmost headways. The darts indicate the course of the air, which you see is conveyed direct into the southernmost board, and from that northward from board to board; and as we proceed along, you see tight deal stoppings in each board end on the east side of the headway course. You will also observe there is not a door nor any other obstruction between the down cast shaft and the face of each board in this district. There is the workmen, with the common pressure of the atmosphere acting upon them daily, which is necessary and must be conducive to health. Now, as it leaves the north board, in returning eastward, it passes through an aperture or slide regulator, sufficiently large to admit compression without obstruction. From this point it is guided by the wasteman's skill through the whole of these pillars.

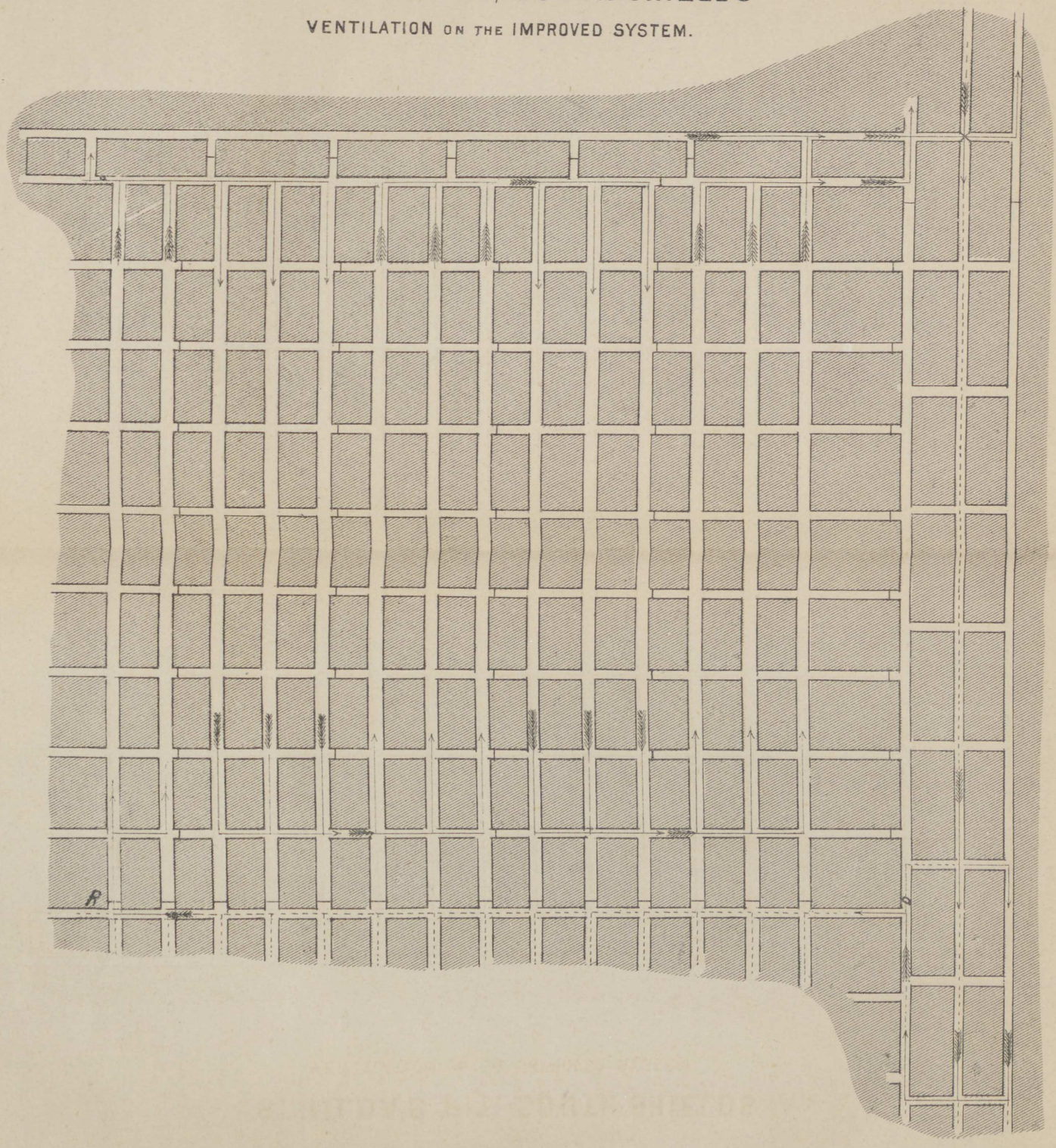
Suppose, now, that a fall were to occur in the upper strata, exposing one of these dangerous blowers, and converting the whole current into an atmosphere of inflammable gas; well, we need not fear, as no one can get there but the wastemen in their travels. As they proceed with lamp in hand, they arrive at this volume, and unexpectedly observe their lamp filled with hydrogen gas. They retreat, and examining the other two boards, find them all alike. There is now no time to be lost, and they return by the way they went in. They enter into the return passages of this air for some distance to ascertain the extent of this unwelcome visitor, when, to their great satisfaction, they will probably find no gas at all. This will give you an idea how easy it is to conquer gas, for you see that in a current of air it requires only a short run to dilute it and render it harmless It cannot be restored to sensibility while in that atmosphere, as its particles are united in the general current of air, and chemically changed into a different body. This illustration I could not give you as clearly on

PLAN OF WORKINGS

AT

St HILDA'S PIT, SOUTH SHIELDS

VENTILATION ON THE IMPROVED SYSTEM.



the Burradon plan; yet you must not conclude that it is a correct district plan of the St. Hilda Pit. I have drawn it to contrast the principle, which I myself prefer, with that which was in use at St. Hilda Pit; and earnestly to recommend the former to your consideration, as the safest and best system of ventilating a coal mine that can be applied; for by adhering strictly to the letter of my instructions you can get whatever quantity of air you wish for into the mine; and it is impossible for any accumulation of gas to take place in any part thereof. Consequently there can never be an explosion of any serious extent because you have nothing in jeopardy, but all being in strict conformity with the laws of nature.

I will now further show you the immense mechanical power of air over an extensive volume of hydrogen gas, and also the subtle nature of that gas when neglected and in a light current of air. On a Saturday morning (the pit being off coal work) the overman set two deputies to draw the timber (brattice props and planks) out of the two northernmost boards; and they had with them a strong boy to take it away. When all was done, and their time up, they went home, leaving the pit, as they supposed, all right, and prepared for a fresh day. But as these two north boards were the passages for the air returning from the whole working boards, it became my duty to see that they and all besides were right and clean before the men came on the Monday morning. Consequently, I ordered my men to be at the pit two hours before the overman and men, to examine and ascertain the true state of these two boards, in connection with the district. And here let me endeavour, if possible, to show you the working of the air, as mechanically guided throughout the whole sheth, which was won out in the formation you see by a pair of headways turned from the narrow boards, and driven north the distance of ten boards, leaving a barrier thirty yards thick to east of them, and dividing them from what was formerly another sheth of boards, but now a goaf, as you see marked, to the east and south. The whole was won out by the narrow boards coming up from east to west, until the south board holed into a convenient return, while it was necessary to continue the north one, until it holed into the incline bank headways, for the purpose of ventilating the whole district apart from the goaf. As you will observe by the darts, the air is conveyed down the north narrow board to the first, the westernmost and working headways. You there see it is borne up by double doors in the pillar east, marked red, and if you follow the darts through the whole sheth you will observe it is coursed in twos through the waste; when it returns down the two north boards and the east winning headways back south to the narrow boards again. It then passes through an aperture or slide regulator in the south narrow board, parallel with the double doors. You now see the atmospheric stream of air encircle the whole district.

Well, we had arrived at the first door in the narrow board at the foot of the first (westernmost) working headways. Our number was six, and as four were above 60 years of age and had walked a distance of two miles from the shaft, I told them to sit down and take a rest, while I myself would proceed up the headways to the north board and see what state it was in. Lamp in hand, I set off; but, to my great surprise, when I got to the first board my lamp was filled with the flame of hydrogen gas.

Panic stricken, I returned, ordered the men to screw on their lamp tops, and told them my discovery. After letting them all see it, I fixed on one of the most experienced to stay at or near the spot, to prevent any one from approaching this dreadful volume of inflammable gas until I returned. I set off to meet the overman and got him to send these ten men into the other districts for that day's work, which he did; and to gratify his own curiosity, he went with me to see this unwelcome visitant. On our arrival at the spot, I ventured in through the double doors in the dark, and took out the slide from the regulator, adding a few more inches area to the aperture, so as to prevent it from getting worse. I then set off to ascertain how far it existed along the return passages. I entered at about a mile distant, but found none there. I locked up the doors again, went back half a mile and entered there, where I found it all inflammable gas. So that we had reason to conclude that the whole district of workings and waste, with a distance of three-quarters of a mile along the air return passages, was purely inflammable gas ready for explosion.

It may be asked what induced me to go down the pit, two hours before the men, on this occasion. My answer is this: It was my duty. I was chief in the ventilation of the mine. A great responsibility devolved upon me. The lives and safety of the workmen were entrusted to my care, and that was an all-sufficient reason for me to be careful. We now left the pit, to return at four p.m., leaving a man to protect the entrance to this working district, and all the other avenues locked up, conscious of its safety.

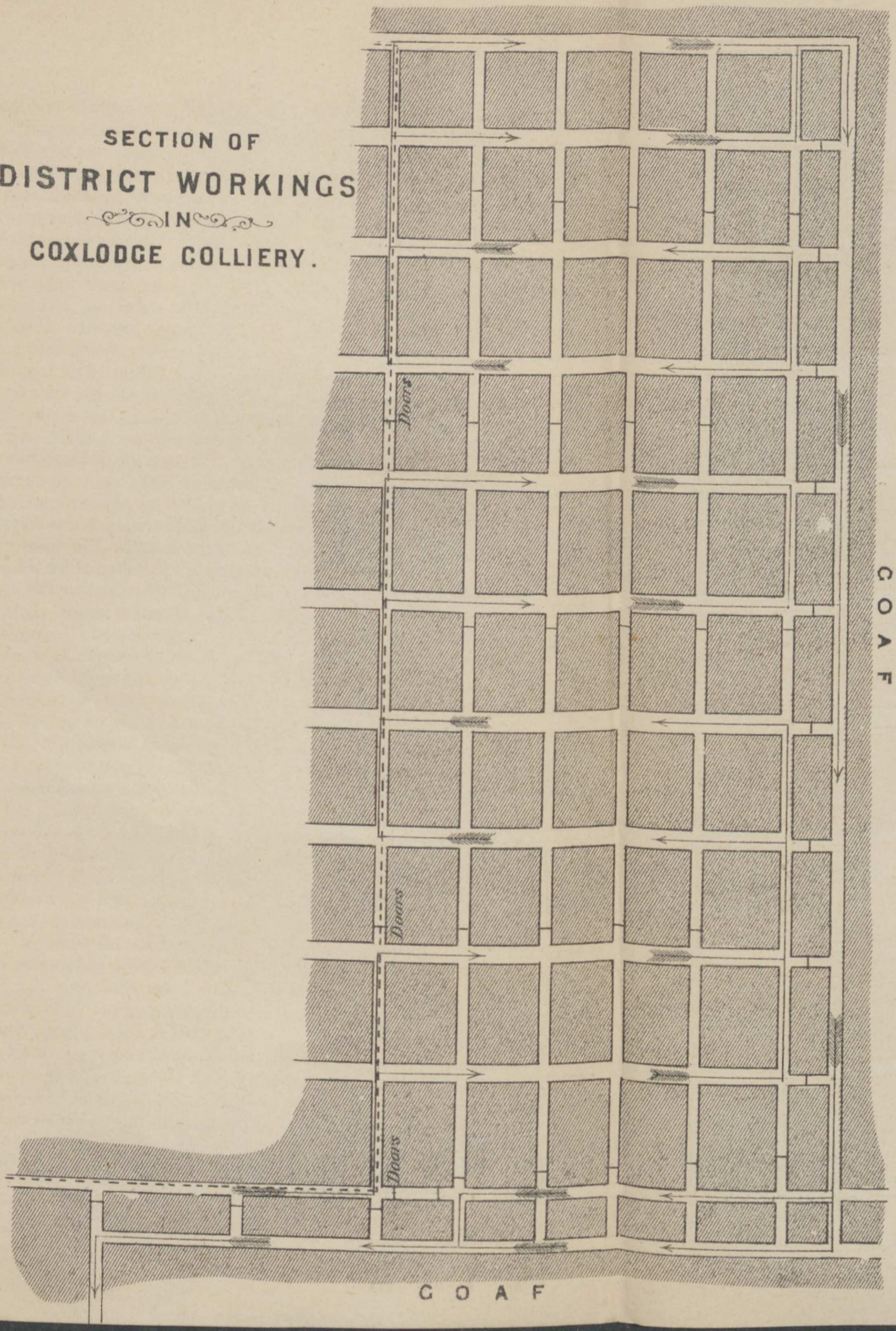
We had to provide two tramway doors for our operations when we came back, and had to take them in with us, and set them before we could begin. Before I left home I deemed it my duty to see the overman, and said, "Are you not going with us?" "What to do?" said he (with a smile). "Well then," said I, "are there any ways or means you can suggest as to the manner in which we may best proceed?" "I think we cannot do better than leave it to yourself. Take your own way. That's what I would advise." I then left him, promising to send a man out to meet him in the morning in time. When I got to the pit the under-viewer was waiting to see me. He also declined to go with us, remarking, "I think it will be best to leave it to yourself." We then descended the shaft, and arriving at the place, found the gas as we left it. The man we left in charge (a brave old Englishman) refused to go home. He was determined to see the process, if he got nothing for his shift. Seeing this, I gave him my "bait," *i.e.* our victuals, and told him to stop. Thus, we had got the doors set, and all was in readiness by nine o'clock. I had ordered them to bring watches and I placed them at those doors, where they had two to open, and two to shut throughout the process. We ventured through the double doors again in the dark, and took the regulating stopping wholly out; my instructions were that they were to operate with the doors so as to lay the whole pressure of the atmosphere direct from the shaft on this district for ten minutes; that done, they were to alter the doors, so as to let the air take its ordinary course for five minutes, and so on until they heard from me. I also sent a man out a mile, to enter the return passages of the air. There to hang his lamp up in a sheltered spot, and if ever he saw it fill with flame he was to prop open the two man doors, and come to me.

SECTION OF

DISTRICT WORKINGS

IN

COXLODGE COLLIERY.



Well, we had not got many attempts made, when in he came, saying the return drifts were as foul as a gun, and that they filled his lamp with flame. I propped the two doors open, and off I set as fast as I could. This was rather awkward, as we were making rapid progress in the workings; but I was obliged to leave my work and run out beyond the inflammable gas in the return passages, which I found in a serious state. So situated we had no time to lose. I came so far in and took the passage in detail, by opening the doors convenient between the in-going and returning drifts. While this was being done, I sent the man about a quarter of a mile from the down-cast pit (leaving it still better than a mile off the up-cast pit and furnace), with the same instructions if he found any inflammable gas there. I had also to go to the other men and stop the operations in the district for a time, while I was clearing the return drifts bit by bit, by means of the man hole doors, situated about 300 or 400 yards apart. Having succeeded in that, I again commenced to operate on the sheth of boards, and finding we had plenty of "law" in our hands, I ordered the men at the doors to change the process every five minutes. By this time the man whom I had out watching the state of the return (he is living yet) came in, and told me he had never seen any inflammable gas, "and as you ordered me, I have examined the return drifts at all the flaps or man door as I came in." This account was good, and begot confidence. I took him in with me to assist in cleaning the working boards and waste, making our preparations in the blank five minutes to be ready for the hurricane of air, for such it was, when the whole atmospheric pressure was laid on this district alone. The process went on satisfactorily, and we continued our careful examinations so that no gas might be left lurking behind.

It was now half-past twelve o'clock, and we had got up to the north board. Then with only five pillars and the east winning headways to clean down south, as you will see by the plan—we let the process continue a little longer, though conscious that all was right and clean as far as we had gone. We now, however, discovered that the cause of this alarming accumulation of inflammable gas in such a short time, was a fall of blue stone up to the post in the north board, which had exposed one of those extraordinary blowers or fissures whose sudden out-burst of hydrogen gas is far above the power of the ordinary current of air to dilute and render harmless. Here, you see, might have been an explosion of a very serious description, if I had not known it was my duty to be the first to inspect and examine this north board, to ascertain the effect produced by the drawing out of the timber, &c. Yet how far this system of ventilating a sheth of boards deviates from the principle I prefer, and recommend to practice, will be seen by the plan. First, you will see that if the air had been taken direct up the westernmost and working headways, borne up with stoppings in the east board ends to the north board, and there passing through an aperture or slide regulator, (as I have described before), it would have been impossible for the hydrogen gas to escape through that regulator to west, consequently, the men would not have been exposed to danger, nor any one under the dread of an explosion, as this inflammable gas would have been compelled by the laws of nature to extend itself in the waste and return passages, where none can reach but the wastemen. This is, I hope, sufficiently clear.

Being so far satisfied, I next went through the double doors in the north narrow board (and south of the workings), into the return air, and had the gratification to find it all right and clean. I then replaced the regulating stopping, but left the aperture double its original area in order to keep the atmospheric air in the ascendancy and enable it to dilute the gas as generated from the blower. It was now half-past one o'clock, and all this vast field (several acres) of inflammable gas was dispelled in the short, almost incredible space, of four hours and a half. Some may perhaps doubt the accuracy of the statement, but "thanks to my footing," there are parties living yet that can and will corroborate the tale I have told. But I was not even yet satisfied. I took the candle and a young man with me to examine all the working boards, up to the north, so that we might leave no trace of danger. We found all was right; and listening to the roaring blower discharging its dangerous gas, we put out our candle, and with the lamp proceeded down east, passing through beneath the blower with cautious step, and so on down the east winning headways to south, back to the narrow boards again. The four old experienced men were sitting at the foot of the headways on the west side of the double doors, waiting with anxious hope our return. They had been commenting on the feat, and their interest had been greatly aroused, for when they heard me open the inner door, their feelings overmastered them, and when I opened the outer door, I found them all in tears. When I asked them what was the matter, one of them (the brave old Kennedy) took me by the hand, and said, "We cannot help it. There never was such a thing done in the coal trade before. I have seen a vast in my time. I was at Sheriff Hill when the explosion was there; I was at Neasham Colliery when the explosion was there, and was one of the exploring parties at each place; I have seen a vast, and a vast of clever men in my time, but never anything like this in the world before. We'll have it advertised in the papers if thou be's willing." "Nonsense," I said, "we are not done yet. You know nothing is done when there is anything left undone. Get the bag of nails, axe, saw, and hammer and come away. We'll put a temporary deal stopping in at the west end of the north board. I cannot go home and sleep until that is done; for this reason, this blower may yet be under the influence of the atmosphere, and it might get back west to the end of the board, I must prevent it, before I can quit it." So off we set to the north board where they heard the blower roaring for the first time. We very soon put up the stopping, leaving an aperture of sufficient area so as to compress the air, and yet not obstruct it. This I knew was a safeguard for the workings. We then left for home, fatigued with exertion, but satisfied with the results.

When we met the overman, we told him that all was right, and that the men could go to their own places; he expressed his surprise at our success: having seen the state of the district the day before, he calculated that it would be several days before we could get it again in a workable state. However, he went in before the men, and was quite satisfied that all was right and safe. The under-viewer also went in to see this district, and expressed his satisfaction; I do not know that the chief agent ever knew anything about it, at any rate he did not know from me, neither

was I ever asked any questions upon the subject. The man that hewed in this north board, at this time, was William Robinson (living yet), and I will venture to say that he never knew anything about this vast accumulation of gas; nor, indeed, was it known to more than a very few of the workmen on the colliery. You will see that if I had not gone into this district first, on Monday morning, the deputy and the men would have gone their accustomed way, candle in hand, when, in the twinkling of an eye, all would have been over with them in this life. As I have told you, this inflammable gas extended itself three-quarters of a mile beyond the end of the other working districts, so that if any explosion had taken place, even the men situated beyond the range of the explosive blast would have been killed with the choke damp. I, therefore, enjoy the consolation of having, more than once, averted the effects of those direful catastrophies that too frequently visit the miners' home. Why should they remain in jeopardy? "The atmospheric air is equally pliable in all its operations in the mine, when guided by judicious care, as steam in the hands of the artisan in its wonderfully vast and beneficial results. Both steam and gas are elastic fluids, and in each the elasticity arises from caloric being chemically combined with the solid particles, of which it is composed, and atmospheric air yields to the slightest impulse, and is put in motion with the exactest ease."

Let me give you another illustration, during my time of practice at Coxlodge Colliery. A stone drift was driven to west, though underneath some old workings, and after going a certain distance beyond, it was found necessary to set off a drift, or perpendicular shaft, passing through strata of eleven fathoms and two feet thick (including between four and five fathoms up), of layers of blue stone, or what I suppose chemists will call a compound of silica and alumina, whose native gas is carbon. They had all the stone to blast with powder, but when they drew the pricker to enter the straw and apply the match, they felt the force of the carbon oozing from its native bed, and preventing the candle from reaching the match, by its deadly effects on combustion. In this manner the work was nearly brought to a stand still, and the principle to which we resorted to ventilate this shaft was as follows:—We had a regulating stopping near to the down-cast pit, with an aperture of 144 square inches, which was quite equivalent to the ordinary task which the air had to perform, through the workings of this west and up-cast pit, and to air this staple, or shaft, I had boxes made, ten inches by fourteen, giving an area of 140 inches, which proved to be inadequate for the purpose, if no additional pressure could be applied to the box. This, as a matter of course, became a theme of conversation, and a point of controversy among the officials. We first, obedient to orders, made everything as tight as possible with lime and clay—this would not do; what was to be tried next? I got all the stoppings made secure, and doors doubled, direct from the down-cast shaft and this drifting staple or shaft. I then broke down the regulating stopping, and laid the whole atmospheric pressure on these boxes, and that produced the desired effect. We now saw no more carbon, nor experienced any lack of air during the whole of the time the men were engaged in their upward progress, until they cut the coals, and then, after

the air's return passage was provided for, and all made complete, I rebuilt the regulating stopping near to the down-cast pit, and reduced everything to its former state.

But I have not done with this staple yet, as I intend to show that miners have many, very many, dangers to dare, even up to hair-breadth escapes, in the coal mine, apart from the dangers of gas. As I have told you, this shaft was won by a stone drift going west by north, and at ten feet to the south by west from the drift, they set off this shaft, all in the blue stone, and near a trouble or an eruption in the strata, consequently it was necessary to arch the drift and side drift with a groin arch, and wall the shaft, connecting the whole up as far as the stratification was bad; to superintend these operations of drifting this shaft, two men of good practical knowledge were appointed, who had charge of everything, except the ventilation, which devolved upon me. After getting the ground work and all cut out ready for the masons to begin the arching and walling, these two men were separated into opposite shifts, with each an equal number of men and masons, to follow up the work day and night, with eight hours in, and eight hours out, until they got it secured. The first shift went in at eight o'clock one Sunday morning, but they had not long begun to work, when the men engaged in the shaft were alarmed by small stones falling down upon them, which made them run into the drift for safety; this alarmed all the rest, thirteen in number, and it was well they did, for the next minute down came the upper strata in a rush right across the drift, seventeen feet up, forming a cone at the bottom of the shaft, and closing the drift. Fortunately nine of the men had run beyond the range of the fall, and they got out the other four, who were barred in behind the falling stones, yet quite safe, as the drift was continued past the shaft thirty yards, which gave shelter to the men in their flight. When all had become settled, it was found that none were injured except two, who had received slight bruises; as a matter of course they left their work, and came to bank to acquaint the masters with what had happened. It was now between ten and eleven o'clock, and the chief agent himself, and the under-viewer, were at the pit with the men. They sent a messenger off for me, and when I went, the chief agent requested me to go and take charge of the job, saying "Go and order what timber you think proper, and take as many men as you like." Obedient to his wish, I went and selected such timber as would answer my purpose; one piece was a beam twenty-two feet in length, and sixteen inches diameter, this was to extend from side to side, with its ends set into the solid stone, to secure the roof off, and it had to be arranged so as not to interfere with the walling or arching, and to remain in when all was built and sowed up solid above the arching and behind the walling: I divided the men into two shifts, eight hours each, and I engaged to remain with both until the danger was past. I took one half of the men in with myself at four o'clock on the Sunday afternoon, the other half to come and relieve them at twelve o'clock at night; we lost no time in commencing our operations, and we made rapid progress, so that I ordered them to bring the masons in with them, when they came back on the Monday morning, at eight o,clock. They came, but were extremely

timid; I could not induce them to believe in their safety until I had exposed wherever they supposed any danger to exist. As the work went on, their fears abated, and their confidence increased, and on the Tuesday morning when the under-viewer came in to see how we were getting on, they expressed their assurance of safety. I left them at four o'clock in the afternoon, for the first time since Sunday at four o'clock—after being forty-eight hours in the pit, amidst danger and difficulty, filled with anxious care—promising them to be back at four o'clock on the Wednesday morning; thus did we persevere until we had got the drift all finally built, and solidly stowed as it is to this day. I then left, with the workmen's thanks and nothing more.

Now, fellow workmen in the mines, who best can appreciate the merits of a man so situated; and ye discerning public, whose sympathy I now seek, let me ask you now, how should a man be remunerated for services such as these? You have read that the chief agent selected me from the vast number employed on the colliery, and took me from my own occupation to be in charge of this hazardous, dangerous, and most difficult undertaking. My ordinary wages were regulated by the deputies, and at this time were 3s. 6d. per day, for eight hours' work; so that you see in this case I had six times eight hours to claim as my due. Do you think I got it? No! That same chief agent thought the one-half quite sufficient to reward me for doing what others could not do, according to his own views. Thus, I performed a difficult operation, and exposed my life to the most imminent danger, during forty-eight hours, for 10s. 6d. This statement can be corroborated by living witnesses; and those witnesses will glory in reading this account; for they knew I did everything carefully and conscientiously, and never neglected my duty, although I was not sufficiently remunerated for it. No, my object was to learn as well as live; always doing my best to keep everything safe, and provide a healthy atmosphere for the workmen. And thus were my energies wasted in the meridian of life. Nevertheless, I was always buoyed up by the hope of bettering my condition in another quarter, and in a similar sphere. Yet in all my applications I was disappointed, and I am sorry to tell you that I am doubly so now, as you will learn by-and-by. With all my pretentions on ventilation, I may tell you that I am, and have been this five years, involved in an atmosphere of the most offensive and pernicious description that I have met with in my passage through life:—L—A—W is the name of this noxious gas; it has accumulated into a volume of unmanageable bulk; and not having been a native of the mine, I was ignorant of its effect, until it was visibly floating on the ruins of a respectable tradesman, with no means at hand to avert the calamity.

However, having given you a descriptive view of the last dangerous undertaking brought to a successful issue, I may say, that at that period of time all operations of this kind, where difficulty and danger prevailed, devolved upon me, whether in or out of the pit. In old or new, I was invariably selected to take charge of the process of labour necessary to re-establish safety. We had a very extensive field to practise in—a field where such a variety of experience could be gained, that any man with an intelli-

gent mind, must necessarily become an adept in twenty years service. And to tell over what he himself has seen and done, must be the most prudent way to illustrate the principle he advocates, and to devolope the system he upholds as the best and safest. In the principle that I adhere to for the ventilation of coal mines there is nothing artificial. The more it is examined in the light of science, the more clearly will it seem to be in unison with the inimitable laws of nature. Let the practical miner adhere to the important lessons held up to his view by the daily indications of the mine, whose variations are subject to, and under the influence of our common atmosphere, when he too, will in candour admit that these remarks might suffice for the purpose of instructing others in the matter of ventilation without entering into a system of geology. My object is, to present as clearly as I can, those doctrines which, to my conviction, stand upon solid ground of proof; but which may have the appearance of being controverted by some. Considering the specially interesting character of the subject, I may be excused for briefly describing some of the actual facts which have been brought to light by practice and experience, without being considered an egotist, or one hazarding a tale by guess. All the explosions of serious importance that I myself have seen, were the result of negligence. All I have read about, however far distant or near at hand, I discover in the examination and depositions of the witnesses to have also originated in negligence or defect of management. Why should such errors of judgment continue to prevail in the coal trade; or why should the country be imposed on as it is, and the miner be placed in jeopardy daily, when the mines can and ought to be ventilated effectually with health and safety to all?

As is the duty of every man, my earnest desire is, and always was, to do all the good I can. I am aware that some one who knew me in practice, perhaps now may say, "Well, the pit once fired on him, and two young men were burnt so that they died; why did he not then prevent the sad accident and avert calamities he so much denounces?" I will therefore embrace this opportunity to vindicate my own practice, and show that such an accident never could have occurred under ordinary circumstances, apart from negligence. I will demonstrate by truth and proof, that this occurrence too stands prominent on the list of many cases of wilful negligence. I recommend your attention to the sectional plan of the workings in the district where the explosion took place, almost immediately after the miners' strike in 1844. First observe the red dotted line from the south is the horseway up to two stentings within the double headways; there the crane stood, when the putters brought the coals out of the working places, as the red dotted lines indicate by 4 pillars east and 13 walls to north, and the darts show the course of the air. Now, observe the fourth board north of the mothersgate or common going board, and northernmost shaded blue, to east. This board previous to the strike was driven in advance of the others, guarded with a bore hole kept ten yards in front, to protect the workmen and prove the thickness of coal between the old goaf to east and the working places. The man that bored this hole was provided with clay, and a wooden plug suitable to the hole; so that when he holed into the goaf, his instructions were to draw out the rods, fill the

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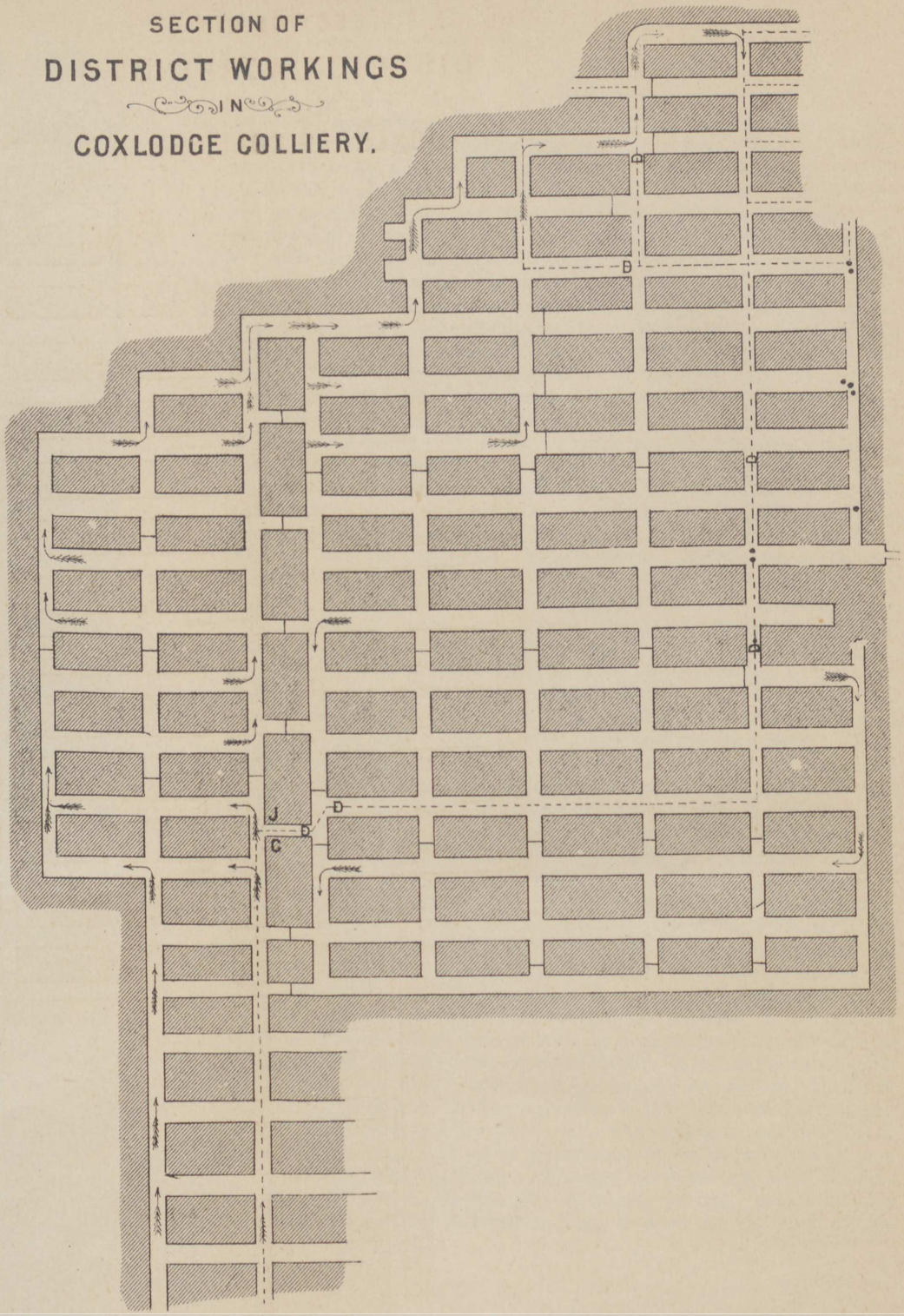
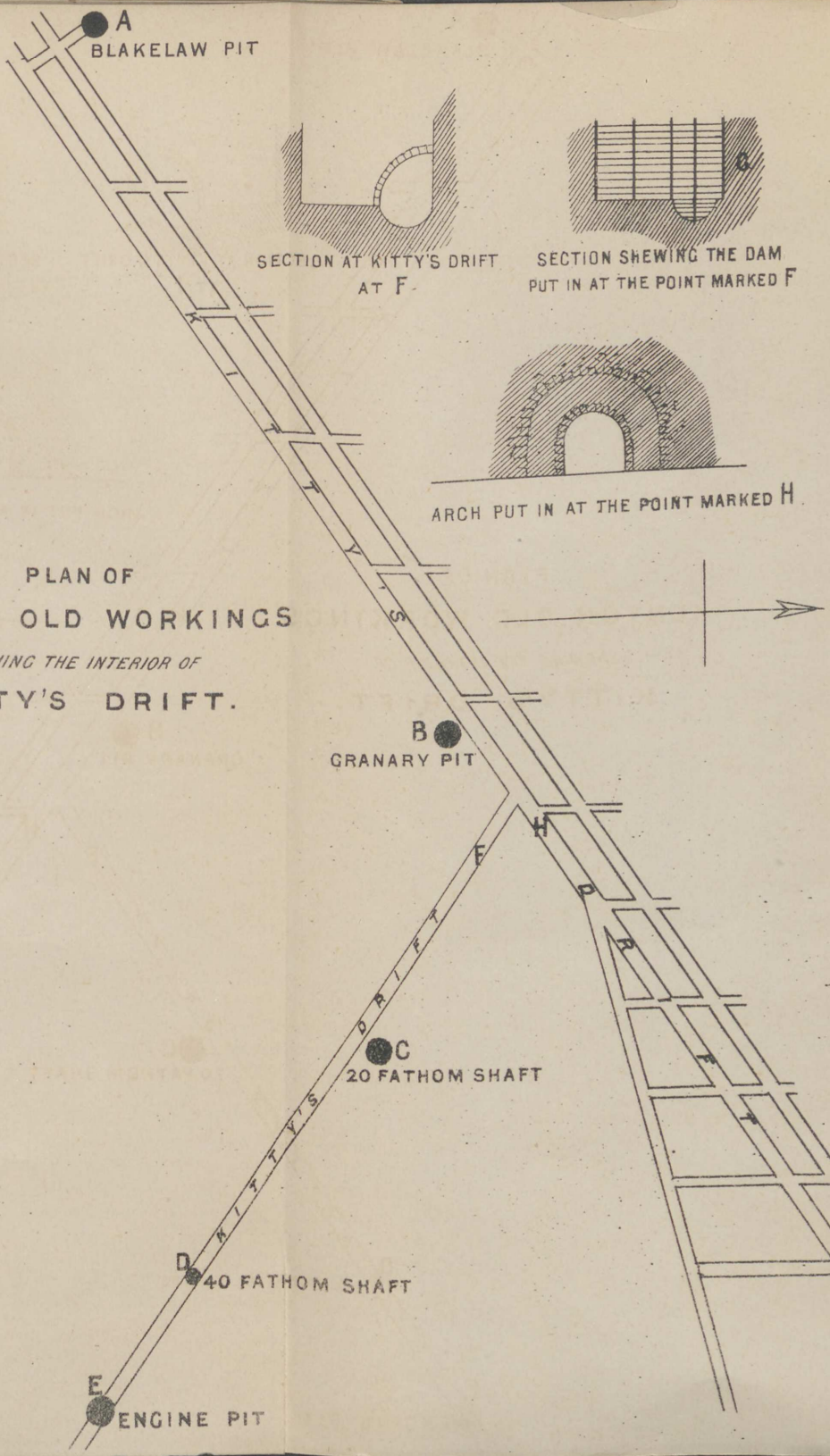


hole with clay, and then drive in the plug, thus making it perfectly tight and preventing the escape of gas from the goaf. But these instructions were neglected. The borer was taken away, and the men continued to drive the board on by guess and hazard until the pay Saturday morning, when the overman set two of the deputies to bore a hole and prove the thickness of coal. In doing so, they holed into the goaf at 2½ yards, without any knowledge of or provision for the plug, &c. They brought away the rods, leaving the hole open as a vent from the goaf. The board to the south is not up nor the wall holed, as you see by the plan, when the strike takes place. The timber is all drawn out and a portion of the upper strata has fallen; and this very important position is neglected, remaining in this state without me having any knowledge of it. After a few weeks had passed over we, officially employed at colleries throughout the coal trade, had to start and hew coals, &c. The chief agent kept me on up to the last day of the strike, and when that was done, we had to go and repair the timber in the horseway by his order, without ever thinking about the waste, or the ventilation of the two pits. By this time the coal workmen had got well underway. We had been four days in the waste, and my object was to look after the most important places within the knowledge of my own ken first. I had no dread of this district, being ignorant of this neglect, when I received an order to wait upon the uuderviewer and a young gentlemen who was serving his time to be a viewer. They were coming down to line round by the face of the workings to ascertain their position and distance from the boundary line, as indicated by the angular border of black to the north. We commenced our survey at the crane, going up west, keeping by the face of the workings to the northernmost board, and down east to the main going headways, as indicated by the the red dotted lines. We had got all the angles, and were now returning back to the south. At our last sight, the compass stood on the main working headways, at the end of the board dotted red leading a pillar to east, to a blank headway, with the timber all drawn out and a portion of stone fallen. I being the leading marksman, I had fixed my plumb convenient for continuing the survey down this headway to the south; and although we had now got far through the required process, yet not one had ever told me of the board being holed into the goaf, as you see by the plan it is, nor that the wall was not holed to the south. I proceeded on knowing nothing, nor dreading anything. I had got to where you see the single black dot in the wall next to the foul board. When I had proved the sight, I fixed my thumb for them at the compass, where you see the three black dots, and all was right and clean as far as I had gone. I was confident in my skill and judgment, inasmuch as I dreaded no danger. But when the two men with the chain had got off the main working headways, they released five putters whom they had been stopping to the north of them; when they all set off running at a rapid rate down the headways a pillar to the west of us, this caused a strong counter current of air to flow up north, in the east headways, where we were, when this volume of hydrogen gas which had escaped from the goaf by the bore hole, and gathered into bulk, in the board below as a floating stream of deception even to the skilful miner, was bore up to the north and me.

I had my back south and I never knew until I was involved in a flame of fire, my strength and action taken from me by the absence of the atmospheric pressure, yet in the midst of this intense flame, I retained my presence of mind; and fortunately for me the fire moved with great force to the north, bearing me with it, when I flung myself head first into a hole by the side of the east wall of coal, with water in it, which hole had been produced by the hanging of a side wafer, or a frame of stone most dangerous to look at, as it appeared ready to drop. My head and right arm were covered over with the water which saved my life. My suffering was only momentary, but I had had enough of it; and two of the putters in passing the west end of this board were so severely burnt that they died from its effects. The three men at the compass were a little scorched 34 yards to the north. You now see me, indicated by the single black dot, in the midst of a solid flame of fire, of above 50 yards in extent—my life miraculously saved, as often the miners is; and yet, while I was bearing my smarting sores, I had also to bear the severe infliction of a public censure, for the defect or negligence of other men.

After this descriptive detail of the occurrence, I need not further point out to the practical miner, nor to the man of science, the extent of negligence in this case, and the true cause of the explosion, which ought to have been prevented by holeing the wall to the south, making a straight and direct passage in the east headways for the returning current of air. Then the hydrogen gas, as it escaped from the goaf, would have been swept away into the waste by the air, and thereby rendered harmless. Or why did they not plug up the bore hole and prevent the escape of gas altogether? Or why was I not made acquainted with this state of things, that I might have adopted ways and means to prevent an accident? They knew I had long been engaged as a common coal hewer, which I had refused to do when first requested by the chief agent, because I viewed it as a punishment imposed by caprice. It was an inconsistent oversight on his part, and an unnecessary degradation on me. And my refusal sprung from a variety of reasons, strongly operating on my mind. We had to be sworn in special constables, and perchance to put the men out of their houses. Thus, are you compelled to draw daggers with your neighbours and friends, when your remaining life time is too short to find a friendly sheath to hide the offending blade in—with the men too, who in youth shared your sports and follies, and afterwards laboured side by side in the dreary mine, cheerfully helping one another. How often is it the miner's lot to risk his own life in saving those of others, and is such a life not calculated to create a feeling of active sympathy among those who have shared its dangers, and whose memories are filled with the same records? Or would the chance-directed hand of agency seek to divert nature, and convert the miner into a hypocrite, to devour his fellow? Is he made like a dog, to pat and fawn on his master only, and obey him right or wrong? Men owe a duty to their employers, which they should at all times obediently perform. But they also owe an important duty to one another, which they must not forget, it being the source of their own general welfare. Their domestic happiness, the social and daily intercourse, all depends on the performance of that duty. Again, a man rising from the ranks of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labour is always viewed with an eye of envy by those he leaves behind. It is some time before they can, or will submit to his authority. They say "what des he knaw, he was a coal hewer only t'other day." It requies an extraordinary proof of his superior qualifications to establish the necessary ascendency, and subject them to his commands. Yet with me this was done to their satisfaction, through a long series of years. My name had become proverbial among them, and they had confidence in their man. But when they saw me doomed to mix with the oucasts of society, compelled to hew coals as a punishment to my feelings, stripped of my little authority, I stood disgraced and degraded in their estimation whose previous approbation I was proud to receive. They joined in the denunciation of my character and conduct. And thus I became disgusted with a life so thankless, which was, to a certain extent, the cause of this explosion. But, as strikes and contentions between master and the workmen are always injurious to both, through the evils they entail on the future—chief agents would do well to consider, and avoid coercion on subordinate agency. As the noble Byron says, "Heads bow, knees bend, eyes watch round a throne, and hands obey—our hearts are still our own." Nothing offends the feelings of man more than the attempt to degrade him in the estimation of others.

So easy was the prevention of explosions to me at that period of time that they required only a secondary consideration by the side of the many and varied dangers I had to encounter almost daily. Some of them I will introduce, although they may be considered out of place.

We had serious contentions with water from the old workings of Kenton Colliery, after breaking up the arching, and destroying in a great measure the passage of the drift which extended to the Tyne side at Scotswood, known as Kity's drift. This was an outlet for the water of Denton, Blakelaw, and Kenton Collieries in days of old. But some adventurers commenced to work the ironstone at Blakelaw Pit, and regardless of consequences, broke up the drift, and stopped the water's passage, which forced all the water of Kenton old workings down to Coxlodge Colliery, amounting to 500 gallons per minute. This created many evils, attended with enormous expenses, and compelled them to put up a second pumping engine to meet the exigency, and enable them to continue working the colliery. After a lapse of years, they at last, in 1829, sent a number of men up into this Kity's drift, to open out the passage for the water again, if possible, by ridding the falls and timbering afresh, the upper strata where the arching, &c., had given way. They had also in several places to build a lesser arch underneath the larger and original one, stowing the vacancy between tight with stones, &c., to make the whole more permanently secure. When this was done, they resolved to put dams into all the south and east holeings, and necessarily force the water down its original passage to the Tyne side. I was selected to take charge of this process of labour, in addition to superintending the ventilation of both pits at the colliery, which I had to go down each morning at two o'clock alternately, as circumstances required, to set the men to their work, and see that all was right. If I found things in order here, I then joined the other men to go down the old pits

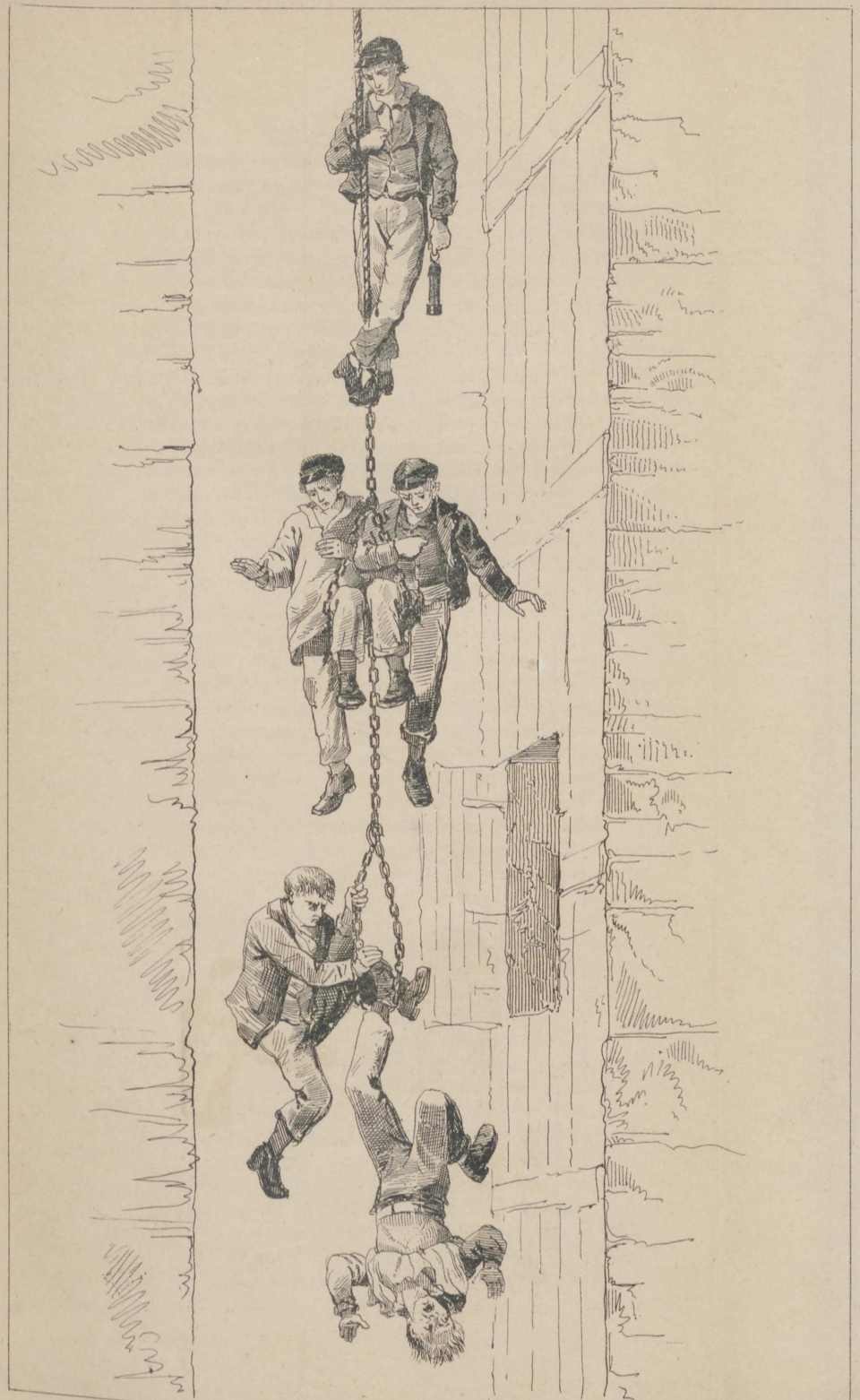
into this Kity's drift at six o'clock (when the weather would permit), it being the summer season of the year. We had two shifts or relays of men to facilitate the process, and as the work proceeded we had to go down different pits to suit convenience according to where the stoppage was, and the workmen required. At the north-east termination of this drift stands the Old Engine Pit, a little to the south of Kenton village, and in the field north of the Town Moor. But as the principal portion of the work lay where it was most convenient for the men to go down the Granary Pit, about 1,200 yards to the west by north of the Engine Pit, we put up a gin, and for years we had to improve and secure the passages from that pit, in the summer of the year only. From this pit too, there was a north-east cross-cut which extended for more than a mile in that direction. The workings to the north and west side were holed into what was called "the old men's workings," to what extent I know not. But they abounded in carbonic acid gas, and on the slightest change of atmosphere, the gas would rush out from these holeings and envelope us in darkness and deadly vapour, in which event we had to plod through water the whole distance to the shaft in the dark; and it was always my opinion that the agitation of the water preserved our lives on several occasions of this kind.

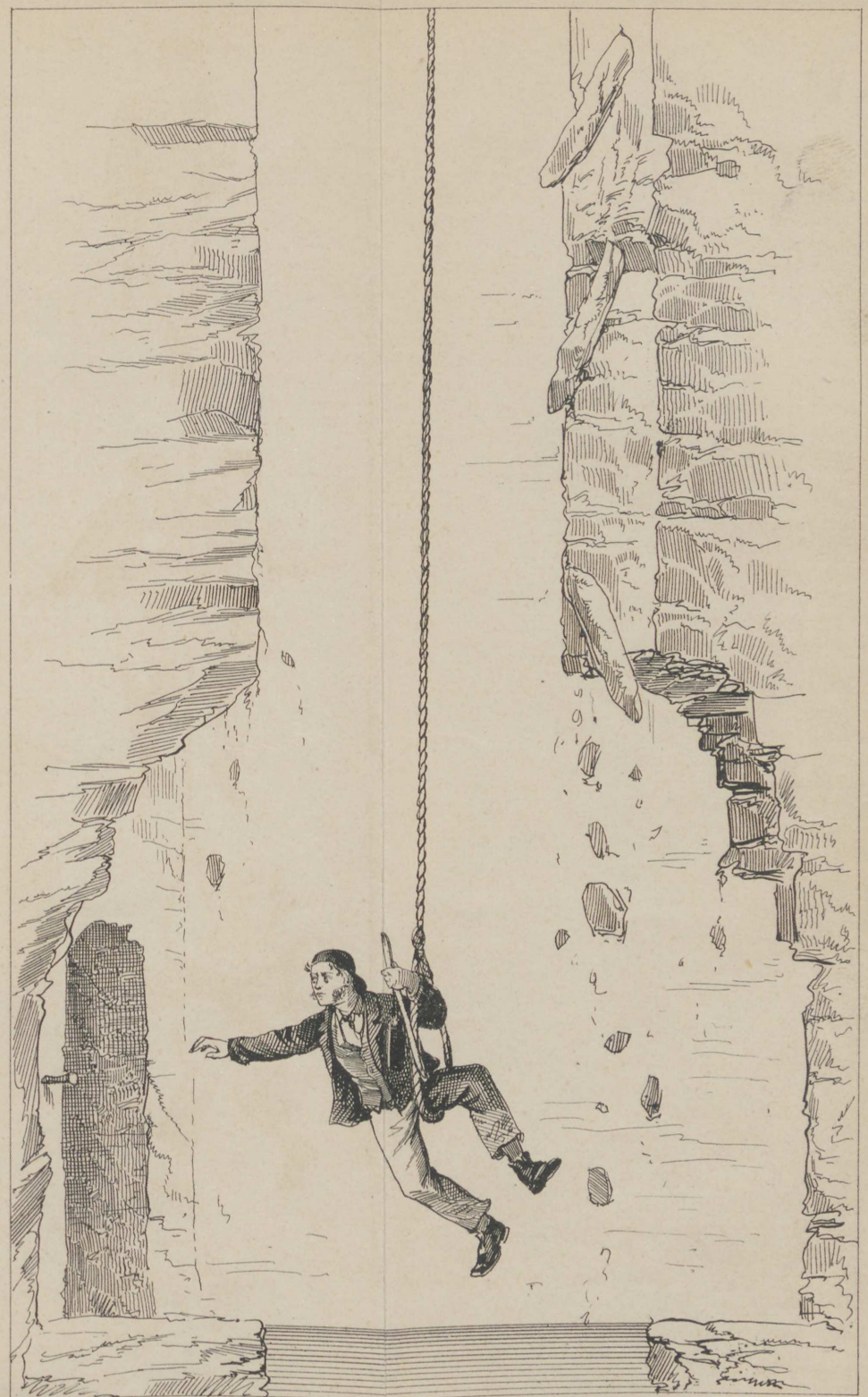
In referring to the plan, it will be seen that three pits, *i.e.*, the Blakelaw, the Granary, and the Old Engine Pit form an obtuse angle, by a close stone drift set out of the main drift, in a south-east by east direction to the Engine Pit, which was sunk on a hill side, or rising ground, to the north, and is 100 fathoms deep, from the surface to the seam of coal, being the southernmost extremity of the royalty, and depth of this colliery; the shaft is ten feet diameter, and had a segment bratticed off to protect the spears, pumps, &c., when a current going colliery. They had all the water the mine made to lift out by this engine, to bank, or nearly so, until she became connected with Kity's drift, when they then shortened the lift forty fathoms, and, of course, reduced the weight and volume of water on the spears and buckets also, by delivering it at the mouth of the drift, and conveying it over the forty and twenty fathom pits with boxes away to the Tyne side; they also shortened the lift for the coals, by working off the strata from the north side of the shaft or drift, and fixed there a lifting engine, with its materials for working, and drawing the coals from the mine, sixty fathoms below, when they, too, were sent to the Tyne side through this drift for a time. As improvements in the system advanced, they, however, abandoned this drift, except for the water, and had to continue to pay rent on wayleave for it. But, in 1818, a fresh company of gentlemen became the owners of the colliery, who ceased to pay this rent, they laid off this engine, took it down, removed all the materials connected with it, leaving the water to take its own level, which soon brought it to Coxlodge Pits, being further to the depth than Kenton; and thus did our troubles begin. By this descriptive detail of the localities, by which you will better understand the formation of the working in these pits, all connected together to the north, the east, and the west of this Engine Pit, which ceased to be a coal working pit in 1814, and was abandoned altogether in

1818, everything being taken out of it that was considered worth removing. It was now 1837, so that nineteen years had passed over since it was laid bare, exposed to the action of the atmosphere, and left to Time's destroying power. On this occasion we had to go down this pit; and to describe the danger in descending this shaft is almost beyond my literary powers. Our mode of descent was a gin, a horse, and a man to manage it, one man only could go down at once, and I having the charge, of course must lead; we had prepared an enginewright's lantern with three candles (sixteen to the pound) stuck in among the clay, to keep them erect, and protect them from the falling drops of water as I descended. The horse had to walk backwards, guided by the man at its head which rendered the motion of descent extremely slow, the man decending with one thigh in the loop, and his left arm round the chain, with a heavy lantern in his hand, and with the yard-wand in his right hand, to guide and keep himself as near as possible in the centre of the shaft; his object being to see everything, but touch nothing. As I passed by, a cistern projecting over the shaft and the collerens which formerly supported the bratticing, were all gone to decay, some broken as if something had fallen on them, some were loose at one end, with iron bolts in them, hanging as if ready to drop; the sides of the shaft too, where the strata was tender, had given way, large side-wefers had slidden off, and others were hanging dreadful to pass by. The sixty fathom below the level of the drift, was filled with debris and water, and in this precarious and dangerous position I at length reached the surface of the water, and was the entrance of Kity's drift. I then shouted "*hold*" at the top of my voice; the signal was instantly attended to, and I hung looking around me with anxiety to find a place to land on. I could, however, reach no object to take advantage of, nor dared to look up to the fearful scenes I had passed in my descent. My duty prompted me to perseverence, and a thought struck me, if I could effect an oscillating swing of eight or nine feet, it would set me into the drift's end, if they at the bank could but manage their part, I again shouted up to those at the top, and explained to them what I wanted to be at, the instructions were that as soon as I shouted *down*, they were to drop me that instant, under the hope of landing me where I wished to be: by this I got myself put in motion, slowly at first, but gradually increasing both speed and distance, like children on the swinging rope, and when I thought I had got the necessary spring, I shouted to those at bank *down*. In doing so I prepared myself for a hold of something, and fortunately caught an iron bolt at the end, and in the side of the drift, set in the solid stone for past purposes; this I clung to with the earnest intention of success, but they were too slow at the top in lowering down, which subjected me to serious inconveniences, and additional danger; by the forty fathom length of rope, in its vibratory spring, striking the sides of the shaft, and bringing down vast quantities of stones, &c., which whistled into the water behind me. This made me loose my hold of the chain, and throw forward the lantern. Depending then on the bolt altogether for safety, I drew my leg out of the loop, and by the aid of this bolt I managed to crawl into the drift, but under these circumstances I could not preserve my lights, and there I stood in the mouth and entrance of the drift, without

any light, except the shade of day, which, falling on the surface of the water, was reflected back to the sides of the shaft, showing in more dismal form the dangers I had passed. Thus anxiously gazing on the dreary scene, I stood alone in contemplative silence, my mind wandering between duty and humanity, the question with me being, whether I should allow any more men to venture down, or whether it would not be better that I should try to get up again myself. While I stood in this frame of mind, those at the bank shouted down, wishful to ascertain if all was right with me, and expressed a wish to follow. On this, I permitted the process to go on, charging them to bring a light, and be careful to keep in the centre of the shaft. The great increase of danger in descending this shaft was, in a great measure, occasioned by the working away of the strata, right round the shaft, for useful purposes, no doubt, when it was a current going pit. On the north and west side had stood the machinery, and on the south and east side had stood a large cistern, or reservoir, into which the engine had delivered the water, the whole would at the time be supported with timber properly arranged to make it secure and keep it safe; the entire excavation formed a circle of great height, right round the shaft; extending the diameter to an enormous area on the level with Kity's drift, but now, at 1837, the timber and other supporters had been out of this shaft nineteen years, and those large projecting frames of stone had been left exposed to the atmosphere, that common changer of nature's scenery. When in this state they had fallen away for several yards up this shaft, which was now, at this part, in the shape of a cone without any support whatever, this was the most dangerous position I ever saw man placed in, and it was at once seen to be so. Well do I remember how those scenes operated on my mind at the time, when in my dreams the appalling vision appeared at my bed, where sleep and rest alone should be. However, the process was continued with safety to all; we got down one by one, and my being there to receive them removed the principal difficulty in landing them into the drift.

When we all got lights, and our first sensation of horror had had time to calm down, we set off as an exploring party to discover the cause of the stoppage, and where the water got down to Coxlodge Colliery. We had advanced, say 400 yards (I cannot vouch for distance) along the drift, when we came to a pit sunk in this drift down to the seam of coal 40 fathoms below. The sides of this shaft also were wasted and fallen away by the lapse of years, so that our passage appeared to be stopped, as there was no way of getting over this obstruction without venturing to creep along the water boxes, which had been in use many years before and might be rotten; but to risk and test them was our only chance of success. Duty again urged us on to perseverance at all hazards; and on to the boxes I got, all fours, and arrived safely at the other side; in the same way, one by one, all braved the danger, and we pursued our journey until we came to another shaft, sunk by the north side of this drift 20 fathoms down to the coal. But there being plenty of space for us to pass we were subject to no inconvenience, nor exposed to any danger. We found that the whole of the water from Kenton old workings was running down this pit, and of course away to Coxlodge engines. Hence the increase of water. Still





our object was to find out the cause and whereabouts of the stoppage, if possible. So we persevered on our journey over monster falls of the upper strata, damming back the water; nothing daunted, we continued our course over the falls and through the water, until we came to another old pit (the Granary), but this exploration was made before that pit was opened out. We now deem it necessary to pause, as on inspection we find this shaft filled up with rubbish, loose dirt, fallen stones, &c., quite solid, but how far up is beyond our ken; yet our determination is to open it out, that being a necessity for the purpose of ventilation, for as we look there is no visible system that can be applied to force the atmospheric air down into this drift, in its present state; the fact being present to our minds that even now, should a sudden change take place in the atmosphere, we would be instantly involved in a volume of carbonic acid gas (a deadly poison), with no other way to escape, but by the road I have been describing. You will naturally conclude, therefore, that our present position is dangerous, with little chance to get out. Yet, such is the daring requisite in the miner's occupation, that many a brave intelligent man loses his life through adventures such as this, whose death is never heard of. He is borne away by his friends and fellow-workmen to nature's final repository (the grave), and nothing more is seen or heard of him. His bold and daring spirit, his genius and prolific mind, his great experimental qualifications and many virtues, are all for ever gone, and nothing now is left to show the spot where these once such graces lie deposited. To these dangers, certainly the general body of miners are not exposed; in an ordinary way, they are confined to a select few. On the other hand, there are many unseen dangers which the miner is subject to, even in a common coal working shaft, where there is little to excite fear, or nothing apparently to dread.

It is a common custom in an extensive coal mine that a certain number of men are divided into two shifts, the one-half going down with the overman, say at three o'clock a.m., the other half going down to release the first at ten o'clock. By this, the process is kept going the whole of the day. On this particular occasion we were in the fore shift, and had got our day's work over at ten o'clock. We were making the best of our way home, and had got out to the shaft, when we told the onsetter we wanted to go up next. He gave those at bank the signal, and we prepared for our ascent. One young man got on top, two men in the high loop, and George Laws and myself in the low loop. Again, the signal is given and off we go cheerfully, whistling as we went for want of thought (as some one says), nor dreading danger until we got to near half-shaft, when a door struck the chain between the high loop and us to the right hand side, where Laws was on. In an instant we were driven right backwards over out of the loop, and might have been sent head-first down the pit to the bottom again. But fortunately for us both, my left hand was free, and in the struggle I caught hold of a link and held fast by it. My leg was out to the ancle and foot; Laws was out altogether, but just as his foot was passing through the loop over the chain, I caught him with my right hand by the toe of his shoe, the heel resting on the edge of a link, and by the lever and length of his foot, I held him in that

state, hanging head-first down the pit for several fathoms up, and all the way down to the bottom. While I myself hung by one foot and one hand, though injured by the blow, yet I never faltered with him; I kept my eye steadfastly fixed on his foot, as the variation of the sixteenth of an inch might have precipitated him into the folds of eternity.

This was one of the many miraculous and hair-breadth escapes, I have had in my time as a miner. And strange to say neither of my brothers had one. They were both cut off in the flower and bloom of life, by an equally sudden surprise of the solemn call, in the twenty-second and twenty-fifth years of their ages; and if in this instance such had been our lot, I have no doubt but at the coroner's inquest it would have been found accidental death. In point of fact, it was absolute negligence. This door was placed in the brattice that divided the back shaft or pumping side from the fore shaft, where the coals as well as the men and boys were drawn up to and from their work by a winding machine, &c. The door was made for the purpose of letting the enginewrights in conveniently to change the bucket, &c. They had been in this morning, and gone out only a short time before we arrived at the bottom to go up; and in going out they had neglected to fasten this door; by being left so, it was working on its hinges in the coal-drawing side, knocked to and fro by the rope and corves as they passed up and down. The young man who was on top was John Cole, now proprietor of the Elephant and Castle public house in Low Friar Street, Newcastle. And fortunately for him, at the time, he had his head below the hooking when it struck the door and drove it with great force to its frame, the motion of the engine enabled him and the men in the high loop to pass; but in rebounding back it struck the chain immediately below the high loop men, driving us from our hold, backwards over as I have described.

Now, was the importance of leaving the door open not sufficient in itself to induce them to be sure that they had safely secured it before they left it? Here you see, that by negligence, that monster of human ills, how easily we might all five have been killed; for instance, if the door had struck the chain below the hooking, and above the Cole, it would have swept the chain of us all, and the rope would have gone to bank empty. As it was, the three upper men were nothing worse, but panic stricken at the frightful scene below them. While Laws was nearly done, by hanging so long in the awful position he was in, his body hanging head downwards, supported only by the heel of his shoe resting on the sids of a link, the length and lever of his foot enabled me to keep it where it was for several minutes; otherwise I could not have borne its weight, which at the time was 12 stone 8 pounds. He was a long time in coming round, and never was able to do the work as he had done, yet he lived several years after this, and told his tale of my presence of mind and his miraculous preservation. He has a son, Richard Laws, and grandsons, at Seghill Colliery, to wit.

Perhaps it may be necessary to particularize species of work in the system of mining with which I have been connected, either as a workman, or responsible superintendent. I have observed that they came to the conclusion to put dams into all the south and east holeings, and if pos-

sible force the water down its original channel to the Tyne, and thereby prevent it from getting to Coxlodge engines. We had got the dams put into all ordinary holeings, but how to get one put into the south east drifts, leading to the Engine Pit, and that too, to the west of the twenty fathom pit, become a subject of controversy. The drift in this distance was constructed for a double purpose, being sunk at the north side, three feet below the sole or level of the horseway, with three feet additional breadth, and a quadrant arch turned from the sole of the horseway, to and against the wall on the north side, making the height between nine and ten feet, and in some parts eleven feet from the bottom level to the roof. This portion of the drift was a horizontal chimney too, to convey the smoke from the engine (that drew the coals, &c., up out of this twenty fathom pit), to the Granary, as the up-cast shaft; it was also the water's channel away to the Tyne. The construction and shape of the drift were in this form, at F. (*See* next page.) But at this time all the working had long ceased, and the place was now a void space of curious form, and apparently it was a prevalent opinion that clay dams would not resist the pressure of water at more than between six and seven feet high, and that they became soluble in the water at above that point. I was of a different opinion, I had had a great deal of practice in putting in dams, and reflection on the operations of nature induced me to conclude that the secret was to prevent a union of action with the water and atmosphere operating on the clay, consequently my object was to exclude this combined influence, and form a dam accordingly. After examining the strata in the whole of the distance, I found the formation best suitable near to the twenty fathom pit for such an experiment; it was here a close grained white poste, or free-stone without threads or facings, yet it was eleven feet in height from the bottom level to the roof. I set the men on to cut out the ground work at this part, confident of success. While so engaged, on a certain day, we had also eight men on getting clay down the Granary Pit, and into the twenty fathom, to be ready for the completion of the dam, &c. To keep up the ventilation we had a large fire lamp at the bottom of this pit as the up-cast, the Old Engine Pit being the down-cast, expecting this would be a protection against every contingency, all hands (thirteen in number) were working away quite cheerfully. The under-viewer came down to see the process, and the principle on which I was going to build the dam. They had not got far from the shaft when a sudden and serious change took place in the atmosphere, and such was the mighty outburst of carbonic acid gas from the old workings to the south, the west, and north, cutting off our communication with the shaft, and instantly enveloped us in darkness. Being so situated, each man was making for the shaft as fast as he could to save his own life, if possible, regardless of his fellows at the dam; we, being furthest in, the fire lamp at the shaft, which a few minutes before was burning a bright glowing fire, was in an instant put out, and the red hot cinders turned as black as coal—such is the effect of the deadly poison on combustion. We at the dam were nearly 500 yards from the shaft, and had to plod through water nearly the whole of the distance, at some parts up to the chest. One man wrapped his jacket round his head and

face, and owing to this precaution he did not sustain the slightest injury; but another man's heart failed him, and he gave himself up as lost. I had a serious struggle with him to get him out, we were so often down among the water, and frequently over head, that the task was quite as bad as if I had had him to carry out the whole distance, which is a serious undertaking in such an atmosphere. I believe, however, in accordance with an opinion I have before expressed, that the agitation of the water preserved our lives. As a proof of this, I may mention that those who were at the bottom of the pit waiting their turn to get up, as only one man could be drawn up at once, being motionless, were much more seriously affected with the gas than we were, who, they concluded, were lost. However, we all got safe to bank to tell our own tales, but were obliged to abandon the dam, at least for a time, until the weather became favourable to admit us back. Our efforts were then directed to the building of the dam, the construction of which is seen on the plan at G; each course of planking is shot with a plane, so as to make them nearly air-tight in themselves, and they are bolted together with bars of iron, three inches in breadth, and three-quarters of an inch thick, and screwed up to their proper seats at the placing on each course, before beginning to beat the clay in between them. The process went on with satisfaction up to the height of ten feet five inches, leaving a vacancy of seven inches above the top of the dam to the roof, this being a necessity, as the only visible and direct passage of communication between the Engine and Granary Pits, for the ventilation of each other. The work was finished on that ever-memorable day, the 10th of February, 1840, when our good and glorious Queen was married to her late dearly-beloved husband, Prince Albert.

And there it is to this day, an entirely waterproof dam; some will see it at no distant date, and its remains will discover the mechanism of its construction, and show to youth the industry of other years. On the day that we finished this dam the under-viewer, and the young gentleman who was serving his time to be a viewer, had the curiosity to come down and see it when finished. The principle I adopted to exclude the action of the air from operating on the clay was simply this—I caused the men to get each a bit of deal, to dip it in water, and by friction form a liquid coating on the top of the dam, which was solidly filled with clay; I then fixed a deal (made for the purpose) the exact width of the clay, between the planks, and set props upon it to the roof, corresponding with and betwixt the bars of iron; I then covered the whole with a coating of lime, which readily adhered to the liquid clay, and would absorb, or unite with the carbonic acid, and thereby form a crust over the top of the dam. We had also built a pipe, three-and-a-half inches diameter, into the second course of planks, and below the level of the horseway, for the purpose of running the water off, if necessity required it. All being now done, we then drove the plug into this pipe, and submitted the dam to the ordeal for testing its utility; each man would write his name with chalk on some favourable stratum, with the day of the month and year, as a memorandum of the completion of the dam. On the front of this dam is a female's head, intended to represent our

beloved Queen; beneath is the magic name of Victoria, with the date; and last of all is my own name. Thus does man build up monuments, even in the mine, to outlive himself; not another man engaged on that day now lives, all are gone save myself, who alone am left to tell the tale of times that are past, days of other years.

We now wend our way home; our ascent was by the Old Engine Pit, and having all got safe up, we bade adieu to the dreary scenes of danger and slavish toil, and transferred them to other men of other times. But we are not yet done with the south and west portion of the waste and water channel; we had frequently to descend the Granary Pit to gauge the water and examine the passages. After the lapse of years we again got the water of Kenton old workings down to Coxlodge engines, consequently I took three of the wastemen with me to find out the cause, and if possible to apply a remedy to the evil. One day, the weather being most favourable, with a bright sky and brisk wind from the north by west, we descended the Granary Pit, one by one, and found near two feet of water at the bottom of the shaft, which told us the stoppage must be along the north-east cross-cut, as the main drift that leads into the old workings. We knew that we had left the innermost dam one foot short from the roof for ventilating purposes, so that we dreaded a monster fall might raise the water until it ran over this dam, and so we found it. After plodding through the water, and over the falls, we at last came to what was truly a monster fall, it had broken down the arching for several yards, and we found the water close up to the roof, dam'd back from this point, and no doubt but running over the dam as we suspected. Being provided with the implements of labour, we began to reduce the fall immediately, and run off the water in the best way we could, so as to bring it below the level of the dam. I had not, however, forgotten the lesser arch, built in beneath the larger and original one, consequently I sent a man out at different times to examine, and ascertain if the water was getting away to the south west, or if it was rising any at this little arch at the cross-cut head. On every occasion he came back and told me all was right; on this information we ran the water off as fast as possible, and at last considering we had done enough for the day, we left our gear to return again and finish the work properly. We then set off for home, but to our astonishment when we got to this lesser arch we found the water two inches above the centre, yet we felt no impediment or inconvenience in the air as to breathing. I accused the man of the imposition he had practised, and the importance of the duty entrusted to him, and the culpability of his own conduct. I then broke through one of the stoppings into the return drift. and found the water up to the roof there also. There we were, barred in with water, the effect of an incautious imposition, with no prospect but to form a resolute determination to save our own lives, by diving through this lesser arch, a distance of eighteen yards, without any delay. The construction of the lower arch is shown on the plan, it is built in beneath the larger, is marked red, and is situated between the south-east by east drift leading to the twenty fathom, marked C., and forty fathom, marked D., to the Old Engine Pit at E., and the north-east by east cross-cut head, leading

into the northern workings of these pits. I wish it to be understood that I do not vouch for the accuracy of distance, or of direction, as I produce this plan solely from memory, but merely to illustrate my statement, and show the formation of the arch, and construction of the dam. There is always a diversity of opinion with men in jeopardy, but under such circumstances reason admits of no comment; as for instance, supposing in this case we again dam'd back the water, it would have been several days, perhaps weeks, before such a volume could have been reduced below the arch, and in the interim, suppose a change of atmosphere were to occur, and the vacuity to be filled with carbonic acid gas, the consequence would be inevitable death. On these considerations, I enforced my views with this arrangement, that if I succeeded in getting through, I would "jowl" back to them, but if I failed in the attempt, they were to make the best of themselves they could. Having come to this conclusion, I prepared myself for a resolute dive, with a determination to be through; off I set, and succeeded, but with nothing to spare. Let me here remark, to those unacquainted with diving, &c., that if you can retain your breath no longer and open your mouth under the hope of respiring, the pressure of the water forces back the collected volume, when, from this adverse stroke of nature, you drop, your strength fails you, and your struggling will soon be over, if there be none at hand to assist you. Well, as soon as I got the water wiped from my face, I jowled back to the men, one of them immediately made the start, but fell before he got through, I sprang in to his assistance and got him out. I again jowled, and off came another, who succeeded cleverly, as did also the last one, so that we all got safe through, and I hope the others are all living to this day, to corroborate my tale. As it was, we had released the engines at the colliery of the water, by what we had done, and it was many months before we went back to make our work perfect, but at length it was done, and I am not aware whether it ever troubled them any more at the colliery or not.

We had previously opened the drift properly between the Blakelaw and Granary Pit, and partially abandoned the former, with the exception of occasionally going down it to ascertain whether the water was getting away to the Tyne, or if it rose any at this part of the drift. On this occasion, after an absence of near three years, I had to go down it for that purpose; our mode of descent was a jack roll, seven inches diameter, and a small rope above 100 yards long, with two men to work it. The roll was fixed ready for the day of favourable weather, and I ordered these men to be at the pit at eight o'clock, and took one of the wastemen with me. On arriving at the pit, I first got them to run the lantern and two candles in it down, dreading the stythe, or carbonic acid gas at the bottom of the shaft. The candles were extinguished, but we satisfied ourselves that they were put out with the water, as we could see it distinctly at the bottom; consequently I ordered them to bring the rope to bank, and I would go down. By this time we had got all in readiness, and for better security I had provided a portion of rope to tie us in the loop, *i.e.*, the rope was put round our body, below the arms, and safely fastened to the chain. All being now right, and the men ready, I launched myself off into the shaft, and told those at the roll to lower

away. My descent was slow, but comparatively safe until I landed at the bottom; there I became immersed in a body of carbonic acid gas, compressed on the water by the pressure of the atmosphere. As soon as I alighted on the bottom amongst the water and stythe the candles were put out as if dipped in water; by this I discovered my risk, yet in my movements, and disturbing the water, a vast number of frogs went leaping out in all directions, which induced me to believe that danger was not imminent. I was, however, soon taught a different lesson, by advancing towards the drift, and stooping to enter, I inhaled a dose which was nearly enough; I got back into the centre of the shaft, and had strength to shout up to those at bank to draw me away immediately, which they instantly obeyed; but, by the agitation and movement of my body I broke up the hitherto compressed volume, which rose to a higher expanse, and compelled me to breath once or twice more the deadly poison; I now became powerless and unconscious of my state and position. In this condition, they drew me up the pit, fifty fathoms deep, in imitation of and as if a dead man, my arms hanging down by my side, and my head reclining on my shoulder. On arriving at the top, they treated me as if dead. A blacksmith and farrier lived close by, who came with a bottle of castor oil, and put the neck of the bottle into my mouth, and had me laid on my back, while he patiently poured drop by drop into me; when at length by agitating my body and the operation of the oil, they succeeded in restoring animation and consciousness, I began to vomit and gradually come round, though a long time feeble and dizzy like. I relate this for the purpose of instructing others who may be exposed to the risk and danger for their livelihood, as I myself was, to describe the symptoms and first sensations felt, when similarly situated; the first effect is an internal fulness, as if the lungs were inflated beyond the power of action; the second is a sleepy dizziness, with an inclination to lie down, which leads on to death, if they do not retreat at the feeling of the first symptoms; yet you feel no pain, nor thought of dying; you give up life, and quit this world in that state of unconsciousness. I once saw a man under the influence of excited feelings rush into a headway's end standing stagnant, filled with pure carbonic acid gas; at the first breathing, or inhalation of the deadly poison, he dropped on the spot as if shot. He was only four yards in, and another young man and me being on the spot we dived in for him, and got him out alive, although nearly dead; for diving it is, and must be so to succeed in it; for, believe me, if ever you breathe, and it be pure carbonic acid gas, I am afraid you'll breathe no more; and why doubt my statement? Hear what an author says on the subject of breathing:—"By the rise of the breast-bone in man, and the descent of the diaphragm, room is afforded for forty-two inches of atmospheric air at every drawing in of the breath. A deeper inspiration will give room for more than twice this quantity." Now, imagine a man so situated as to be compelled to inhale forty-two cubic inches of pure and rank poison. What are we to expect will be the consequences but instantaneous death. These were about the last of my adventures in connection with Kitty's drift. Often do my reflections accuse me for the daring risks I exposed myself to, without pros-

pect of profit; I was insufficiently remunerated, even for the actual labour, without the industrious contrivance and responsibility. For who do you think planned, constructed, directed, and completed all this vast variety of work but myself. The chief agent never saw the operations, neither did he devise or suggest anything beyond formal orders. I am induced to insert these truths, from the fact, that practical miners, however intelligent, or however skilful in experimental knowledge, are excluded from governmental consideration, as being fit and proper persons for the inspection of the coal mines; I also wish to show that they are the most suitable for the Government to rely on, as they are those in whom the miners have most confidence. A suggestion of this kind, however, like all other reforms and improvements, is viewed with a prejudicial eye, and cannot be admitted. The time has not yet come for the acceptance of clever, intelligent, practical miners into the service of the Government and the country. Yet come that time when it will, and when it does come it will be to the unanimous satisfaction of the miners.

After enumerating these particular incidents as a small fractional portion of my own practical experience in the coal mine, in which I myself bore the most prominent part, it may perhaps be the wish of some to doubt the veracity of my statements on one or each of those accidents or events. If so, I wish him to particularise the how and where through the public press, where he will find them corroborated by living witnesses, and if necessary a further explanation from myself will be forthcoming. Or it may be the author's lot to find that some may scrutinise and criticise on the absence of education, and hold his imperfections up to public view. In this I humbly beg a lenient forbearance, as I assure them I have done the best I could to make the subject by them properly understood. And I know the generous mind will respond to my appeal, particularly when I tell them that in my youth there were none, or few, colliery villages that had schools in them. Consequently many a brave miner's boy was put into the pit without any knowledge of letters. The little they knew they had learned by rote, or acquired by instinct; and you who are born under a more favourable state of things ought to look upon the exertions of your forefathers with admiration and gratitude, and be thankful for the wonderful advance of science and civilisation, those beautiful products of the march of intellect.

Permit me to relate to you circumstantially an occurrence from the history of my early life in the way of an anecdote. It relates to a period when I was ten years old. It cannot be interesting, but it may be amusing and excite your sympathy. Pleasure-seekers who frequent the banks of Tynemouth in the summer season of the year will, I have no doubt, often regale themselves with a draught of that hydro-sulphuretted stream, or supposed spring, issuing from the bank side a little to the north of Tynemouth. Little do they know the cost of toil that brought it there. In 1812 the owners of Whitley Colliery, then working in the top seam to the south and west of the colliery village, deemed it necessary to drive a drift east by south from the then working places, for the purpose of freeing the mine of a portion of its water. After duly examining the locality, and an accurate survey having been made on the sur-

face, this little drift was set off from the face of a south-east cross cut, with the compass and two plumb lines to guide the men in their course which was adjusted every day by my father, then overman. As it was for no other purpose beyond what is now seen, namely, as a vent for the water, it was driven in as little area as the men could possibly work in, say two feet in width, and was arched over at the top. The coal was conveyed out from the workmen with corves made of the small rods in an oval or oblong shape, which held eight pecks. The work was kept going night and day by three men, stopping eight hours each, and two boys, stopping twelve hours, to fill up the process for the week. It was my lot to be one of these boys; we had to plod through water, to and fro the whole of the twelve hours, which scalded our feet to a serious degree, so much so that when we got home, in the short time of eating our victuals they became swollen to a painful size. Well I remember the washing of them, with its acute pain and suffering—my mother dressing my feet, and my father carrying me away to bed, until three o'clock came again. The same weary routine followed day after day, and week after week. This was the school of my learning in the days of my youth. The present spring is on the spot destined and pricked off by the owner and his agent; when the drift got the required distance, they put down a bore hole, and hence the apparent spring.

In this digression relating to other years I have a double purpose to serve; first, to remind the rising youth of the present day of the wonderful improvement in the system of mining, as well as in the manners and customs, and of their easy access to education compared with fifty years ago. Again, to show them that although their education in youth may be neglected from various and unavoidable causes, yet if, after they arrive at manhood, the mind becomes bent to its proper course, there is no one can tell to what extent of knowledge even the miners themselves may attain in your own time, as "no height of daring is so high, but higher still the earnest soul may yet find grace to climb." As a stimulant to your exertions, and with your permission, I may hold forth myself as an example. Many of the seniors among you knew me when I literally knew nothing, being led astray by the follies of youth; they know that fourteen years in the best time of my life, *i.e.*, from 19 to 33, was devoted to the science of music. Yet, even after that age, I set to work in right earnest to acquire a knowledge of the higher branches of mathematics, and my practical working in the mine will tell its own tale. I soon discovered, and have often proved, the suprising extent to which labour may be economised. Consequently, I demonstrated every species of work (let it be arching, walling, drifting, ridding, or timbering &c.,) mathematically before ever I began the process, so that there was nothing done unnecessary, nor without its profit.

I will here show you a specimen of the principle I pursued in all things. I had long urged the necessity of making a new additional return drift, on the high, or north side of the main horseway, which could be easy done, as there was coal to drive it in for about three-quarters of the distance. I had pointed out on several occasions the heavy friction the air was sub-

jected to (amounting to obstruction) in the present return passage, and had told the authorities that by doing so they would double the quantity or volume of air in the pit. They disregarded my advice, and set it at nought. For several years I could not prevail upon them to believe in its utility. At last, however, after the strike of 1844, the country became agitated, and a rumour was raised of persons being appointed by Government to inspect the coal mines. The viewers knew that the air's return passages were the places for a Government Inspector to look to for criticism or defect. Consequently, more from dread than a belief in its utility, they set to work in right earnest, breaking in at several places together, determined to make another return drift, the distance of one mile and eleven hundred yards. From this point to the up-cast pit, we had plenty of air-way at command. The object was, or at least ought to have been, to drive this drift parallel with the horseway, or as near that as possible, to save both cost and labour. The coal stood in the form of angnlar barriers: we drove places up west, say, twenty yards or so, and then turned them away north-east and south-west, with plumb lines put up with the compass, to guide the workmen in their course, and to keep the drift parallel with the horseway if possible. At this point branched off a district, known as the Wellington way, which was won out by a pair of headways to north a great distance. When working in the whole, this district was aired with the same volume and current of air, as was the interior workings, after it returned back by the water level board, to a board, driven up to the east winning headways for purposes of convenience, (*See* the plan,) it there crosses over the main horseway by an arch, and also over an arch in the east headways, when it was borne up the west headways by two doors to south; ventilating the workings to the north, and returned back south-west by the east headways passing through underneath the arch at three stentings up, and over the horseway by an arch at the east headways end into the water level again. At three stentings up, and the inbye side of the double doors marked red, was one place where the men were appointed to watch the state of the air as it returned back from the inner workings, there being then a daily dread of an explosion; such was the seriously vitiated state of the returning volume, arising entirely from the want of ample area in the return passages, added to the distance of one mile and twelve hundred yards of excavated drift, and other workings penetrating varied strata, each sending forth its native gas or material particles, when it is absorbed by and united with the current of air, which no longer possesses its own natural body (atmospheric air), but a body of compound matter occasionally dangerous to life, and at all times injurious to health. This, however, was several years before the time that I am now writing of, and long before I got charge of the ventilation of the mines; when the coal was all wrought off, and this district brought back as a goaf to within forty or fifty yards of the horseway, the seam of coal dipt to the south, and this being the south-east angle, the vacancy was filled up with water. The horseway here was north 27 degrees east. I measured away from the east headways end 125 yards, and set off a place to west; at 20 yards up, I stopped it, to drive the air drift each way, and parallel with the horseway, leaving a wall of coal 20 yards thick sufficient

DIAGRAM I.

To FIND AC.	To FIND BC.	To FIND A B.
As 30° = 10·00000	As 90° = 10·00000	As 63° = 9·94988
is to 125 = 2·09691	is to 125 = 2·09691	is to 111·4 = 2·04679
so is 63° = 9·94988	so is 27° = 9·65705	so is 90° 10·00000
yd. 111·4 = 2·04679	yds. 56·75 = 1·75396	yards 125 = 2·09691

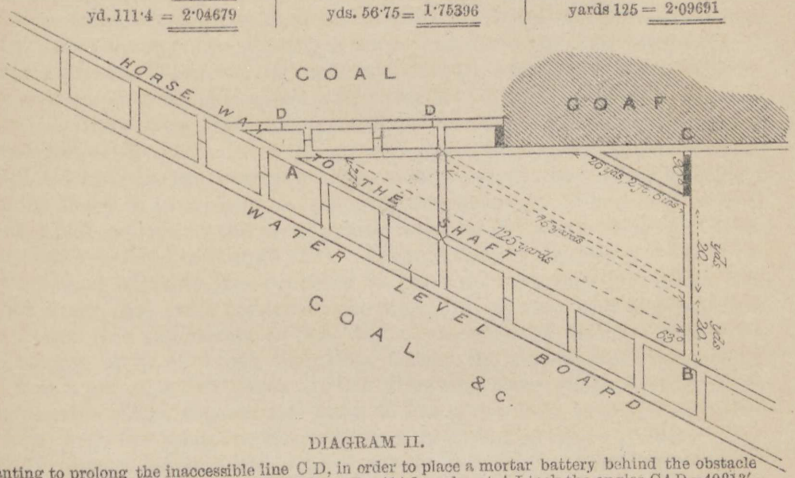
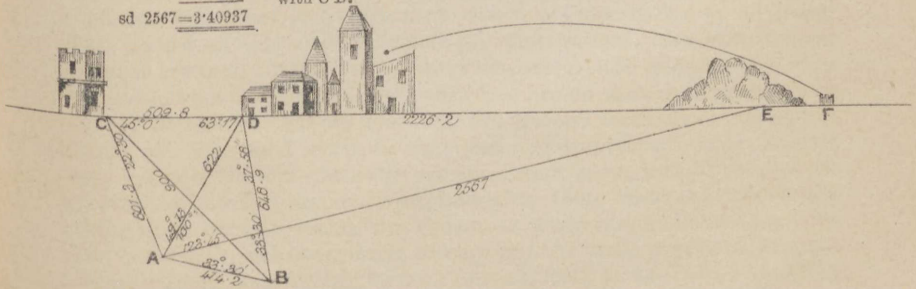


DIAGRAM II.

Wanting to prolong the inaccessible line C D, in order to place a mortar battery behind the obstacle C in the direction of CD, I measured a base line A B = 414·2 yards; at A I took the angles CAD = 49°13′, CAB = 123°45′, and the angle CAE = 100°, having first set us a pole at E, behind the obstacle. At B I took the angles DBC = 33°45′, and DBA = 67°30′; hence it is required to find the angle AEF, which will determine the position of CF with respect to CD.

C = 22°30′ = 9·58284	C = 22°30′ = 9·58284	37°58 = 9·78602
414·2 = 2·61721	414·2 = 2·61721	414·2 = 2·61721
33°45′ = 9·74474	180° — 123°45′ = 56°15′ = 9·91985	67°30 = 9·96562
12·36195	12·53706	12·58283
CA 9·58284	CB 9·58284	DA 9·78902
sd 601·3 = 2·77911	sd 900 = 2·95182	sd 662 = 2·79381
180° — 101°15′ =		
= to 78°45′ = 9·99157	33°45′ = 9·74474	12°30′ = 9·33534
900 = 2·95424	509 8 = 2·70740	601·3 = 2·77909
33°45′ = 9·74474	45° 0′ = 9·84949	100° 0′ = 9·99335
12·69898	12·55689	12·77244
CD 9·99157	DB 9·74474	CE 9·33534
sd 509·8 = 2·70741	sd 648·9 = 2·81215	sd 2526 = 3·43710
12°30′ = 9·33534		
601·3 = 2·77909		
67°30′ = 9·96562		
12·74471		
AE 9·33534		
sd 2567 = 3·40937		

Find AC = 601·3 AD = 622 and the angle A C D = 67°30′, then A C D + C A E = A E F 167° 30′, if therefore the angle AEF be made = 167° 30′, the point F will be determined in the same line with C D.



as I thought; (*See* the dotted lines on the plan,) bringing it direct to where the crossing arch once stood at three stentings up the east headways; from this point, through the stenting 8 yards, and down the west headways; 32 yards, gives a distance of 40 yards ready made, it being previously a horse-way of ample area; this added to 75 yards is 115 yards made at no expense. At this time, there was a young gentlemen serving his time to be a viewer, who frequently came down the pit with the under-viewer about seven or eight o'clock in the morning. On their road in they called at each of these places to ascertain what progress was making. When they came to this place and found the men turning away to the south-west, they asked him who ordered him to do that. He told them it was Scott. Well, you must leave off there, and continue the place up west other 20 yards. The man knew they were masters above me, and it was his duty to obey them. So there his jud stands to this day, a memento of defect. When the place got up to 40 yards, they then turned the men to work south-west. After it got in a few yards in that direction, those masters ordered me to provide plugs, staples, and lines, to bring two men with me, and meet them with the compass the following morning at eight o'clock. But, their former conduct had roused me up to energy. I had wrought the question out mathematically by the rule of plain Trigonometry and Logarithms, (*See* diagram, fig. 1,) by the question on the two inaccessible sides.

To further illustrate the principle on which I acted, and guided every process through its operations, I here introduce another question, also on engineering, in a different sphere, done by the same rule, to show you fellow-miners, that your minds, if bent in the right course, can reach the extreme point requisite to a practical miner. (*See* diagram, fig. 2.) Nothing came wrong to me when in practice. All drifting, ridding, arching, walling; everything I demonstrated by these rules of plain and spherical Trigonometry, as you see, before I began the process. And I particularly recommend, in addition to Parkes's Chemical Catechism, Sir Thomas Keith's work on these rules. They are two useful books, almost indispensible to the practical miner, furnished with the opportunity of observation and reflection on the natural indications of the mine. In reference to this question in dispute, I also demonstrated it by construction, from a scale of equal parts, properly to my own satisfaction. Therefore, I refused to put up the lines, and told them the men would hole into the goaf at 26½ yards, pointing out the inconveniences, the immense difficulties and cost they would subject us to by so doing. They looked at each other, treated my observations with ridicule, and asked if I was so absurd as to pretend to measure the distance of a place I could not see. "Well," I said, "can you not do that, and serving your time to be viewer. Or am I to conclude you are mocking me, if so, you ought not, you see I want to keep you and everything else right, if I can." I here showed them the question and figure, and explained the particulars in full, I distinctly impressed on their mind the infallibility of the rule; but they either would not, or could not understand it. So they insisted on the lines being put up, and the place droven as it ought to be, without any further bother. In common, to hear and obey is the

duty of a miner. To work they go, and up with the lines. As the process went on, they, the men, true to the figure (as you see by the plan), holed in the goaf at 26 yards 2 feet 6 inches. The water rushed out and inundated the horseway by flooding up the inlets to the water level. Thus began difficulties of various discriptions, serious in their effects, and costly to contend with. After the water was all run off, and the rubbish led out, they commenced to work two yards breadth of the coal off, to form an air way, timbering by the side of the goaf to protect the workmen; but as they proceeded in working away the coal, they exposed and undermined large splinters of stone which had previously been supported by the solidity of the coal, these extended to the upper part of the goaf in an oblique direction, and were of such immese size and weight that no timber could be applied to support them. To these difficulties were added the frequent presence of hydrogen gas, without the means of ventilation to keep the workings clean, and enable the men to proceed with the formation of the air's passage. The consequence was, they were lost for a time, and it became very costly before they could discover the right channel again. Whereas, if they had permitted the place to have gone on at 20 yards up (as you see by the plan), they would have completed 115 yards with no expense at all, the roof being poste, while the price of the coals would have more than covered the cost of the work required. This leads me to the conclusion, that many men serve their time to be viewers, &c., whose knowledge and intellectual capacities are not far raised above mediocrity, and that those noble gentlemen, the generous govenors of our glorious country, are under a delusion. I am afraid they are misled by the report of envy, and by a false representation of the miners as a body, and a labouring class of the community. It must be ill judged to continue the present system of exclusion, particularly when all the world see their good intentions, which are to alleviate the condition of the miners as far as is compatible with reason and justice; and to procure a system of ventilation which would remove the dread of those direful explosions from the miners' mind, and impart to their humble homes comfort and health. This, I infer from a sentence in the pamphlet written by a Government Inspector, in which is discovered at last, the *grand* secret that has been so long and anxiously wished for, "How to prevent accidents in coal mines." In it, he says, "hence, they (the Government) have constantly refused to countenance snb-inspectors, especially those taken from amongst the uneducated colliers." From this we must conclude, that the general rule, which allows of exceptions in all cases, is not applicable to the miners; whereas the inspector knows, the viewers know, and the workmen in general know best that there always was, is now, and always will be a certain portion of the miners, of first-class education in their line, which alone is requisite in the coal mines. For be it understood, a man may receive all the varieties of knowledge that education can give, he may issue from the universities, those nurseries to the human mind, big with learning, equal to the senate, the pulpit or bar. But, if he has never been in a coal pit, reason will tell him he lacks the knowledge requisite for the inspection of mines.

To prove this, let us take the extremes of two individuals, each perfect in his own sphere; I am sure the noble Earl Russell will not take it amiss of the humble author using his name in conjunction with an intelligent practical miner, when this object is to illustrate a principle. Imagine the miner introduced by the noble Earl into the senate House of Parliament, and that too at a time when a great national question of high import is under discussion. See with what a bashful simplicity he sneaks in behind the nearest object; lost in amazement, he seeks shelter in silence, and listens to the finely tuned flow of rhetoric as it issues from the resources of profound learning, of practiced statesmanship. At length it becomes the duty of the noble Earl in his official capacity as representative of the government to rise and reply to the opposition members' speeches. See with what consummate wisdom he takes each speaker's speech in detail, and mark how the great analytical master reduces their compounds to single substances, modifying and confuting a part, and by his exquisite skill reconciling the whole. Thus, by his almost infinite power, acquired by practical experience, he shows the folly of rashness, and the virtue of reason, and effectually presents to view those elementary principles, attention to which is essential to the perservation of our greatness and glory as a nation. It is now moved that the house be adjourned to another day; but where have we our miner. Is he wondering still at the material and intellectual grandeur around him, acknowledging the mighty disparity of their spheres, and the superiority of education? He looks upon himself with an eye of pity, seeing clearly his own insignificance and ignorance of the world and the way we live, he concludes this is not the place for him, and wishes himself back to his own native mines and humble cot. But stop, the noble Earl condescends to accompany him to see for himself, and endeavour, if possible, to fathom the depths of those hidden mysteries and deep secrets in the system of mining, for the future benfit of the miners, to enable him to remove obstacles and imposition from the government, to the satisfaction of the country. When all is ready, off to the north they bend their course, and soon arrive at Newcastle, the metropolis of the coal-mining district. Without delay they prepare for their descent into the mine, in search of knowledge, and to see the dangers thereof; fully equipped as an intelligent practical miner will be with book and yard wand, with candles and lamp they descend the shaft, alight at the bottom and enter the excavated drift that leads away into the interior of the mine and all its workings. The drift being a horseway, there is sufficient height, breadth, &c., for the convenience of men and boys travelling in and out. All is now in readiness. The noble earl expresses a wish to follow the miner, confiding in his honesty, honour, and qualifications to lead him through the interior and workings of the mine, and conduct him back with safety and satisfaction. At a quick step the miner leads the way. See him, his fins expanded, his mind afloat, and visibly in his own native element. They travel on near to half a mile, when they come to a part of the drift somewhat uniform in its dimensions, where he stops, and holding out his arm its full length in a horizontal direction, with the candle perpendicular, he gazes intently

on the light for several seconds, until the flame is diminished and nearly extinguished by the atmospheric current of air, whose uniform velocity seems satisfactory to the miner's observation. He then withdraws his hand, and prepares to be off; the noble earl interposes by saying "What do you mean by that statue-like posture, and earnest looking at the light?" "This, my lord, is a true example of the practical observations of the miner. I have been taking the angle of the flame on the candle as indicated by the current of air, and I know by that process whether there is more or less air in the pit. I am now satisfied that there is no incidental obstruction since the last time I took it, therefore I can proceed in confidence."

They now travel on the first district of workings, which they enter and proceed on their journey. When at forty yards up they come to an arch, a crossing where the air in returning from the whole working places passes over the in-going current. At this arch also he took the same or similiar observations as he had done before. The reason why he does this is that the air is here devided from the general volume, although we have not yet seen a door on the road, and by taking this observation from the same indications given, he can tell whether there is more or less air in this district also by the angle formed with the flame of the candle. Being again satisfied, they proceed on until they come to the first working board, which he enters. After observing the air by the candle he walks on cautiously a few yards further towards the face, when, with all the activity imaginable, he is down on one knee, and raising his light up on a horizontal line with the eye, he places his other hand between the light and his own sight, looking with intent earnestness, and gently raising it up to the roof. He is then satisfied once more, and off he goes to the face of the board and repeats the same process. His noble companion asks "What do you mean by that?" "By this observation my lord, I can tell what quantity of hydrogen gas is generated in this board. It is shown by the colour and motion of the spire of light you see above the margin of my hand." As the process is the same in each and every one of the boards, fourteen in number, that form the sheth, it may perhaps be as well to explain to you at once the principles of ventilation, and the system requisite to inspection.

First, you will observe the brattice in every board, as you see in this, and at the end of each brattice is one loose, which we call a slide, and which is drawn across the tramway to the opposite side in a sloping direction, for the purpose of flinging the air up this and each board at nights, when the pit is not working. But if any of the boards should at any time, as they advance up the distance of a pillar, be generating gas in such a quantity as to endanger the safety of the workmen (which is easily discovered by the intelligent practical miner), then there should be immediately a door hung at that board end, to fling the whole current of air up that board end, so as to sweep away the gas as it generated from the strata, dilute it in its flight, and thus prevent it from accumulating into a volume of inflammable gas. On this principle we proceed from board to board, until we arrive at the (say) northernmost board. As you have observed deal stoppings in every board as we came

along on the east side of the tramway you see the common pressure of the atmosphere is acting on every man while at work, and in leaving the last man, it then, and only then, enters the waste or back workings, when it is conveyed through it by the wastemen. In entering the waste to east, it passes through an aperture, a regulating slide giving sufficient area to admit compression without obstruction.

We now leave this whole working district, satisfied with what we have seen, and in returning, come to a broken or pillar working district to the south, ventilated with the same current of air after its leaving the waste and crossing over the horseway by the arch, where we stopped at forty yards up, when going in. On entering it, we have to pass through two double doors, set to a frame, quite air tight, with "snecks" on each, and a sufficient distance from each other to admit the set to pass through one before the other is required to be opened. When at the first door, we prepare our safety lamps, and leave our candles. Thus we proceed on our inspection. After passing through the inner door we find ourselves entering into a dull, drowsy atmosphere, which evidently denotes a serious innovation on the general current of air, and shows to our view the eruptions of nature in the mine which is sending forth its gases and noxious effluvium, its acids and oxides, and the respiration of perhaps 250 men, boys, and horses. The effect of all these causes is that the air has lost the cheering vitality of the oxygen. The affinity of the latter to these mineral bodies, by causing them to unite, have destroyed all the former elasticity of the atmosphere, which has become now by this chemical process of nature a fluid body quite different in its character, and which must, therefore, be treated by laws suitable to its present organization.

In a proper system of ventilation the aim is to give it space and ample area in the passages it has to return in from the interior of the mine, according to and in unison with its bulk of matter. For be it understood those gasses generated by the different strata in the mine, whether they be as an aeriform gas or a vapour fluid, have their solid particles, and cannot be compressed without friction, which immediately becomes an obstruction to the general current of air. Consequently, in an extensive mine, as this is, with four or five working districts, each aired with a divisional split from the general volume of air, there should not be less than four drifts for the air to return back in, and each of these drifts should contain from thirty to forty feet area to be equivalent to the ingoing drift. For instance, from the accumulated mass of matter generated throughout the whole extent of the mine, it must be obvious to the practical observer, who has carefully studied the elements of nature, that carbonic acid will, nay must, be the predominent portion of the returning volume of air, inasmuch as it exists in union with earth and stone in vast quantities, however far they may be hid from the surface of the atmospheric boundary. This alone may tell us in indisputable language the vast increase of area required to permit the returning volume composed of such material to glide through its passages without obstruction, back to the furnace and upcast pit. As I have in a former part of this treatise described with scientific care the instantaneous resus-

citation of the transmigrating mass of matter in passing over the burning furnace, &c., I need not now enter into any elaborate or chemical illustration; it will be enough to state that every particle of combustible matter is here destroyed, and caloric set at liberty. As Darwin says—

> "Thus heat from chemic dissolution springs,
> And gives to matter its eccentric wings,
> With strong repulsion parts the exploding mass,
> Melts into lymph, or kindles into gas."

I may also point out that it is a mistaken and false idea, prevalent with men of high pretensions too, to conclude that obstructions to the general current of air can or do frequently take place in the shafts. To the contrary of this, too, I have added proof. And why doubt it? Why doubt the mighty influence of caloric acting on a gaseous substance, whose capacity is increased by the vitiated matter combined in the inert volume approaching the furnace; particularly when men know that by fire metal dissolves, rocks vitrify, clay hardens, iron softens, and all the productions of the earth are formed and combined as necessity require them by the aid and power of caloric? Let the practical observer mark its volatility and elasticity when over the furnace; and bear this in mind, that if the shafts be nine feet diameter we may then calculate on sixty square feet area, and that is equivalent to 180 square feet in the main returning drifts.

These scientific truths have been demonstrated by myself, in my long practice as chief superintendent in the ventilating department at Coxlodge Colliery, near Newcastle-upon-Tyne. I may not be able to define my views properly to meet your understanding, and have reason to regret the absence of education—I mean that education which constitutes the learning of the higher spheres of society, and fits man for the senate, the bar, the pulpit, and the stage. Had I possessed this education it might have enabled me to gild my words with a silvery influence sufficient to induce the owners and agents of collieries to at once adopt the system I here prescribe, and carry its principles effectually into operation throughout the coal trade. Education, however, may be considered as divided into branches. One species of education is requisite for the senate and bar, another for the pulpit and stage, and so on down to doctors and chemists. But the education requisite to the miner is altogether different from any of these. The school of his learning is the great storehouse of nature. His principal teachers are the elements actuated, governed, and indicated by the power and influence of our common atmosphere, and from their indications the truly scientific and practical miner takes his daily observations and conveys them to his prolific mind for reflection, the only laboratory the poor man can build for his analytical solutions. Thus he may labour and toil without remuneration or profit, and thus dare the dangers of the mine without prospect or reward; and while others are sleeping or enjoying their pleasures and their ease, you may see the intelligent miner plying the compass and scale, searching for those qualities which alone can protect the miner's safety and health. Yet, says an inspector of mines, "hence they have constantly refused to countenance sub-inspectors, especially those taken from amongst the uneducated colliers."

But why stagger at the sound of the harsh sentence, or pause upon the denunciation of the miners as a body, without exception? We old ones save seen and heard the like before; look back to the late George Stephenson when he was a practical brakesman; mark the difficulties he had to contend with, and the obstacles raised in his way; by scanning his illiteracy, and denouncing the abruptness of his language, they pronounced him insane, or a madman. All this did the man of genius, the immortal engineer meet with; yet by dint of perseverance and timely aid, he succeeded in carrying his deep (and to himself clearly defined) projects into operation, becoming one of the greatest benefactors of the age. This was the man of practice, the truly scientific engineer, and how many have sprung up after him, and following in the wake of science and truth. I am not so vain in my pretensions as to attempt a comparison with such a man, although he himself had a high opinion of my qualifications as a practical miner, &c. But this I have said twenty years ago, and I repeat it again, that no power on earth could produce such serious and extensive explosions in any *pit*, of which I myself superintended or inspected the ventilation thereof, as we have had too frequently in the *coal mines*, causing such havoc and human suffering.

Perhaps I have said enough on this score previously, for as Byron says: "*Self* is always fluent, but never agreeable." Nevertheless, such is my unbounded confidence in my skill, that when the explosion occurred at Teddesley, I volunteered to go and put the pit right again, and the same at Barnsley, through Mr. M. Dunn, the Government Inspector of Mines, but there was no notice taken of it. I was brought forward by the men; when first the report of an increase in the number of inspectors became known, two of the men were delegated to Mr. Dunn, requesting him to use his influence on my behalf, and to represent me as a *fit* and *proper* person for the inspection of coal mines. Neither was that ever heard of again; the cause ("the uneducated colliers") was not known then. You will observe that in treating on Burradon, I have said, if I had by chance or otherwise been in that pit one hour, or from that to twelve months before the explosion, there would not have been one there, and I have shown them what I would have done to prevent it. This much will I say for myself, I practice no deception, I see too much of it afloat in the affairs of men, and witness too much of its effects as the first moving principle, the primary cause too frequently of sorrow and grief, in the lowly cot of many a brave miner.

The noble earl, was about to express his satisfaction with what he had heard and seen, when on a sudden he waived the subject, and after a pause, he observed—"Do you know of any other obstacle in the way of your advancement, or why you might not serve the government and country. For my part, I shall be happy to assist you all I can; I am clearly convinced in my own mind, and will endeavour to induce my colleagues to believe me, that I have seen for myself, a *fit* and *proper* person for the duty of inspecting the coal mines."

"Yes, my lord, there are many obstacles laid in the way of the man that has to rise from the ranks of labour. All history proves that, from the days of our Lord and Master down to those of George Stephenson,

the same or similar characters still exist as busy as ever. There are two constantly hovering about in the village where the man of genius and perseverance dwells. The one is a tall, thin, lanky-looking fellow, his name is Jealousy, he appears to be ever watchful, ready to propagate evil reports, and confirm them as truth; "a man of such frightful mien, that to be hated, need only to be seen." The other is a diminutive, infirm, ugly-looking creature, going about grinning and squinting, as if mocking every one he saw, and ready to pull them down if he thinks they have a better stand than himself, his name is Envy. These are two hateful beings—they delight in doing ill and injuring a fellow man, although they reap no benefit by the injury inflicted. And are you aware, my lord, that there is a number of men in this world of ours, going about, and covered with a respectable garb too, that partake to a very high degree of the principles and dispositions of these two men, indeed, their evil dispositions sometimes appear to have even reached the upper class of society; and so industrious is the immortal imp, though lurking unseen, that he will circumvent the man of genius and worth, and Ichneiomon-like, prey upon his position, until the vital principle of preferment is destroyed. This he effects through a system of false representation, knowing that his striving cannot ascend the steep hill of eminence step by step without the aid and assistance, the approbation and approval of the chief agent, &c., who I am sorry to say, does not seem to be actuated by the pure essence of generosity at all times. To this rule also, however, there are exceptions, and I firmly believe that the majority of viewers, and chief agents of collieries in the counties of Northumberland and Durham, are some of the best and bravest of men our country can boast of—men whose energy cannot be thwarted, nor their courage intimidated by danger. But these are not the men that will be seen arm in arm with the little imp. No, on the contrary, they have chosen for themselves men from the ranks of labour, and reared them up under their own tuition, until they have become ornaments to their patrons, and safe-guards in the trade. Again, there is a class of men in or out of the trade, who (as far as time is concerned) have served their time to be viewers, but for the mediocrity of their intellectual qualifications, their masters could not conscientiously recommend them to the country, as fit and proper persons for the responsible position of chief agents of collieries; still they must be somewhere, as lookers on, or hangers on, no matter what or where. These are the men seen at the street corner of circumstances, in company with that vile squinting imp, ready to denounce even his master as he passes by. And I am afraid that the vile monster might prompt these men to attempt an imposition on the government and country, by inducing them to apply for and accept situations as inspectors of coal mines. Nothing could be more absurd, nor more cruel in its effects towards the miners. I consider them guilty of forgery, perjury, and misanthropy; they are culprits in the eye of reason, and morality. I cannot induce myself to believe there are such men as would forge a tale of pretensions, and profess themselves conversant with the science and system of mining, while they never had the opportunity to know it, who would perjure their conscience for the sake of a sinecure,

and would accept of a situation of such grave importance and solemn responsibility, whereby they recklessly place in jeopardy the lives of hundreds of their fellow men, for the sake of the glittering gold alone, accepting and pretending the fulfilment of the duties required, while they must know that all they can do is, after the catastrophe is over, to ask questions, and attend the coroner's inquest. This is a curious inspection of the mines indeed, it would be so certainly if it were in general operation, which God forbid for the miner's sake. Yet I am afraid there is something in the system like this as it now exists—it cannot be otherwise with men who never had the opportunity to know what the ventilating of an extensive mine was. It is an easy task to look at the plan and talk about it, but it is quite a different thing to possess the skill and judgment requisite to go into the mine, take hold of the volume of air with the hand of mechanism, and work it through all its zig-zag windings, through every hole and corner, with safety back, and without impediment; for in the mine, the atmospheric air is as pliable and powerful in its operations as elsewhere, it acts with the same utility in all its results, as steam in the hands of the artist and mechanic, so long as it retains possession of the vital spring of elasticity, which must, and will be the object and aim of the truly scientific, intelligent, and practical miner. But, is there any other class of men who would be so base, so depraved in nature, as to pretend to operate with such scientific skill and judgment, as the intelligent practical miner? As well may we send a chemist, or any other opposite tradesman, into a tailor's cutting shop, as send a man to the inspection of mines who never had an opportunity to see the varied processses in the system: there is nothing chimerical there, nature forms its own analysis, and the assistance requisite is the material to work on. It might be said, these men served their time to be viewers, and their superior learning must furnish them with the qualifications necessary to the inspection of mines, in preference to the practical miner. As I hate controversy, we will submit the matter to two of their own body, and after a fair trial before reason and justice, and abide by the decision; and having no interest in the case, I beg to select two of the oldest, whose intellectual qualifications have been nearly equal, and the school of their learning being the same. Now, suppose the one to be restricted to go every day to school (down the pit, not even Sundays excepted) practising on the varied incidations in the mine, when after a proper survey through the whole of the district, with a minute observation, which he enters in his book and commits to his mind for reflection daily; thus he proceeds from day to day, adding to his store and accumulating a wealth of knowledge, gathered from that source which alone the rudiments of perfection is seen in the elements, while in combination with the general current of air, circulating throughout the whole extent of the mine. The other goes one day in each fortnight, say one to the other's fourteen, and is not down the pit the rest of his time; thus they go on for fourteen years. At the end of that time we want to know which of them has acquired most scientific knowledge. We find that one of them has been in practice daily for fourteen years, the other for twenty-six days the first year—say 364 days, the other 5,110 days. Suppose we ask the lesser number his opinion of their respective qualifi-

cations, keeping that vile imp (Envy) out of the way. He would probably say, I cannot see any difference between your time of service and my own—if I was not down the pit daily, I have my plan, and was in direct communication and correspondence with the mine through my subordinates, men in whom I could confide; I had my under-viewer, my overman, and master wasteman, all men of tried talent, tested by experience, on whose vigilance I could risk my life."

"And so could I," said the noble earl, "and must conclude that in future government will select and choose from that class of miners, for the inspection of the mines in general; as it is evident to me, and must be admitted by all concerned in the welfare of mines and miners, that from the position, adaptation, and general practice of these men, they must be the most fit and proper persons for the work; indeed, they are admitted to be so by the chief engineer himself in his defence, which is a reasonable conclusion, without he can show, and prove a wonderful superiority of intellect; and even practice must stand before theory, and I vouch for the skill and judgment he discovered in going through the inspection and examination, he appeared as a masterpiece of mechanism in the system of mining, with a host of knowledge applicable only in the right place when he became the right man."

"I thank you, my lord; those are, and have always been my opinions, founded on the principles here expounded, which leads to the conclusion, that the mines never will nor can be inspected (according to the true meaning of the term) until the government condescend to accept of inspectors selected from that class of miners (now rejected) who have had the best opportunity of gaining the indispensable knowledge, and have devoted their time and attention to practical observations and experiments on the varied and important indications on the mine. There are viewers, whose disposition of practice are to watch carefully every occurrence, and to be first on the spot, to examine effects, and search out the causes, so as to enable them in the future to avert approaching evils. Those who follow this line of conduct acquire a practical knowledge, which, when added to their superior education, gives them an ascendency over every difficulty in the system, and clearly develops to their view the operations of nature in the mine. But these are not the men who go to seek employment elsewhere; their sterling qualities command respect, and procure for them ample engagements in the trade; their energy and skill cause them to be looked up to as ornaments of the profession. None, however, know better than they do that there is a class of men who have passed through the forms, and are designated viewers, but who from their dilatory carelessness, or perhaps from a natural defect in their intellectual organisation, bring little credit to the profession, and are ever ready to accept any situation which to them must be a sinecure. Yet these are the men who look with a supercilious eye on the intelligent practical miner, and even ridicule his pretensions, if perchance he has merited the favour, and received the patronage of some worthy viewer, as the just reward of varied practical learning acquired in a life of labour and reflection, as if they forgot that practice is second nature, and leads to perfection in all things. Let the man of theory read his works, the elements

of engineering or mining, but the public must not consider him a Stephenson or a Wood. Theory is a speculation, practice is nature's self—the origin of art and science."

The particulars I have narrated are but a fractional portion, although the most special and important, of my practical servitude. They show how the mind of the observing miner may be enriched by opportunity, and how, like gathering shells on the shore of the ocean of circumstances, our store of mechanical and scientific knowledge is increased from day to day, and from one occurrence to another, exercising the constructing faculties, furnishing the memory with ready resources, and gradually amalgamating well tested theory with expertness in practice. I have looked back on those accumulated heaps of toil, indulging in pleasing recollections of the past, and awaiting the future with buoyant hope. But disappointment is often at the bottom of the sweetest cup; I had to quit that colliery on dishonourable terms, after a service of thirty-four years, having been always in the van of labour of every description in the mine; twenty years of this period I was engaged in the ventilating department; for near fifteen years I had charge in chief, and effected many improvements in the system, for the benefit of my employers. But changes of agency neutralise all the virtue of long services in the working classes, however important and beneficial these services may be to the colliery, or to the owners thereof. I am sufficiently frank to admit that I had my faults, but let the difficulties be also borne in mind; whatever might be the thirst for knowledge in my early days, it could be gratified by surmounting perpetual obstacles. Ye rising youths of the present day, ye have no excuse for ignorance, you have your reading rooms, your teachers and preachers, your libraries, and opportunities to store your minds with the knowledge necessary for your occupations. Let not this opportunity slip, introduce into your libraries works on the system of mining. Above all, I would recommend "Park's Chemical Catechism," which is necessary to every man engaged in the ventilation of a coal mine, the principles of which ought to be, nay must be guided by the common rule of arithmetical progression; the plan incurs no additional expense, if proper provision be made in the formation of the pit. Four drifts can be driven (if requisite for the air's returning passage) with the same facility as one, and in that lies the whole secret of successful ventilation; let your object be to prevent friction being applied to the volume of air in any part of the mine. You will then require no steam jets, fan blasts, nor any other artificial means to furnish the necessary quantity of air. Its mechanical application through the mine will be the principal lesson you have to learn, when your daily practice with due observation will give you the requisite dexterity. My object is to make you inspectors of the mine you are employed in, to qualify you to protect yourselves against approaching danger from your own immediate resources, as Dryden did at the Burradon explosion.

I confess to you, I have been under a delusion in reference to the system of government inspection. I understood it to be, that persons so appointed, were to inspect the mines daily, or nearly so, to protect the workmen against ignorance and negligence, to guard against the introduction of false principles in the system, and above all, to ascertain for themselves

that each and every colliery had a sufficient quantity of air properly applied through the mine, so that the workmen might have a healthy atmosphere, and be free from danger. This not being the case, I must apologise for my own ignorance in the system they pursue, and leave the important subject in your own hands, until another coroner's inquest is made necessary by one of those human sacrifices which cannot be prevented by government inspection, as at present put in practice. However, I was after this transferred to another colliery (Seaton Delaval), where my office was that of a gaffer over a certain number of men, who were employed at nights for the purpose of making a district ready for broken or pillar working. There was a general master-shifter over us all, who regulated our proceedings in conformity to the orders of the resident viewer and overmen. We were set on and directed by this general master every night, with this exception, that we had to act by the orders of the back overman and deputy in reference to preparing and repairing certain places in this district, each night. I had not been there long, when one night as we went in we found that the back overman and deputy had not come out, as was their usual custom: we wondered what was the matter, waited a short time in suspense, and at last we set off to our work. On reaching the spot, we found them repairing the board-end stoppings, and the inbye side of the separation doors. I asked them what was the reason they were doing that. They told me that the south jud was foul, and that the backmen were obliged to go home. I said, "Let's go in and see it." In courtesy, I also asked how they got their air, and if these were not down going boards. The back overman said they were. "Well then," I said, "Go off home, and we'll clean the place for you." From my character, they confided in me, and went home. I then took an old man with me, and broke a hole in the up-bearing stopping, to admit us through into these down going boards, to the west of the foul jud, where I found the west end of the pillar that was foul quite close, so that no air could pass down it. I immediately set to work and made a hole of sufficient size to set the air through, after which we returned back to our work again, making the stopping good as we came out. When we got back to the other men, there was no inflammable gas to be found; and they, not knowing the nature and principle of true ventilation, in wonder asked me what I had done with the gas. I relate this little incident merely to show the simplicity and ease by which hydrogen gas may be conquered and expelled by any one who has acquired skill by experience; but it cannot be expected that those who never had the opportunity to learn, nor saw the subtile gathering of the deceptive element, could possibly know how to deal with its peculiarities. I mentioned it to show, as well, how easy it would be, when work of this kind is exposed to the management of persons situated, as these men were, for an accident to happen in their hands, they being without the knowledge necessary to meet the emergency. Who would be to blame? I say, not the men, but those who fail to provide the knowledge requisite for every contingency.

However, whether this master-shifter made use of me as a tool to fill up his own defects or not, I cannot say, but whenever there was anything fresh to be done, or difficult to do, he invariably told me it was the order

of the viewer to take me in with him. On one occasion, he took me into a district where I had not been before, to look at a trouble which was difficult to keep secure with timber from side pressure, &c. The strata were deranged and brittle, having fallen a great height. In going in we came to a place were the water was pouring down a strong feeder on the horseway. He told me to take care of my light, and keep on the top of the railway if I could. We tried the experiment, but failed; and after I got through and over the water, I turned round to look at it, when I observed a crevice or thread running parallel with the horseway for several yards in extent, the water pouring down on the backs of the horses, and also subjecting the men and boys to sad inconvenience every time they went in or out, the drift being completely inundated, and the penning swimming about on the top of the water. I said to him, "I wonder you have this place in such a state. Why don't you take off that water, and thereby render the drift dry like other parts of it, it's a shame to see it in that state." "Can thou take it off," he said. "Yes, easily, it's soon done," I said. He walked away, and as he went he said, in a scoffing and ironical strain, "Thou can do more than any man at Seaton Delaval Colliery this nine years, if thou can take that water off. It's killing the horses very fast, I can tell thou. We have had three horses died within a month of the gripes: I would like to see thou do it." "Well, I can do it, and easily too, at a very little cost I assure you." We proceeded on our journey until we got to the trouble. After examining it, I prescribed a plan to timber it, but recommended them to build an arch through the distance, and stow it well up on the top, as the best way to secure it. The following day, when he saw the under-viewer and was telling him my opinion of the trouble, he also took an occasion to tell him what I said about the water. The viewer sent for me, and asked if I could take the water off the horseway. I said I could. "How will you do it?" he asked. I then described the process, which he saw through clearly, and told me to begin with it immediately. I went to the head enginewright and ordered two bags of wood wedges of two sizes, the lesser of hard wood, and also a few dozen iron wedges of various sizes, with a point, mallet, and hammer. I then went to the master blacksmith and told him to make us a sheet iron arch, giving him the shape and dimensions with chalk, and eight cramp-irons to hang it with. This order being completed, I took another man (still living) with me, and commenced at one end of the thread, wedging it up tight as we went on and bringing the water to one point, were the crevices were largest. The following night, when we got a sufficient distance wedged up, we placed the sheet iron arch in its proper place beneath the water, so that the water fallen on the top of the arch, was borne by the latter down on each side of the horseway. We next formed a bridge with the penning to let the water run through into the levels. The rollyway men also got all the other penning wholly adjusted in its proper place, and there it is, perhaps, to this day, as dry as any other part of the drift, and equally secure. You here see that, what it was considered could not be done, or at least was not done, was completed by two men in two shifts, although certainly the shifts were long, wet,

and slavish. But we had succeeded, and success is everything in this life. When the work was examined and approved of, the master, with good sense and generosity, paid us for our labour, and also remunerated us for our ingenuity; which was as it ought to be. But how often are the suggestions of the working man taken hold of, without it ever being known that the ideas emanated from such a source. In this way I persevered week after week, bringing every energy into full play, anxious to earn money by any means, and volunteered to work over the end of each week, whatever the work, or wherever I might be wanted; such was my position and the family demand for my exertions at the time.

On a sudden, however, I received my quietus again, which forced me out of the coal mines, my native element, where I had done so much to improve the system of ventilation, and render the mine safe. Thus situated, I left the coal mines in disgust and commenced business as a Licensed Victualler for my future livelihood. But my heart still clung to the mines; I was frequently told, moreover, that it was a pity that the coal trade was deprived of my services. You will excuse me, when I tell you I could not resist the appeal to my conscience, when listening to the sad wailings of widows and orphan children, anxiously looking on the stranger for sympathy and help. Thus did I stand, in my own estimation, a traitor to my country, a guilty culprit to humanity, in the village of Burradon. I there vowed to myself, "I will do the best I can to impart to others the knowledge I have acquired by experience, being deprived of the opportunity of doing so by practical instructions in the mine; and I have made the attempt to write this little work, which I dedicate to you, the miners in general of the United Kingdom. Conscious I am, that many of you can and will acquire the requisite knowledge, if you have but the opportunity to exercise the talent nature has endowed you with. But my dear followers in the passage of life, without opportunity no man can learn the true system of mining, nor discover those great principles, the operations of nature in the mine. Let me impress this truth upon your minds, as a stimulant to your perseverance, inasmuch, as all the evils that haunt the coal mines is brought upon them by imperfect laws and defective administration.

I will go back to a time when I, like unto some, perhaps many of you, had no knowledge whatever of the importance of ventilating truly the workings of a mine: to an explosion of hydrogen gas, which occurred at Coxlodge Colliery, in 1823. The accident happened about half-past three o'clock a.m., just as the night shifters were leaving their work, and the fore deputy and first of the hewers were arriving at the crane. I was then 22 years' old, and a hard coal hewer. My marrah (mate) and I had got about 600 yards from the shaft, when we met the air only of the explosive blast, which upset us topsy turvy, scattering picks, lamps, and us in various directions. Yet, we were not injured, and gathering ourselves together, we made our way to the lamp cabin where we got lights. We then went in search of our lamps and picks. The picks we laid out of the way, and went back to the cabin and got our lamps trimmed afresh. Observing the air in its regular course, we set off in-bye to tender what assistance we could to any that might re-

quire it. We had not proceeded far when we met five of the men running out-bye in the dark, more afraid than hurt. We continued our course and met with the overman and a deputy at the end of this branch-way where the explosion had occurred. He requested us to go in with him. Other six men came out, nothing worse, but could tell us little of the effects nor where the accident happened. We proceeded on and began to meet men maimed, burnt, and mutilated, and fearing that those twenty three behind were lost, we pushed on till we arrived at the switch or branch-way which formed the high and low cranes. We here found the double bearing up doors and stoppings all blown out, and the air rushing along the west winning headways at the bottom, east of the whole sheth of boards. This being wrong, they also were alarmed for all the rest of the men; while we, following the current of air, found at last the air rushing up west, which was a proof that the separation stoppings between the pits were blown out. We got up to the low crane, and in venturing into the headways to north we found the afterdamp so strong that we were obliged to retreat. Yet we were all certain that we heard the groans of men, who, though yet living, had not strength to get out. We paused at the risk of venturing further. The other men put tobacco in their mouths, but I put a crust of bread in my mouth, and gave one of the men my lamp. Off I set, groping my way to the first east board end, where the deputy's chest stood, and found the men there: I seized one and dragged him through the wall into the fresh air, when those who were there carried him down to the headways, where there was a beautiful stream of water running. The overman laid him down with his face over this running water, and as we succeeded in getting more men out, they were all treated in a similar way by the overman—a judicious, discreet man, and considered a good practical miner—his name was William Eggleston. We persevered in this manner until we got seven men out of this east board end, some of them apparently dead: yet, strange to say, they all came round, undoubtedly by the virtue of that running stream of water. By this time they had got an increase of the exploring force, with news that 13 of the night shifters had gone through to the other pit and got to bank all safe. This was good news, which made only three wanting now. These fresh men conveyed the seven we had got out (where they had evidently been in the act of putting on their clothes) to the shaft, thence to bank, when the doctor was in readiness to attend and administer restoratives. Our party was satisfied there were no more men in this headway, and as we could not get any further north for the strength of the afterdamp, we proceeded up west with the current of air, examining the headway ends as we went on. When near to the high crane, the destructive effects of the explosive blast were awful to look at. We found one young man (William Brown) lying quite dead, but not burnt. After searching and risking our own lives for the purpose of saving others, it was found that all hands, men and boys, were out of the pit. They then commenced to restore the ventilation to its proper course again, by renewing the stoppings with deals, and setting the doors afresh. By this time the chief agent had arrived on the scene of action. I was engaged with one of the wastemen replacing the separation stop-

ping between the two pits. . By his observations every one understood that his attention had been attracted to my conduct and perseverance on this occasion, and from this time, up to his leaving the colliery and district, he continued to be my patron and friend.

While writing the above, our district is again visited with one of those serious and ever-to-be-lamented calamities that the miners have so much reason to dread. The recent explosion at Walker Colliery almost leads me to conclude that my writing on the subject is in vain, and induces me to believe that similar accidents will occur in spite of all the skill and practical knowledge that man can possess. I am compelled to admit this, because I am perfectly acquainted with Mr. Cole, the resident and practical viewer, and know him to be a cautious clever miner, far beyond the common herd. Yet in his case the evil lies in his absence. I can with ease persuade myself that, if he had been in the pit, the accident would not have occurred; that by his superior presence, he would have anticipated the approach of danger, and discovered the column of inflammable gas before it reached the vicinity of the workmen, as the process of accumulation would be of gradual increase, originating from the slackening of the furnace and the gas from the goaf. But it would be absurd on my part were I to presume to point out the cause where and how the accident did occur, after the examinations and opinions given in their depositions by those eminent viewers at the coroner's inquest. Yet there are three distinct ways in which the accident might occur. First, by the slackening of the furnace they destroy the attractive power, and produce a serious diminution of the circulating volume of air, thereby reducing the weight and pressure of the atmosphere on the goaves, whose contents were previously pent up by compression. But now, that pressure being removed, the result is an expansion takes place, extending its bulk, and spreading throughout the board-rooms and juds. In this attenuted state it reaches the atmospheric air, unites with the oxygen, when the product is a volume of inflammable gas. Suppose the men's lamps to be stuck in props hanging behind them, filled with the flame of gas, the men dreading nothing nor observing this, continue to work on for a time unconscious of danger. The process goes on for hours, the goaf becomes an empty void by the removal of the hitherto pent up gas, and the solidity of its particles—which would be a support to the upper strata of the goaf, and prevent it from falling—this being removed, a fall of the upper strata, the full extent of the goaf, is the result. These lamps, or any other lamps filled with the flame of hydrogen gas within the range of this blast of air, would have the flame forced through the meshes of the gauze and produce an explosion. Second, if the men were working in an inflammable atmosphere, with or without the knowledge thereof, and an accident happened to any of their lamps so as to injure, or break the gauze, that would produce the explosion. The third and last way is, through the wasteman, who was found beside the two men engaged in blasting the stone at the trouble, if he was such a man as I myself have seen—presumptive without skill or knowledge. Suppose the inflammable gas had reached to near the top of the trouble, this man goes in, perhaps requested by the stone men to examine the place as they are about to fire

a shot. He passes by them on the top of the trouble, when, without due caution or observation—thinking, because it was always clean before, it will be so still—he unscrews his lamp top, and produces the explosion. The principal body and volume of inflammable gas being situated to the west and north of this as its tail piece, accounts for the destruction and range of the fire with its explosive blast in this district. Not that I say this was the cause of the accident. Neither do I impeach the memory of that, perhaps, innocent and good man, or wish to injure the feelings of those he leaves behind to mourn for his untimely fate. But I wish to show the possibility of such an occurrence, and also to show the necessity, of all men entrusted with the ventilation of coal mines, being possessed of the requisite practical and scientific knowledge, to enable them to anticipate effects from every cause, natural or incidental in the system of mining; and thereby avert the approach of evil, or the existence of danger in the vicinity of the workmen. By watching narrowly the avenues of the goaf he would have discovered the advance of the extending volume, and immediately removed the workmen beyond the bounds of danger, conscious that the danger would increase, so long as the cause existed. The primary cause of this accident was the slackening of the furnace, the effects of which are the reduction of the attractive power, a diminution of the circulating volume of air, and an expansion of the contents of the goaf, hitherto pent up, and rendered harmless by the weight and pressure of the atmosphere, with an adequate current of air to keep all clean and safe, under ordinary circumstances, and known to be guided in its mechanical application through the working of the mine, on truly scientific principles, by those worthy men who aided and assisted in the inspection, and who from their examinations, gave their opinion for the satisfaction of the public and all concerned. These were men, too, of the highest standing, acquired by long experience and practical knowledge in the system of mining. Although they could not come to any definite conlusion as to how or where the accident did really occur, yet they were determined not to leave a stone unturned in their examinations, but, if possible, to find out the cause that produced the accident, for the satisfaction of their own minds, and to enable them to adopt a preventative for the future good and safety of the miners. You also see them invite the government inspector of mines to accompany them through the district—only, of course, where the accident had occurred—and that he refused to do so. Thus you perceive that the public servant of the country, paid for attending to the protection of the miners, refused to accompany a volunteer on your behalf in the examinations necessary to remove the mystery from their minds, and to satisfy you and the country at large, as to how the lives of sixteen of your fellow workmen, were sacrificed. And we are to receive the coroner's remark as a sarcasm, or does he consider the life of Mr. Dunn to be more valuable than Mr. Forster's? or does he conclude that Mr. Forster's skill and judgment being vastly superior, enable him to protect himself and others engaged with him on such adventures? The coroner's inquest is undoubtedly the only place where the talkative theorist can excel to any degree, but it is certainly not the place for the inspection of coal mines. This will be

understood by you miners. You know well from what source your misfortunes spring, and to counteract the danger is the inspection you require. What will those great and good men, the governors of our country think, when they reflect upon such conduct as is even here, in the face of the accident, pursued by the man they have appointed to inspect and superintend the whole, for the protection of the miners and the country's general good. Yet amidst all this confusion and official defect, what a pleasing consolation it must be, to my worthy friend, and all the others officially engaged at Walker Colliery, to meet with and accept the grand eulogium passed on them, by those truly eminent men who assisted in the examination, and who expressed their admiration of the scientific arrangements and ventilation of the mine. This, too, must be a solace to the bereaved, to a certain extent, and a satisfaction to the workmen in general. What a difference is here to be seen, between this stealthy and deceptive, perhaps purely accidental disaster, and the nature and circumstances of the explosion at Burradon, that monster sacrifice to negligence.

The man I alluded to, who almost wilfully set fire to a volume of hydrogen gas, was a person introduced into the coal trade at the strike of 1844. Having being previously a country servant, he came into the pits to hew coals during that disagreeable and costly dispute between the masters and the men; after the strike was over and everything was reduced to a calm business-like order, he was made a deputy, and on this occasion he was in the fore-shift in the broken or pillar working district, there being also some whole places, where they had wrought with candles a few weeks previous to the day in question. At this time, however, the ventilation was precarious, and it was not without danger to allow candles or firing off shots in the district at all. It appeared this man had continued his habit of inspecting the whole of the working places situated to the east and south of the goaf, now only three walls. On this particular morning, just as the night shifters had finished their work, and the hewers had arrived at the crane, he according to his wont passed through the double and separating doors, with his lamp ready trimmed and lighted hanging on his fore finger, and with the candle also in his hand, he proceeded on his inspection. He met some shifters, and others putting on their clothes, who emphatically told him that the east headways and northernmost places had been foul all night, and that they were sure that the foulness came from the goaf. Regardless of this important information, he with self-sufficient incredulity went on as if saying to himself, "What! would nature presume to practice her freaks upon me, a deputy? When he got up to the stenting, and entering to pass into the east headways, he lighted up the collected volume of hydrogen gas. What earthly power could then stay its ravages, or mitigate the destructive flame expanding blast. The men who were the moment before in quiet conversation on the labours of the past night, were now lying maimed, mutilated, and deeply scorched by the intense flame. The hewers at the crane were all injured, some seriously so; and the deputy himself was terribly burnt, but he recovered. Now, if in this case all had suffered death, you see no one would have been able to tell the tale of how or by what means the explosion had occurred. The cause would

have been left to public conjecture, and its truths involved in mystery. I give you this information to show the possibility of men of this kind being employed in the coal mines previous to, and after this man, John Brown, of Coxlodge Colliery. I may further add that this, although a slight explosion in comparison with some, formed the greatest vacuum on the adjacent goaves I ever witnessed in my time of practice. It filled the waste with inflammable gas, back the whole distance to the main returning drifts, where the whole district currents were united in one volume of air. Neither was that all, inasmuch as the hydrogen gas flowed down from the crane along the horseway over the ingoing and ordinary district volume, for several pillars to east, with this singular phenomenon. At the sole or bottom of the drift was seen and felt the atmospheric stream of air, wherein we could carry our lamps free from the effects of the hydrogen gas; while by raising them eighteen inches up, they immediately became filled with the flame which was for a time an impediment to our exertions. As soon as it became comparatively safe to do so, men ventured up to the crane, creeping on their hands and knees, in this current of air, and below the inflammable gas. On arriving at the crane they found the two men that were there injured to such an extent that they could not get out, though they were still living, supported by the low-lying current of air. Their groans led the searchers direct to them. One, a hewer, had his thigh bone broken, the other was the man that died from the injuries he received. The expansion from the goaves continued for several hours, while the gas was visibly seen spreading in a convolving volume over the top of the ingoing air. The waste was full of inflammable gas, which only became diluted when united with the general volume of air returning from the other districts.

We now persevered on the same principle, and succeeded in getting to the regulating stopping, which we immediately broke down, increasing the quantity of air threefold in this district. With such a volume of air in circulation we soon got the ascendency over the difficulties we had previously to contend with, and after the operations of a few hours we got all made clean and right, and things restored to a workable state. This accident is one of the lessons nature teaches us in the school of experience, and furnishes the practical miner with the knowledge requisite for his future guidance. It also shows the necessity of never at any time, nor under any circumstances, permitting hydrogen gas to collect itself into a volume in any part of the mine. It is a lesson, too, that I am sure my worthy friends at Walker Colliery will profit by, as it shows with sufficient clearness that when once collected into a volume of whatever extent, there is no saying by whom, or by what means, the destructive element may be lighted up. You who have seen the sad havoc of an extensive explosion in a coal mine, know as well as I do that there is no shelter for the miner to escape the explosive blast and its concomitance of deadly vapour.

Ah! no, the young, the old, the strong, the weak,
Alike are laid, in eternal sleep,
By elemental strife, the ever-changing mass,
Its forms and solids are dissolved to gas;
Emerging matter with caloric combine

In a floating fluid, his works confine
Through endless ages, since nature first began
Her creative power over God-like man;
The common air, the source from which all things spring,
The fœtid maggot and the haughty king,
With all that breathes has He set forth
In water, air, and on the earth;
The rolling billows and foaming floods,
The earth's green verdure and lofty woods
Are subject all, to the immortal nod
Of the great alchymist—the omnipotent hand of God.

"A regular circle of compositions and decompositions are thus perpetually going on, and all organised beings are made to surrender in due time to the general mass of those elementary substances which nature kindly lent them for the preservation of their existence. Such a supposition is not only countenanced by the most eminent of our modern astronomers, but is more honourable to the Deity, and more analogous to the general economy of the universe."

It is also sufficient to induce us to conclude that nothing artificial—nothing which deviates from the general law—will, for any length of time, operate with advantage in the affairs of men, or be productive of safety to those in the mine, where the principle of decomposition is in full force throughout the whole system and process of mining. Hydrogen gas is generated from a variety of substances, and must be met with an equivalent volume of atmospheric air, whose nitrogen possesses the power of diluting or decomposing it as it issues from its sources. Yet very different from this was the case at Wallsend, in 1835, when 101 of your fellow-workmen were swept from the stage of being; and such was the mighty magnitude of the natural derangement from the violence of the concussive shock by that awful explosion, that all animated nature ceased to exist in the twinkling of an eye, as was seen by men found as if in the act of working in their places beyond the range of the explosive blast. And this, too, was the effect of a false and defective ventilation at that colliery, notwithstanding the natural provisions and many facilities they possessed. They had their air's returning passages reduced to creeping holes, and could not observe the heavy friction to which is was subjected, amounting to a serious obstruction on the general volume of air circulating through the workings of the mine. They saw the sluggish movement and vitiated state of the air; they saw, too, the hydrogen gaining a mastery and spreading its dangerous volume for several weeks (as at Burradon) before the explosive blast did occur, as was represented by the man Craister, before it happened, Yet, as the result shows, there was no one at that time engaged on the colliery who possessed the requisite knowledge to avert the advance of the approaching danger, or prevent the soul-stirring effects of the sad catastrophe which followed, desolating the homes of the miners, and destroying the happiness and comforts of life.

I now conclude this record of practical experience in the coal mines, under the hope that you may profit by the development of the science of ventilation it unfolds to your view. For your future good, I have imposed upon myself the task of clothing my ideas in this dress: for any imperfections (it being my first attempt) I humbly beg your lenient con-

sideration on account of the circumstances I have already explained. The work would have been completed ere now, but for my own pecuniary position, which has subjected me to many inconveniences, and raised up difficulties almost insurmountable. However, should it meet your approbation, and be found acceptable to the trade, then will I have gained the object of my wish, and if at any future time it may be the means of qualifying some of you to protect and preserve the lives of your fellow-workmen, then will I be amply rewarded for the toil and trouble that attends a life spent in earnest pursuit of the knowledge necessary to enable a man to guide each district volume with mechanical skill, so that it shall be sufficient in quantity for its required purposes, and good in quality for the health and safety of the workmen through the whole extent of the mine. Many of you will no doubt discover, even in early life, an active and inventive mind, and a desire to find a field for the exercise of your faculties. But if you should fail to procure a patron to assist you in the development of your conceptions, you will soon find yourself in a precarious position even among your fellow-workmen, and also your employers and masters. This I have experienced in my passage through life, with deception on the one hand, and disappointment in my applications to the firm I choose for myself, and to whose interest I had resolved to give the benefit of those acquirements which I possessed.

And now, as the approbation of the public is as a feather in the cap of the author, so your judgment will guide my future intentions. This narration of details has been hurried into the press to meet the exigency, almost without a revision of its contents; but I flatter myself to give you more satisfaction on some future occasion, should health and my circumstances in life permit me to do so. I intend to give you a historical and descriptive account of the mines, with the manners and customs of the miners of fifty years ago, interspersed with their native anecdotes, showing their progress of improvement up to the present time. And you, fellow-miners, who are in your day struggling with the labour and daring the dangers of the mine, excuse my loud complaining until you learn the cause, with the sad effects on my circumstances. The truth, if I tell it, is almost a libel; indeed I am threatened with an indictment for publishing it to the world, but, come what may, I am resolved, as "the breast that inly bleeds need little dread the outward blow." As you will learn, my present position is a precarious one; for even now, although far removed from the scenes of your labour, misfortune mocks me in the face, and disappointment follows in my path, imposed on me by a class of men who are articled and licensed by the state to inflict injuries on their fellow men with impunity. What now is death to me? or what would life be without the moral fortitude to adopt the noble advice imparted to the human family by England's great and immortal bard—

"When remedies are past, the griefs are ended
By seeing the worst, which late on hopes depended:
To mourn a mischief that is past and gone,
Is the best way to draw new mischief on.
What cannot be preserved when fortune takes,
Patience, her injury a mockery makes;
The robb'd that smiles steals something from the thief;
He robs himself that spends a bootless grief."

While this little treatise is passing through the press, our ears are again astounded with the report of a colliery explosion. The scene of this catastrophe was Coxlodge Colliery, where twenty more of your fellow-workmen have been hurled into eternity; victims again, no doubt, to that monster of the coal mines—negligence. It is necessary, however, that I should support such an opinion by evidence. This Leonard's cross-cut was driven north so many degrees east, parallel with the boundary line of Gosforth, and formed, as it were, a string to the bow of the main horseway, There were two boards driven on the north side towards the out end for stowage, and were, I dare say, solidly stowed up. There were several headway boards driven down south, beyond the centre of the bow, for the same purpose, and these were also solidly stowed up; but beyond these again, a pair of headways turned off the main horseway, and were driven down south to the line of Leonard's cross-cut. At about thirty yards down the west headways a board turned off to west, but to what distance it was driven up, or for what purpose I know not, as it was then holed into no other place. When the timber was taken out of these headways and that board a portion of stone fell, leaving us a passage over the fallen stones of about four feet high. Many a time I was up to the face of that board with the lamp, and, strange to say, I never once found any inflammable gas in it, although there was plenty to the south and west. The present workings I can only view by anticipating their formation, which does not affect the principle I am about to illustrate. Our evidence must be taken from the depositions in the Coroner's court. The first witness says he has 9,000 cubic feet per minute of atmospheric air to ventilate Leonard's cross-cut and the workings therein. This would be ample indeed, if properly guided through the whole of the workings. To convert that current of air into a volume of infiammable gas it would require a source generating 67,000 cubic feet of hydrogen gas per minute, and to men of scientific knowledge this must appear as an impossibility, particularly when they know that the native gas of the adjacent stratification throughout the district of limited extent is carbonic acid gas; but, as hydrogen gas is generated from a variety of sources, we will include all, incidental and accidental, and when we do so, it is manifest that this current of air, if mechanically applied through the workings, would not leave a particle of hydrogen gas therein; it would be all swept away as it issued from its sources, just as a feather is borne away by the wind, and effected by the same law too. In all the twenty years' practice at this colliery, I never once saw hydrogen gas collected into a volume but the place of its lodgment was clearly indicated; and I conclude from my own experience in connection with the destructive element, that all those extensive explosions might really be prevented by proper care and judgment; the contrary of which must be defect or negligence. Again, take a scientific view of the two bodies, and mark the difference of gravity. One cubic foot of atmospheric air weighs nearly 1¼oz., or 600 grains, whereas one cubic foot of hydrogen gas weighs only 38 grains. Now, carry that forward to 9,000 cubic feet of each, and then describe the disparity. You will also see the circulating volume propelled into motion by the pressure and influence of our common atmosphere, and towed onward in its course

by the attractive power of the furnace, while the other is lying dormant, or issues forth from its secret beds of varied sources by slow degrees and in detached portions. Such is the ascendency atmospheric air possesses over hydrogen gas, that the latter cannot possibly exist in a current of air any length of time. The witness goes on to say, "there is an old board, and it is my opinion that a little gas escaped from the top of the stone, and got to a man's candle. This was the most northern board."

From this statement it is reasonable for me to infer that this old board is the one I have alluded to; and if so, there is a possibility of the statement being correct, by this board being connected with a pair of headways to the east. These headways might furnish the necessary apparatus for abstracting the hydrogen gas from the general volume of air, through the agency of caloric, when by that process these headways might be filled to north with inflammable gas. But even then, that board not being holed to west, nor having any connection with any other place but the west headways, would be filled with a fluid body, whose natural gravity would far outweigh that of hydrogen gas. Consequently, the contents of this board would operate equally with the barrier of coal against the advance of hydrogen gas at the east end of it. But admitting that these men working with the candles did hole into this board at the west end of it, and that there was at the time 9,000 cubic feet of air borne up this western-most headways to the north board—and suppose this headway be 24 feet in area—such an immense volume of air would fill it from side to side, from sole to roof, moving at a rate of not less than six feet per second; and if so, who would presume to say they could collect a volume of hydrogen gas to stay the force and pressure of that current of air? The man of science, fully acquainted with the specific gravity of the two bodies, would know that this was contrary to the law of nature; yet the natural channel of this current of air is by south to east. It would never go up these north headways without the aid of artificial means, such as doors and stoppings to bear it up; and even when borne up to the extreme north, it would make its course to south immediately it had the chance, omitting the north to the east of these workmen. This might really be the case in the present instance, if there was not an immediate provision made to force the air down this old board; it would, of course, continue in its former passage to the south, and as it passed these headways to the east it would, undoubtedly, produce a counter current by the connection of these headways up this old board; and if so, the previous contents of these headways to the north of the current of air, with this old board, might, by a process of nature, become converted into a volume of inflammable gas, and, in process of time, be borne up to the west, and come in contact with the men's naked lights. But before we conclude this it must be admitted that it was highly improper for the men to be permitted to work so situated with the candles.

I am, however, of a different opinion as to how the inflammable gas was formed, how collected into a volume, and how ignited. The same witness admits they were making a goaf; but, notwithstanding some pillars of coal being taken off, the stone had not fallen except where it had left plenty of space for the air, and for men to travel through, over

the fallen stones. The witness travelled this part on Monday morning, and it was as clear of gas as Newcastle Town Moor. That was four days before the explosion. Now, I have observed before that the natural course of the circulating volume of air was by south to east. Suppose they had wrought one wall of coal off, extending some pillars east and west, that would be a breadth of 12½ yards; and if there were two walls wrought off, it would furnish an extensive reservoir for the collection of hydrogen gas. They could not, indeed, have provided nature with a more convenient laboratory for its operations. The air at this point becomes somewhat heated by the respirations of men, boys, and horses. In this state it passes through this district. It is first borne up to the north board, and as it returns to eastward, it is also pressing to the south by the influence of the atmosphere. Let the candid observer watch the process of nature, as the air is gliding down by the south wall side of this little goaf, and he will discover the phenomenon I am about to describe. Let him enter in from the south, at any part of its extent from west to east, and he will pass through the current stream of air, in about three yards from the south wall side, admitting that the whole space of breadth be uniform in height from south to north. Let him step on to the middle of the space or goaf, and he will feel the medium sensation. Let him advance up to the north wall side, and in all probability he will find himself involved in a volume of inflammable gas. And how came it there, is the question? This is a useful lesson to those who have not had the opportunity of learning it by their own practical experience in the coal mines. As I have observed, the air had become heated by animal respiration, &c., and caloric being the name given to heat of every description by chemists, we now have caloric added and uniting with the circulating volume of air. Hydrogen gas is produced by the decomposition of water, and by putrid animal and vegetable matter, and caloric is necessary to all gaseous compounds. This might be the source from whence the hydrogen gas is generated. When the air is passing down through this little goaf, in the whole distance from west to east, caloric is in operation, abstracting the hydrogen gas from the body of air. By its own natural gravity it ascends in a rotated movement into the calm and more elevated space to north; when there, the hydrogen in its turn abstracts the oxygen from the caloric, and their union forms the volume of inflammable gas. This process I have carefully watched with the candle alone, and will prove it again. But in this instance, the process had been in operation for months before the explosion, and no doubt would have continued so long as the present system of ventilating the district was continued. The accumulated volume of hydrogen gas is at all times inflammable, by the partial goaf, with three sides open, affording it communication with the circulating current of air at intervals, arising from certain causes; and when the bearing up door is open at the bottom of the westernmost headways, or the air taken off by whatever cause, it will immediately appear at the west end of the northernmost board, as if there was a pressure of air laid on at the east end of the board, by the perceptible movement of the hitherto compressed and stagnant volume, extending its course as a counter current to west, and also down the headways to south, if the air

is continued off for any length of time. This process in nature is produced by the pressure of the atmosphere being taken off the west end of the northern board, when the hydrogen gas, which is ever ready to climb the hill first, advances and comes in contact with the men's naked lights, and hence the explosion.

In my opinion this was not such a slight fire as some have represented it to be. I infer this from the quantity and quality of the over damp. There must have been a large quantity of hydrogen and oxygen exploded to produce such a vast amount of carbon and nitrogen as was discovered in the main horse-way that killed the men. I have made no inquiry, and want no information on the subject. My statement is based on the law of nature, which was at all times my guide when in practice. And I find the opinion nearly corroborated by the deposition of another witness, who says he examined this north board, where the explosion occurred, two days after, and behold! the place was sweet, and not a particle of hydrogen gas being to be seen. The reason why he saw no gas is quite clearly demonstrated to me. The officials of the Colliery had applied the necessary means, they had put up doors and stoppings to bear the air up to the north board, a precaution that ought to have been taken before, and which would have prevented the explosion. Yet they were always in jeopardy, because their system of ventilation was false, and contrary to nature. Let them take this advice, and act upon it. Put a crossing arch over the main horseway, at the east headways end, where we once had one, to carry their air over into the north return passages. They will then be able to ventilate the district effectually, with 4,000 cubic feet of atmospheric air, and never more see one particle of hydrogen gas. They will at once adapt a preventative against any more explosions; and the reason is that they will then ventilate the district in unison with the law of nature, by shifting the pressure of the atmosphere from the south to the north, which is the natural place of lodgment for hydrogen gas.

Some busy looker-on might say—"But how are we to get the workings of this angle situated to the east of these headways ventilated?" Put a deal stopping into their present return or south cross-cut, with a slide regulator in it, of 18 square inches. That will do for that portion of the district, as its homeward bound course is also by the north, which is the only place of residence for hydrogen gas. It was just about 600 yards due north from the place of this explosion, where I expelled so many acres of hydrogen gas in 4½ hours, which I have previously described, and given the plan of the workings. And a sheth of boards east of it was the place where I first discovered the busy caloric stealing the hydrogen gas from the circulating fluid, and forming a volume of inflammable gas. There is a man employed at the colliery yet who was with me the first day I found it so; but at that time we concluded that the north board had exposed one of those blowers which frequently break out in the whole working district. Our road in, to travel this waste or sheth of boards, was by the east headways to north, which was the horseway, and back to south, down the west headways. On this day, I had three men besides myself for the purpose of working up the falls as we came to them. We were engaged in ridding some fallen stones a few yards north of the

first and northernmost board. When nearly done, I took my lamp and left the men, to look up this board, not that I dreaded anything, but that I liked best to make my observations alone. At four yards up the board to west I saw the volume of inflammable gas, and at six yards up it filled my lamp with flame. I then turned back and told the men my discovery. We had this sheth coursed in threes, and as we proceeded we found the whole body of air was pressing away, down and up the south board, as if the other two were both fast, and the air could not get up them. At every pillar I examined the north board, and found it filled with inflammable gas from east to west, and end to end. We were nothing alarmed, as we knew no one could get near hand it but ourselves, and so we proceeded on our journey. In passing through the walls to south, we found the air rushing away to the south board, and down it in a similar way, and so on through the whole sheth of boards, the result being produced by the natural pressure of the atmosphere. I returned with two old men the following day, and put stone steppings in the south and middle board, at the west end of the up going boards, which was seven pillars in length. But long before we had got these stoppings finished we had the volume of inflammable gas in motion, passing by the west side of these stoppings on its march to destruction. We then allowed a few days to pass over, and again returned to examine the state and condition of this north board, which we found quite clean and clear of any gas. I then took my candle, and with an earnest search examined it from end to end, to find if possible the blower or fissure, or whatever it was that discharged the hydrogen gas; but the search was not satisfactory to me. We then went and spread down the two board end stoppings, reducing all things to their former state again. I next went to the east end of this north board and, with my candle, I examined and watched narrowly the process to my own satisfaction. I went one pillar up, and repeated the process from pillar to pillar, with equal satisfaction. I now became clearly convinced that the cunning caloric was at its stealthy work again, like the spider at his web, weaving afresh another volume of hydrogen gas. We then left it again for a week. When we went back the board was foul, but not so bad as before by far. Yet I had learned the lesson I sought—the one I now tell to you. We again rebuilt the stoppings, and adopted a similar plan throughout the whole waste, so that we were not again troubled by the enemy's intrusion. From this description some may think and perhaps say, we were trifling with danger too far, and incurring it almost unnecessarily. But such is the school of the practical miner. He must dare its dangers, or remain in ignorance. Again, hydrogen gas is only dangerous when in the hands and trusted to the care of those who are not acquainted with its nature, and do not know how to handle it. It is the simplest of all gasses, and the easiest to conquer and expel from the mine. Yet it is the most subtle and deceptive to deal with, if allowed to rove at random in a field of vanity, without system or rule, without science or practice. Let no man think that the current of air will pervade the whole district of workings without the necessary mechanism being strictly attended to. But the man skilled in the art of ventilation by science recognised the evil in the beginning and

meets it on a well ascertained principle. There are some at that colliery that I expected had a knowledge of the true system of ventilation from the experience, time, and opportunities they have had. But there is this difference in men, that some can be made good scholars and dutiful servants, who, when left to themselves, lack the genius to be clever masters. Besides, age has its effect on both the mind and body. With defects of the mind, however, I have no wish to quarrel. My object and sincere wish is to mitigate as much as possible, if we cannot do away altogether with those direful explosions that have swept away so many of your cheerful brethren and fellow-workmen, by imparting correct principles to the mind of some vigorous youth, who will manfully carry them into operation throughout the coal trade, and receive the credit due to his exertions.

The witness goes on with his examination.

Mr. DUNN: Is it not contrary to all principle for the after-damp to be carried on through the workings?

Mr. FORSTER: It is not contrary to your principle; you are always against splitting the air.

Mr. DUNN: I would not split the air, as at Burradon, into shreds and patches.

Mr. FORSTER: You had better not say anything about Burradon.

The CORONER: No, nothing about Burradon.

On another occasion the same witness was questioned:—

Mr. FORSTER: You have asked me many questions. Why were you not down before the explosion?

Mr. DUNN: I was down but recently. You might as well ask me why I am not down every colliery before an explosion.

Mr. FORSTER: How many collieries do you go down in a year?

Mr. DUNN: That is not the question.

A VOICE: Would you have had that done if you had been down here?

Mr. DUNN: Yes.

The VOICE: Then why did you not go down? It was your business to see that it was put in.

Mr. DUNN: It is not my business to manage the colliery.

A DISTANT VOICE: But it was your business to inspect it.

In another part of the inquiry we observe Mr. Dunn say to one of the witnesses, "Do not laugh; its a serious case."

WITNESS: I am not laughing

Mr. DUNN: I am asking your opinion as a practical man. [Bah!]

My dear fellow-miners I do not know what you in general think about a Coroner's court; but for myself, I conclude that the intelligent public will view it as a farce—a burlesque on humanity. Is it prudent to ask, have the Coroner and the person appointed by Government for the Inspection of the Coal Mines become inured to their trade; callous, like Jack Ketch with his culprits? True, it was a serious case, and a solemn one for reflection. These twenty human beings, although of humble birth, were willing to toil and content to labour in the coal mine for their livelihood. They were as much endeared to their parents, their wives, and

their friends as the prince to the king. The enjoyments of life were as sweet to them as to another; and, if they had lost their lives in any other way but by an explosion in the mine, there would have been a rigid and strict inquiry into the cause of how they came by their deaths, regardless of who were the perpetrators, and without any mockery. But the brave, industrious, and fearless miners are sacrificed at the shrine of negligence by scores, and the cause or circumstances connected with their death have to be hushed up by prevarication, dissimulation, and intimidation. And this, too, we find in a Coroner's Court applied to a Government Inspector of Coal Mines, both by the Coroner himself and also by one of the witnesses. What, I ask, is meant by "You had better *not* say anything about Burradon," and "No, nothing about Burradon." What are we to understand by these incomprehensible and cautionary remarks? Are we to conclude that these gentlemen knew something which was kept back from the public on that lamentable occassion? And dare witnesses presume to laugh in that court when cross-examined by the Inspector? Or was the witness forced into laughter by the simplicity discovered in the question asked? And why attempt to extract the opinion of a humble miner in the presence of his master? It is enough to compel him to perjure his own concience unnecessarily, and ought to be avoided. For my part, I say that any person professing to be proficient in the science requisite to the situation he holds, and who has carefully studied the elements of nature, and seen their operations in the mine; and who has also, by his own observations and practical experience acquired the true principles of ventilating a coal mine, ought in himself to be able to find out the cause from the effects produced and held up to his view, without asking questions of what is right and what is wrong of the unskilled miner at the Coroner's inquest. That is not the place for the inspection of mines. You will never derive any benefit from that quarter until the system is altered.

Yet, you miners of the present day, apart from those dread catastrophies, have one advantage to cheer you on to perseverance. The great spread of knowledge even in your own ranks, and the wonderful improvements already achieved in the system of mining, ought to encourage you in the hope that the day is not far distant when some of you will understand the operations of nature's inimitable laws in the coal mines, and that in your own line you will be equal with the astronomer, describing the far off sky bestudded with wonders; or the philosopher expounding the virtue of knowledge; or the truly scientific chemist at his analytical solutions, extracting the carbonates and gases from stone, the sulphur and acids from metal. The mine is also an analytical laboratory, where there is a perpetual process going on of amalgamation of all the gaseous productions therein; separated from their native bed where they had been pent up for ages, and which, agitated by the penetration of the strata, and precipitated by the force of pressure, are now all combining and uniting with the circulating volume of atmospheric air. To understand the requisite treatment for this volatilized mass of matter, and to do away with explosions, is the lesson you now must endeavour to learn. Then will my name and memory be rewarded for the misfortunes of the past.

It is also necessary for the officials of Coxlodge colliery to bear this in mind, that the long range of district which is now left for them to work off is situated between the goaves, from the place of the explosion to about one mile out; Gosforth is on the south side and Coxlodge on the north and south. The whole of the distance to near the down-cast shaft, which must make it precarious to deal with, and difficult to ventilate, requiring at all times the utmost caution, with strict attention towards the safety of the workmen, inasmuch as they will frequently have to contend with stealthy volumes of inflammable gas, not generated from the stratas, but arising from the same source I have already described—stagnation, putrifaction, and decomposition. Such is the natural subtlety and deceptive principle of hydrogen gas, that it will, as it were, embrace every opportunity offered by any important change of the atmosphere, or any trivial neglect and defect in the arrangement of the system. Thus, it must appear obvious to all concerned, the inevitable consequences of duty neglected, and the virtue of a just and due regard to a daily prospective throughout the whole process of mining.

And now, to end the work as we begun, with an humble address to you ye fellow-workmen of the mines; let not then any man attaint my memory by believing me actuated by selfish motives or individual hostility. My whole object is the general good, without prospect or remuneration; and while I await in silence on the reception of these precepts, let me endeavour to stimulate you in the universal belief of the merits of their truth.

You are aware that a man in my situation has not only to combat with the difficulties of the mine, in the absence of fortune, but also the difficulties of prejudice. Let not, then, their virtues be consigned to obloquy, or their just appreciation left till other times and other men can do them justice. Then will my object be seen, and my character be vindicated.

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