HASWELL COLLIERIES.

RETURN to an ADDRESS of the Honourable The House of Commons, dated 11 April 1845;—*for*,

"COPY of the REPORT of Messrs. LYELL and FARADAY to the SECRETARY OF STATE for the Home Department, on the subject of the EXPLOSION at the HASWELL COLLIERIES in September last:—Also, COPY of the REPORT addressed to the UNITED COMMITTEE of the COAL TRADE by the Special Committee appointed to take into consideration the said Report of Messrs. LYELL and FARADAY; and COPY of the REPLY of Messrs. LYELL and FARADAY thereto."

Whitehall, 14 April 1845.

H. MANNERS SUTTON.

(Mr. Manners Sutton.)

Ordered, by The House of Commons, *to be Printed,*
18 *April* 1845.

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REPORT from Messrs. LYELL and FARADAY to the Right honourable Sir JAMES GRAHAM, Bart., Secretary of State for the Home Department, on the subject of the EXPLOSION at the HASWELL COLLIERIES, and on the means of preventing similar Accidents.

To the Right honourable Sir *James Graham*, Bart., &c. &c. &c.

Sir, London, 21 October 1844.

HAVING, in our former letter, expressed our entire concurrence in the verdict of the jury, which exonerated the proprietors of the Haswell Colliery from any blame in connexion with the late fatal accident (September 28, 1844), we now proceed to consider how the recurrence of similar catastrophes may be obviated in future.

The Haswell Collieries, where the explosion occurred, are situated about seven miles east of Durham, in that part of the Durham coal field which is overlaid by the magnesian limestone, and about two miles within the outer limit or escarpment of that formation. In sinking the main shaft, which is 155 fathoms deep, they passed through, below the outset or artificial elevation, first, 18 feet of soil, gravel, &c., then 363 feet of limestone, red shale, and sandstone of the magnesian limestone formation, and afterwards through 540 feet of the coal measures; the strata of both formations being so nearly horizontal, that they may be considered as being here in parallel or conformable position. The accompanying section of the beds passed through in excavating the shaft, will show that no less than 10 seams of coal were met with, varying in thickness from one inch to 3 feet 7 inches; and that at a depth of 925 feet from the surface, the coal called the Hutton seam was gained, which is 5 feet 5 inches thick, comprising, first, the top coal of superior quality, 4 feet 1 inch thick; secondly, layers of impure coal, 16 inches thick, the upper portion of which, called the brassy coal, is much charged with pyrites, and the lowest part, of better quality, is said to give out much more gas than the top coal. The dip of the beds is about 1 foot in 24 to the S.E.*

In the Great Pit, which lies to the S.W. of the Little Pit, and is ventilated by the same shafts, a large dike of trap or greenstone was encountered, which had turned the coal into coke, with numerous veins of calcareous spar, for a distance of about 40 yards from the point of contact. Notwithstanding the intrusion of this igneous rock, the strata in general are remarkably undisturbed. In the Little Pit, which we examined carefully, only two or three slips of a few inches, and one fault of two or three feet, appeared. The roof near the entrance shaft was of white sandstone, with occasional seams of mica, but throughout the greater part of the workings, which are about 250 acres in extent, the roof or ceiling is composed of shale, very unbroken and secure, and having given rise to extremely few accidents, by falling in, in the course of the 13 years during which the pit has been opened. The chief danger to be guarded against, arises from what are termed "cauldron bottoms," which are the stools or lowest portions of erect fossil trees, filled with sandstone or shale, and having their bark converted into coal, which gives way when they are undermined, and allows the heavy cast of the interior of the trunk, several feet or yards in height, to descend suddenly. The Hutton seam rests on a sandy clay, which has not been found adapted for a fire clay. The floor composed of it does not often rise in creeps.

It will be seen by the section, that several upper seams of good coal, the united thickness of four of which is no less than 13 feet, have been left untouched, in order that the thicker and more valuable seam called the Hutton, should first be worked

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* As no part of the section obtained in sinking the shaft of the Haswell Pit was exposed to view at the time of our visit, except the lowest 10 or 12 feet, the division into coal measures and magnesian limestone, and of the latter into upper magnesian and lower red sandstone, with about 20 feet of superficial gravel and clay, has been inferred from the description of the beds given in the miner's section. We have substituted geological names for the miner's terms, as far as we were able to do so.

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worked out. In adopting this plan, the proprietors have been guided by considerations of present profit, which the competition of other neighbouring coal works renders indispensable. Nevertheless, it may not be improper for us to advert to two evils which result from this system.

First,—The upper seams which are undermined on the extraction of an inferior bed of coal, sink down, often unequally, from failure of support, and become fractured, and therefore much more liable to give out gas, which gas (it is well known by experience) has sometimes found its way into the workings far below, as attested by Mr. Buddle in his evidence given to the Committee of the House of Commons in 1835; by which some of the most serious accidents from fire-damp have been occasioned. The greater the number, and the larger the size of the upper seams, and the nearer they lie to the seam which is worked at a lower level, the greater the risk of such communication by fissures.

Secondly,—The higher beds of coal, which might have been worked to advantage before they were undermined, and when the expense of a shaft had been already incurred, may never be available after the workings have been for many years abandoned, and the shaft partially filled up, and after the coal has been injured by the continued permeation of water and gas through its fissures, whereby property of great value may be irrecoverably lost to the country. With a view to prevent this prospective evil in the mines belonging to the Duchy of Cornwall in Somersetshire, it has recently been proposed to make provisions in the new leases to secure the more regular extraction of all the workable seams which, exclusive of the great seam, range from 14 inches to two feet in thickness, the whole of them being less considerable than five of the seams neglected in sinking the Haswell shaft.

Before going into a particular consideration of the causes of the late accident at Haswell, and the possible means of preventing the recurrence of the like in future, we wish to point out the fact well known to the viewers in this district, that the pits on the north side of the Wear, in which the Hutton seam is worked, are more infested with fire-damp than those on the south side of that river. If, therefore, at Haswell Colliery, situated among the latter, the danger has proved to be so great, still more necessary will it be to endeavour to take additional precautions elsewhere.

There can be no doubt that, as regards the safety of the men in coal mines from injury consequent upon fire-damps, ventilation is of the utmost importance; but there is a practical limit beyond which it cannot be carried, for in works deep and extensive, as the coal mines often are, to dig shaft after shaft would quickly involve an expense more than the value of the produce of the mine, and have the effect of closing it altogether. There is one point in ventilation, however, which, at the same time that it appears to us capable of improvement, touches a part of the mine of the utmost consequence to the safety of the whole; and though our observations and thoughts are not founded upon long experience, or the examination personally, of many mines, yet considering that the one we have so recently been called to observe is as simple in the character of its workings, contains as small a proportion of fire-damp, and is as well ventilated as any in that part of England, surpassing in these respects most of the mines, we do not think that they will be exaggerated in respect of, or less applicable to other cases. We allude to the ventilation and general character of the *goaf*.

The *goaf* is a mass of ruins in the middle of the works, growing from day to day, as the workings of the mine extend. The miner, as he works in the undisturbed coal (which is called the *whole*) removes it, so as to form passages which are usually parallel to, and at right angles with each other; the square portions of coal left between them are called *pillars*; the passages or ways are, upon the average, about five yards wide, and the pillars are about 16 yards by 22 yards; the pillars, whilst they remain, support the roof and the superincumbent rocks and strata; this part of the works is called the *broken*.

Afterwards the coal of the pillars has to be removed, and as it is carried off, the roof so exposed is supported by many wooden props; this state of things constitutes a *jud*: at last these props are withdrawn, and this is called *drawing a jud*; during or after which the roof falls in masses, larger or smaller according to circumstances, a fall being sometimes many tons in weight. The pillars are not removed indifferently, but those next the mass of ruins already formed are taken away first, so that the first jud which is drawn produces a heap of broken strata, and this increasing with every succeeding jud that is removed, forms the goaf.

These

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These goafs grow to a great size.* There are three in the Haswell Little Pit; two are small as yet; the largest has an extent of 13 acres. At the edges they are very loose and open, having accidental cavities and passages for air running into them, as might be expected from the falling of rocks from a height of five feet one upon another. There is every reason to believe, that the falling goes on towards the middle of the goaf; but how high the heap of broken strata and the vault inclosing it extend, is not known in a large goaf, or, as far as we are aware, even in a small one. The goaf may be considered as a heap of rocky fragments rising up into the vault or cavity from which it has fallen, perhaps nearly compact in the parts which are the oldest, lowest and nearest the middle, but open in structure towards and near its surface, whether at the centre of the goaf or at the edges; and the vault or concavity of the goaf may be considered as an inverted basin, having its edge coincident with the roof of the mine, all round the goaf. Within this basin there must be air-space (as long as the surface of the country above has not sunk), either in the space between it and the goaf, or in the cavities of the goaf itself, nearly equal to the bulk of coal removed; this in a goaf of 13 acres, and a seam in which 5½ feet of coal, including the top and bottom, are taken away, is equal to a vault 5½ feet high and 13 acres in extent.

Let us now consider this goaf as a receptacle for gas or fire-damp, a compound of hydrogen and carbon, known as light hydro-carbonate, and by other names. The weight of pure fire-damp is little more than half that of air; it gradually and spontaneously mixes with air, and the weight of any mixture is proportionate to the quantities of air and fire-damp. Any gas that may be evolved in the goaf, or that may gradually creep into it along the roof of the workings, against which it will naturally flow, will ascend into the goaf vault, and will find its place higher, in proportion to its freedom from air; and this will go on continually, the goaf vault forming the natural basin into which all gas will drain (upwards), from parts inclining to the goaf, just as a concavity on the side of a gentle hill will receive water draining downwards from its sides, and from the parts above inclining towards it.

The gas which may thus be expected to collect in the goaf of a mine, where there is any fire-damp at all, cannot escape at the top of the goaf vault; instead of passing away there, the whole surface of the vault may rather be viewed as having a tendency, more or less, to evolve gas from the upper broken and bruised coal measures (often containing small seams not worked) into the space beneath; and the only escape for the gas is by the flowing of it under the edge of the goaf vault into the workings of the mine. Two main circumstances tend to this effect: the one, the continued accumulation of gas in the upper part of the goaf vault; the other, the continual tendency to mix with the air beneath, and consequent formation of mixtures larger and heavier than the gas itself. As Sir Humphrey Davy has stated, any mixture containing from one-fifth to one-sixteenth of the gas, will explode. These mixtures are, of course, from six to seventeen times greater in volume than the fire-damp in them, and evidently not much lighter than air (0.91 and 0.96). Except, therefore, in the almost impossible case of a goaf quite filled with fire-damp, it will be these or weaker mixtures that underflow the edge of the vault, unless upon extraordinary occasions.

The underflow will not take place all round the edge of the goaf basin, but at that point which is highest; for just as water takes its level in a pond on the side of a hill, and flows over the lower edge, so here, air strata of equal density will be horizontal. Coal seams are rarely quite horizontal; in the Little Haswell Pit, the rise is about 1 in 24, and the coal very regular. At the lower edge of such a goaf, nothing but pure air might be present in the air-space, and also for a considerable distance up into the vault; yet at the upper edge, a mixture of gas and air, and even a highly explosive mixture, might be escaping.

Thus goafs are evidently, in mines subject more or less to fire-damp, reservoirs of the gas and explosive mixtures; giving out their gas into the workings of the mines by a gradual underflow, in smaller or larger quantities under ordinary circumstances,

* Goafs vary in size. That at the Meadows Flat Little Pit is 13 acres; the goaf of the High Brockley Whin is 1¾ acre; and the one at the Low Brockley Whin 1¾ acre. In the North Way of the Little Pit, at Haswell, there is a goaf of 35 acres, and in the Engine, or Great Pit, one of 17 acres. Perhaps the greatest goaf is that at Felling, near Newcastle-upon-Tyne; it is in the same seam as the Haswell, and has an extent of upwards of 100 acres.

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cumstances, or suddenly, and in great proportion on extraordinary occasions; and they may either supply that explosive mixture which first takes fire, as appears to have been the case at the spot called Williamson's jud, close to the goaf of the Meadows working of the Haswell Little Pit; or they may add their magazine of fire-damp and explosive mixtures, to increase the conflagration when the fire reaches them from an explosion in some other part of the mine. This appears to have been the case at the goaf of the High Brockley Whins working, on the occurrence of the Haswell event.

We are bound from all the evidence, and from our own personal examination, to state, on the part of the owners and officers of the Haswell Colliery, that as far as the principles of ventilation in coal mines have been developed and applied, and in comparison with the general practice of the trade, the Little Pit appears to have been most admirably ventilated. No expense seems to have been spared in the first setting out of the works, or in carrying them through, or in the daily arrangements under ground; and this care was further favoured by the natural circumstances of the mine, the seam of coal being very regular, having a strong shale roof or ceiling, and with scarcely any fault. The mine has the character of being one of the best ventilated in the whole trade, a circumstance which, though it leads us in the fullest degree to exonerate the owners and officers from all blame in reference to the late terrible event, makes us more anxious, if possible, to discover its cause, and suggest some practical guard against its recurrence in future. With this intention, and without going into the ventilation generally, we will state our view of its effect at the goaf. A great body of air, equal to 25,400 cubic feet per minute, is sent into the Little Pit, and a third part of that goes to each of the three workings. This is directed, according to the judgment of the viewer, to various parts; the main portion to where the men are at work, and certain portions to the waste and the goaf. In the main passages, as the Rolley way, Mothergate, &c., the wind is so strong, that it is almost impossible to keep a candle lighted; but where the works expand, it becomes slower, and the speed is least in the waste and the goaf. As a matter of observation, we found the speed small at the goaf, though full care had been taken by stoppings, &c., to make the current good and strong in the workings near it, *i. e.* in the upper boards. If it be considered that the goaf is about 13 acres in extent, and that with the surrounding workings it can hardly be less than 26 or 30 acres, the diminution in speed of the current of air there can easily be understood.

The air which flows into a mine will generally tend to move along the floor; for it is colder, and therefore denser than the air against the ceiling, warmed as it is by the men and the lamps, and it is heavier than any mixture of air and fire-damp. Where the men are at work, this tendency is guarded against by the force of the current sent in, which sweeps the air already there before it; but in the goaf, near which the current is slow, where the roof is a large concavity, where the gas, if present, is likely to be present in greater quantities, and so to make a mixed atmosphere, which is lighter than that in the working parts of the mine, there the current probably never ascends to any height, but takes its way sluggishly through the lower parts of the goaf, or moves round the outside of it. We think it probable, that the current does not rise much above the level of the highest point in the edge of the goaf basin, and that the top of the goaf is seldom, if ever, reached by it in any sensible degree.

We have thus far considered the goaf as if in something like a constant state; but there are occasions of sudden and limited disturbance, which affect the atmosphere of gas within and about it. The evidence at the inquest states, that a rumbling was heard on the morning of the accident within the goaf, and this was probably a fall somewhere from its roof. Such falls tend to mix the lighter and heavier strata of gas and air, and so virtually cause the gas to descend. Again, if the atmosphere four or five feet up in the goaf be an explosive mixture, and a fall of this kind take place there or near it, such an event is very likely to throw out a portion of explosive mixture into the workings of the mine, not merely by the agitation, but also by the mixture of upper with lower strata of air, making the lower explosive.

One cannot but suppose that another source of sudden and partial evolution of gas or explosive mixture from the goaf may be the fall of upper parts of its roofs, and the crushing of the rocks there, by which gas pent up into the seams of coal above, and the strata associated with them, has passages opened for its escape into the goaf. If a bag of gas (as it is called) were thus opened into the goaf,

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goaf, it would rapidly increase the quantity of gas in it, and might soon cause explosive mixtures, or the gas, almost pure, to underflow the edge of the concavity into the mine.

If the goaf cavity were full of gas or explosive mixture to the highest edge level, the mechanical fall of the roof, in drawing a jud close to that edge, would, by mere agitation, drive some portion of the gas or mixture into the workings of the mine.

When a jud is drawn, and the roof has fallen in, the fall becomes part of the goaf, and the cavity left by it becomes a part of the goaf basin, the edge of the basin extending to, and inclosing the new fall. If this take place at the highest point of the basin, it suddenly opens a passage into the mine for a great quantity of air and gas, which before, by its relative levity to the air, was retained in the goaf basin. Thus, assuming a goaf of 13 acres, in a coal seam inclined 1 in 24, and that a fall of six feet in extent takes place in the roof at the highest edge of the goaf, it would heighten the edge at that spot three inches; and if the goaf were full to the edge, either with fire-damp or explosive mixture, these would flow out more or less rapidly into the workings of the mine, until a horizontal stratum of three inches in thickness had thus escaped. Even if the roof of the goaf rose very slowly, making an exceedingly flat dome, this stratum would extend to four-fifths or more of the horizontal area of the goaf; and assuming that the greater part of this space is occupied, not by gas, but by the solid materials of the goaf, and that only a band round the goaf could be considered as air-space, still, from what we saw of the goafs at the Haswell Little Pit, this would be from four to six feet in horizontal extent; so that a mass of explosive atmosphere or fire-damp might escape equal to a band about 3,000 feet long, by five feet wide, and three inches deep, making about 3,750 cubic feet. It is not likely that this would escape all at once; but the tenth, the twentieth, or the fiftieth part, or even the hundredth part, would be enough to take fire at an injured lamp, and to communicate fire to the whole, though the whole condition between safety and danger up to that moment may have depended upon three inches of the roof.

The above is no hypothetical case, but must occasionally, and as to the evolution of gas, frequently occur. If there be gas in the mine, it is expected at the goaf; gas does come from the goaf. All working at the goaf, except with safety-lamps, is forbidden: the seams in mines are usually more or less inclined; and this mine at Haswell, where gas has come from the goaf, is very free from gas, and well ventilated as compared with other pits.

There is one other point connected with what may be called the action of the goaf, and the occasional sudden and temporary discharge of gas from it. One of the witnesses on the inquest, Mr. G. Hunter, pointed out the effect he had observed in the mine, on a change in the barometer; that as the barometer fell, fire-damp would tend to appear, and that it did this the more suddenly and abundantly, if the barometer, having continued high for some time, fell suddenly: and Mr. Buddle has already strongly stated his opinion, that accidents from fire-damp always occur with a low barometer. This is very natural; for during a high barometer, the fire-damp, tending to escape from the coal and strata, would be in some degree pent up or restrained by the pressure of the atmosphere; and the diminution of pressure indicated by a sudden fall taking off this restraint, would let the gas expand and escape more freely, and hence its more abundant appearance. Now, without reference to the fire-damp which would ooze out of the strata and from the surface of the goaf basin, let us for a moment consider what would happen as respects the gas already free, but held by its small specific gravity in the upper part of the basin. The barometer will sometimes sink an inch in 12 hours; on such an occurrence, any portion of air or gas pressed on merely by the atmosphere, will expand about one-thirtieth part in that time. The portion of air or gas contained in the inverted basin of the goaf is, as has been said, equal to the volume of coal withdrawn beneath, as long as the surface of the country above has not sunk, but, because of the inclination of the coal seam, which we may for the present assume as that at the Haswell Little Pit, the air-space which is above the level of the highest point of the edge of the concavity may be taken, for illustration, as four-fifths of the bulk of the coal, or four-fifths of 13 acres by a thickness of five feet (2,265,120 cubic feet); of which the one-thirtieth part, or 75,500 cubic feet, will, by expansion, be driven below the level of the highest point of the goaf basin. If it contain any portion of gas, it

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will by its lightness begin to flow out at that particular part; if it contain much, it will flow out the more rapidly, and be the more dangerous; and if, in a mine infected with fire-damp, it be an explosive mixture, it is easy to imagine that such a cause may occasionally bring about most fatal results.

A fall of an inch in the barometer, of a sudden, is rare, but a fall of one-tenth of an inch is not, and that in such a goaf as the one supposed would place 7,556 cubic feet below the edge of the cavity; this all tends to issue forth at one place, and that generally a place where the ventilation is weakest. If, as an influential circumstance tending to diminish the quantity of issuing atmosphere, we assume that the country above has descended, so as not to leave more air-space in the goaf than one-fourth of the volume of coal removed, still that would permit 1,887 cubic feet to issue forth at one spot, on the occurrence of a fall in the mercury of the barometer equal to one-tenth of an inch. Hence it does appear to us that the goaf, in connexion with barometer changes, may in certain mines be productive of sudden evolutions of fire-damp and explosive mixtures, and that the indication of the barometer, and the consequent condition of the mine, ought to be very carefully attended to.

The recent terrible event appears to have originated at the Meadows Flat workings, at a point near to the upper edge of the goaf concavity, at a place where a jud was in the act of being drawn. A man of the name of Williamson, and other men, were engaged in this work at the time of the accident; all were killed; and the jud has since been named after Williamson. All the evidence derivable from the way in which the stoppings were blown, the charring of the posts, and the adhesion of charred coal-dust to them on this or that side, as also to the walls of the mine and edges of the irregularities of the walls, confirm this view in the opinion of practical men, the viewers of the mines, and with this conclusion the results of our own close inspection perfectly agree. At this place Davy lamps were found. The state of the gauze indicated that they had been in good condition prior to the accident, but two of them were much crushed and bruised, and one of the others had the oil-plug out; this and the fourth were probably found lying on their sides, for the oil was out of the bottom part of the lamps, and had soaked into half the gauze along the cylinder, as they may have lain on the ground. We could get no exact evidence as to how the lamps were, in respect of position and other circumstances, when found. The gauze of one of these lamps had been heated all round for about two inches from the bottom, as if fire-damp had been burning inside at that part of the cylinder; and there was also on the side of the upper part of the gauze of the same lamp, an oblong spot of oxidation, exactly such as would have been produced at the first entrance of increasing fire-damp into the lamp, and consequent elongation of the flame, supposing the lamp had been placed a little obliquely against the wall of coal or any other upright object. These appearances accord perfectly with the idea that fire-damp came into the workings whilst this lamp (which had been given out that morning perfect) was there and in use.

At this place the men were drawing a jud. It may be that fire-damp issued into the workings there independent of any thing the men were doing; or, it may be that in the falls of the roof (for it had fallen, as was evident by the stone and timbers), they broke away a portion of the upper edge of the goaf concavity, and by that, both let out explosive mixture into the works, as before explained, and mechanically mixed it up with the air beneath. This issue of gas would not of itself have caused the explosion, if the lamps had been right; but of these lamps there are now three that might have fired the gas, for two of them are so bruised, that if these bruises were occasioned by a fall of stones, either before or at the time of the issue of gas, then the gas may have taken fire at them; or if they were not bruised by a fall before the explosion, but by one consequent upon it, then it is possible (though not probable) that the third lamp, with the oil-plug out, may have occasioned the firing.

When once the combustion began, even though from only a small quantity of gas sent out of the goaf, it would instantly reach up into that greater portion within the goaf vault, and we believe that it was the inflammation of this large portion which gave such force to the blast, as to blow down the stoppings between the Meadow and High Brockley Whin workings, and to reach so far as to the goaf of the latter works. Here, from the appearance of the posts and walls, and also from the burnt bodies found, it would appear as if the fire-damp in this goaf had

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had been driven out, mixed with air and inflamed; a very natural result of the circumstances.

In considering the extent of the fire for the moment of explosion, it is not to be supposed that fire-damp is its only fuel; the coal dust swept by the rush of wind and flame from the floor, roof and walls of the works, would instantly take fire and burn, if there were oxygen enough in the air present to support its combustion; at ' we found the dust adhering to the face of the pillars, props and walls in the direction of, and on the side towards the explosion, increasing gradually to a certain distance as we neared the place of ignition. This deposit was in some parts half an inch, and in others almost an inch thick; it adhered together in a friable coked state; when examined with the glass, it presented the fused round form of burnt coal dust, and when examined chemically, and compared with the coal itself reduced to powder, was found deprived of the greater portion of the bitumen, and in some instances entirely destitute of it. There is every reason to believe that much coal gas was made from this dust in the very air itself of the mine, by the flame of the fire-damp, which raised and swept it along; and much of the carbon of this dust remained unburnt only for want of air.

At first we were greatly embarrassed by the circumstance of the large number of deaths from choke-damp; and the evidence that that had been present in very considerable quantities compared with the small proportion of fire-damp, which, in the opinion of those in and about the works just before, must have occasioned the explosion. But on consideration of the character of the goafs, as reservoirs of gaseous fuel, and the effect of dust in the mine, we are satisfied that these circumstances fully account for the apparent discrepancy. The blowing down of the stoppings, by destroying the ventilation of the mine, caused all this choke-damp to be left for a time in the workings; and there is reason to believe, from the circumstances, that the men met with a death comparatively sudden.

With such views of the character and effect of the goaf as we have ventured to express, and with a strong belief that it has been the cause of the recent sad event at Haswell, it will not be thought surprising that, in thinking of the means of preventing such calamity in future, we shoul turn our attention almost exclusively to it. The first idea is to ventilate the goaf. If a shaft could be sunk over the crown of the goaf, it might perhaps carry away all the fire-damp; but the probability is that, where furnaces are used in the upcast shaft, that over the goaf would become a downcast shaft, so that all the fire-damp evolved into it would have to pass into the mine and out with the ordinary ventilation. Besides that shafts of such magnitude are very expensive, the bottom part would be liable to fall in; the crown of the goaf vault, also, is in many cases probably changing its place continually, and in inclined strata it might easily happen in the course of working that the bottom edge of the shaft would soon be below the upper edge of the goaf basin in the mine, when it would be of comparatively little use. These are difficulties and objections which occur to us even in our theoretical considerations; whether practical men would set them aside, or whether they would add to their number, we cannot say.

Another mode of action has occurred to us, which, the more we think of it, seems the more practical, and offers greater hopes of service to humanity, and which, therefore, we shall venture somewhat minutely to explain. It is founded on the principle of drawing away the atmosphere in the goaf, not of ventilating it by blowing air into it; it is better in principle than blowing into the goaf, because it proposes to take away the fire-damp in a concentrated form, and never to give it to the air of the workings; whereas, blowing would first dilute and expand the gas, and then throw it into the works. The difference is especially important for mines where the gas is abundant; for suppose, for a moment, a goaf cavity full of fire-damp, and an apparatus that could either blow into it or take from it an equal quantity, in each case, of air or gas; to take out one cubic foot of fire-damp would be to prevent the formation of from six to 15 feet of explosive mixture; to drive in one cubic foot of air would be to send an equal quantity of fire-damp, by displacement, into the mine, there to form, at one moment or another, from six to 15 feet of explosive mixture, which would afterwards have to be carried out of the works by the usual mode of ventilation.

In the first place, we propose that the pillars and juds should be so worked and drawn, as to have reference to the form which it is desirable to give to the goaf. This form must be dependent on circumstances, but the point required is that it

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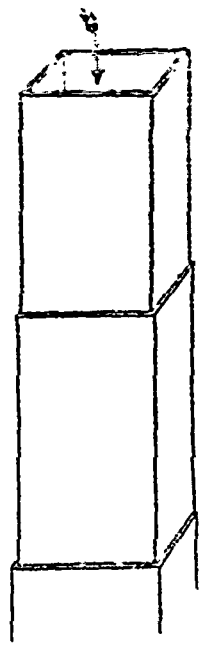
should draw together at its termination in the upper part of the works, *i. e.*, that as the strata rise, the goaf should not have several projections or bays, running independently into the higher works, but one only where the highest point of the goaf basin may occur, and towards which all the fire-damp in the goaf may drain and tend to run under. It is as if in making a pond on the side of a hill, there should not be two or three low places on the bank where the superfluous water may run over, but one only,—that being the lowest, as in the fire-damp case, it would require to be the highest. This condition would probably be obtained with facility by continually keeping one jud drawn in advance of the rest; and the inspection of a working plan, with the inclines drawn on it, would easily determine, in every case, what should be done. The next point is to drain or clear this place, as well as may be, of its fire-damp, which, if it could be done effectually, would, in all probability, prevent danger from the goaf, if not absolutely, yet to an extent far beyond what is the case at present; and for this purpose two plans suggest themselves, the same in principle, but differing in extent.

The first plan consists in laying a pipe from the goaf to the upcast shaft, introducing the one extremity into the vault of the goaf at the upper edge of its brim, and furnishing the other extremity with necessary means of drawing the air out of the pipe. The pipe itself may be of cast iron in lengths, joined together with sockets and caulked joints, or in any other of the many well-known manners; its diameter may be about 12 inches, until experience may have directed some other dimensions. Its place, for the chief part of its course, would probably be in the return-way; for it ought to be tight, having no other opening than the two extremities; and in the return-way it could be best examined from time to time, and would be safest from the effects of creep.

The exit or upcast end of the pipe is to be supplied with means of draught or suction; this might be either a blowing cylinder, or a rough box double bellows, or a revolving fanner, any of which might be worked by the engine, or even by a man or boy, for the work would be easy, there being no resistance to the exit of the air analogous to that offered by the contraction of the stream of air in the ordinary use of blowing machines. But even these are, in our opinion, not required; for from the powerful draught in the return of the Haswell works, we are at present fully persuaded, that if the goaf ventilation pipe, of the size proposed, simply entered the upcast shaft, there would be draught enough to draw away the atmosphere of the goaf. It is true, that if the atmosphere in the goaf vault, to which the end of the pipe might penetrate, were pure fire-damp, we should have to consider its lightness, and the vertical height between that extremity and the end in the upcast shaft. But this, probably, is a state of things which could happen very rarely, if ever, in the Haswell Pit; explosive or still lower mixtures, there and in most cases, are rather to be expected, and these, as has been shown, are not so much lighter than air as to offer difficulty in this respect. If a case of pure fire-damp, or a mixture so rich as to offer difficulty on account of its lightness, were to be reached by the pipe, then, indeed, it would be well worth putting on the mechanical means already referred to, to drain it out.

The goaf end of the pipe offers more difficulties, but we do not see at present that there are any that are not easily surmountable. It has to rise up into the cavity of the goaf, at the point nearest to the highest part of its edge; to enter into this cavity, four, five or six feet, or even more, if possible; and to be temporary, moveable and tight. The iron tube may, in the first place, be continued from the upcast shaft, by any course which, on consideration of the works, may be thought most expedient, towards, and within a certain distance of the draining point of the goaf, as near to it as is practicable, probably to within 15 or 20 feet. From thence the pipe may be continued, by wooden trunks fitted together temporarily, having the same sectional area as the pipe itself; and where the pipe rises in the cavity of the goaf, it does not seem difficult to fix wooden adjusters together, either square or round, the joints of which may be made tight by a little mortar. It is even probable that the upper extremity of the pipe might be a tube of air-tight cloth kept open by rings, and raised into its place from a safe distance by a rod of iron or wood. In all cases this end of the tube should be fully open, not allowed to collapse or be contracted in any part; and the joints, if adjusters are



used,

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used, should be in the direction which opposes least resistance by irregularities to the passage of the air: the roof should of course be propped up as much as may be required about this end of the pipe to protect it; the character of a fixture being in some degree given to the arrangement, until such time as it is again necessary to extend the goaf in that direction.

The second plan which we propose is of the same nature, but more local in its arrangement. In this plan, we contemplate carrying the exit end of the drainage pipe only into the return-way, but into a part where there is such a current of air that the goaf gas thrown in is sure to be thoroughly diluted and carried away. It ought not to be near the furnace, lest at any time there should be gas enough to take fire at the furnace, and communicate explosion back through the pipe into the goaf.

The goaf termination of the pipe will be as before. But in some part of the course of this pipe is to be placed a blowing apparatus, either bellows or fanner, as before directed, drawing from the goaf, and blowing towards the return-way. The apparatus may be placed in any convenient part of the course of the pipe, but would probably be more effectual the nearer it were to the goaf, as there is then the chance of fewer leakages between it and the goaf. It would probably have to be worked by a man, or by any power that was available; whether the draught into that part of the return where the goaf pipe entered would be sufficient alone or not, is a point which must depend on the nature of the works, and must be determined, if determined at all, by experience.

Such is the general plan, which, with some degree of confidence in its principles, we venture to submit to practical men for their consideration; and we do it with more readiness, believing, from the spirit which we have seen manifested at the Haswell mine, that they are earnestly desirous of carrying into effect everything that can be practically useful. The effect of it would be to remove that condition of the goaf atmosphere, which ordinarily exists at the upper edge of the goaf basin, to a distance of four, five or more feet higher up within the basin, so as to allow abundant space for all the variations of this atmosphere, without the underflowing of any explosive, or perhaps even contaminated, portion of it into the mine. In the case of a regular mine working downwards or into deeper parts, there does not seem much difficulty of application, since the highest edge of the goaf is there stationary. Where the pitmen work towards the rise, or upwards, as is the case at the Haswell Little Pit, then the goaf end of the pipe must change its place from time to time. Where faults occur, and the mine is irregular in its workings, each case must be considered by itself, and met, if it can be, upon the same principles. The more faults there are in a mine, the more difficult it may be to regulate the place and form of the upper edge of the goaf cavity; but, on the other hand, the more faults there are, the more fire-damp is there generally in the workings, and therefore the more occasion for some means of obtaining the end proposed. If, as is manifested by the Haswell Pit, mines considered the most safe and best ventilated need some such means, how much more must others require it.

It would be a very important addition to the information requisite to indicate and lead to the fittest means of guarding against such events as that at the Haswell Pit, if the state of the atmosphere in the goaf vault were from time to time examined, and especially upon fallings of the barometer; so that we might have a general knowledge of its nature. This would not be at all difficult in the hands of an intelligent man; for a piece of small copper pipe about one-third of an inch in diameter, and 25 or 30 feet in length, might easily be introduced by hand into the cavity of the goaf, at the place where the edge is highest, and this being attached to an air-pump syringe below, a few strokes of the hand would suffice to make the latter bring down the gas or air from the place reached by the upper end of the pipe; and if, after the pipe and syringe were filled with such air, a large and sound bladder, or gas bag, were screwed on to the syringe, it could then easily be filled with other portions of air drawn from the same place. The bag being carried away to a safe part of the mine, could easily have the character of its contents examined into, either by a Davy lamp, or by a candle placed in a glass cylinder, as, for instance, the chimney of an Argand lamp, the air from the bag being then passed in from beneath. Specimens of the air from the goaf might be obtained in a still simpler way, by having a tin, copper or other close vessel, of the capacity of three or four quarts, with a stop cock at the top, and another at the bottom, filling it with water, attaching it to the lower end of the small copper pipe proceeding up into

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the goaf, and then opening the cocks until the water had run out. On shutting the cocks, the vessel would be filled with, and would retain a specimen of, the air of the goaf.

Supposing that such a ventilating arrangement as that proposed were established, another place for examination would be at the exit end of the goaf ventilation pipe. Ordinarily, we trust, but little gas would be found there, because of the effect of the continued drainage by the arrangement. But this examination, like all others, should be made with every care, lest upon any sudden evolution of gas, or fall of the barometer, an explosive mixture should be issuing forth, and this by a naked light, if such were used for the examination, communicate combustion to the goaf gas through the pipe itself.

Both in the mines, and at the inquest, our attention was called to the stoppings and doors in the workings, upon which the course of the general ventilation depends. When these are blown away by an explosion, the ventilation is altered, and at times, as in the Haswell Pit accident, entirely withdrawn. Mr. Buddle proposed to have dam doors, so arranged, that when the stoppings were thrown down, these should come into action. We do not think that it would be impossible, or even very difficult, to carry such a plan into effect in some of the permanent ways of the mine; but, considering that if the stoppings were not blown down, the probable effects after an explosion would be the firing of the mine, and also that Mr. Buddle did not himself work out his own proposition in the many mines where he had power, we are not prepared to say that it is a matter that can be brought into practice, and ought to be enforced, or to give any opinion on the subject.

We perhaps ought to apologize for this lengthened statement, especially as we have no right to assume that we have that kind of knowledge that can be gained only by practical men; but we have been encouraged to proceed by the hope of being useful; and have endeavoured to write this Report, not in technical phrase, but in plain and simple language, which, if useful in its suggestions, may be comprehended by all.

In conclusion, we cannot but express a hope, that some step may be taken without delay, with a view to afford a better education to the persons engaged in working in collieries. When attending the late inquest, we were much struck with the fact that more than half of the pitmen who gave evidence, some of them persons of great intelligence, and one master wasteman, were unable to write, or even to sign their names as witnesses. The best conducted and well-informed from amongst the pitmen are occasionally promoted to some of the subordinate offices of charge in the mines; and it would be in the highest degree useful, if greater facilities were given to the underviewers, overmen, wastemen and deputies, to learn the elementary knowledge more immediately bearing upon their business. They might be taught, for example, such simple parts of chemistry and pneumatics as relate to the nature of gases and air; the first principles of hydrostatics and of geology, as far as concerns the position and dislocation of strata, the intrusion of trappean or volcanic rocks, and other points.

In countries such as France and Germany, where a far less amount of capital is embarked in mining enterprises, there are large schools of mines and scientific establishments, in which professional men of different grades are carefully instructed in those branches of knowledge which are closely connected with the art of mining. We are aware that, notwithstanding the want of such institutions, viewers in this country combine a large amount of scientific information with great practical experience; but such qualifications are enjoyed by a comparatively small proportion of those engaged in the superintendence of coal pits, especially of that class to whom the subordinate offices are entrusted.* If peculiar difficulties attend the organization of schools for the mining population, owing to its migratory habits, and because the workpeople are often congregated suddenly at places far distant from towns and villages, and do not remain permanently resident at fixed points, it is the more necessary to endeavour to overcome these obstacles; and provision might, perhaps, be made for appointing teachers whose duty it should be to visit in succession the different localities

* In the present state of science it is unworthy of the viewers and other mining agents, that the nomenclature employed by them in the description of rocks should neither be intelligible to the geologist, nor uniform in neighbouring mining districts. Such terms as *post*, *metal*, *whin*, *splint coal*, *mild* and *strong*, *thill*, *scares*, *girdles*, and others used in the original of the Section copied for this Report, are illustrations of the strange phraseology which prevails, and which cannot easily be interpreted, even where the miner attaches a definite meaning to the terms he uses.

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localities where the large pits are opened from time to time. Among the many thousands whose thoughts are now continually engaged in the coal mines, there will be always some individuals of strong natural powers, who, if they had mastered the elements of the sciences above enumerated, might be enabled to invent new methods, or, at all events, would be far more capable than persons unconnected with the business, to appreciate the dangers to which they are exposed, and to judge correctly of the adaptation of philosophical principles to practice. We believe, therefore, that if the education of the miners generally, and especially of those set over them, can be materially raised, it will conduce to the security of the lives of the men, and the perfecting of the art of mining, more effectually than any system of Parliamentary inspection which could be devised.

There is no reason to fear but that the owners, and all the authorities, high and low, would combine with the men in enforcing regulations for the application of scientific principles to practice, if their minds were prepared by instruction to estimate the true value of the new methods proposed, and if, by that instruction, those prejudices were removed which disincline the ignorant to every change of system.

There are here no conflicting interests to contend with, for the proprietors are always anxious to prevent explosions and accidents, not only by their feelings of humanity, but by a regard to the property they have at stake; while the viewers, underviewers and other officers, are continually risking their own lives, and share in every danger with the men.

We have the honour to be, Sir,
Your obedient humble servants,

M. Faraday.
Chas. Lyell.

REPORT addressed to the UNITED COMMITTEE of the COAL TRADE by the SPECIAL COMMITTEE appointed to take into consideration the Report from Messrs. LYELL and FARADAY to the Secretary of State for the Home Department, "on the subject of the EXPLOSION at the HASWELL COLLIERIES, and on the means of preventing similar Accidents."

Coal Trade Office, Newcastle-on-Tyne,
7 February 1845.

WHILE giving their anxious and impartial attention to the Report of Messrs. Lyell and Faraday, on the subject of the late explosion at Haswell Colliery, and on the means therein suggested for preventing similar accidents, your Committee have felt reason to congratulate themselves upon the qualified and judicious manner, with reference to practical considerations, in which these gentlemen advance their views and opinions. With some of these opinions your Committee will, in the course of this Report, have the gratification to express their concurrence. If, with relation to others, they feel compelled to differ from Messrs. Lyell and Faraday, it will be found that the grounds of their dissent are freely, and, as they venture to hope, satisfactorily explained. Your Committee are, indeed, persuaded, from the tone of candour which pervades the Report of the eminent gentlemen to whom Government has confided the investigation of so difficult a subject, that had circumstances allowed them to acquire that amount of practical information which can only be gained by experience, their views would, in such case, have been in many respects greatly modified.

The most important feature of the document under consideration consists of the description of an apparatus, the nature of which is fully detailed in pages 9, 10 and 11; and which, if adopted, is expected to have the effect of clearing the goaves of fire-damp, or of mixtures of common air and fire-damp, either entirely, or at all events, to such an extent as to prevent an "underflow" into adjacent parts of the mine. It is, therefore, to this portion of the Report that the attention of your Committee has been chiefly directed. But allusion is also made to other points, of a more general and less prominent character, to which your Committee feel the propriety of adverting; and some of these they will endeavour to dispose of before proceeding to the discussion of the principal subject.

In reference to the expediency of making the upper seams the first in the order of working (p. 4), it may be remarked, that such is a very usual practice; and

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where a contrary plan is adopted, the correct reason for doing so is given in the place cited, where it is observed that competition renders it indispensable to work out first the thicker and more valuable beds. The High Main coal of the Tyne, a celebrated, though nearly exhausted seam, which, for many years, supplied almost exclusively the London market, is the uppermost of our series of coal beds, and was the first in the order of working. The Bensham seam, which is noted for the quantity of fire-damp yielded by it, and in which the most calamitous explosions of the district have occurred, has since been extensively worked beneath those tracts where the High Main coal is already excavated. As regards fire-damp, the natural inference plainly is, that a coal-field is most efficiently drained of this mischievous agent, by first working those portions of it where the gas is most abundant, that is, as a general rule, its deepest portions; but without going into this, at present perhaps unnecessary inquiry, your Committee have to state, that they entirely coincide with the conclusions to be drawn from the Report of Messrs. Lyell and Faraday, that the utmost will be made of the private property of mine owners which the nature of each case admits; that the interests of individuals and of the country are thus fortunately the same; and that a capitalist will gladly avail himself of the privilege of winning, at a less amount of outlay, an upper, and therefore more accessible seam of coal, provided that by doing so he can compete successfully.*

Your Committee agree in the observation at page 4, that ventilation is of the utmost importance, and that there is a practical limit to the sinking of shafts; "for, to dig shaft after shaft would quickly involve an expense, more than the value of the produce of the mine, and have the effect of closing it altogether." Of the limit thus assigned, an instance is furnished in what occurred at the first attempt to win Haswell Colliery, in a situation not far distant from the site of the late explosion. The "sand," which, in many places, underlies the magnesian limestone, was there found to be 19 fathoms thick; it was penetrated to the depth of eight and a half fathoms, and water-feeders were for some time contended with by means of heavy machinery, to the extent of fully 4,000 gallons per minute, a quantity adequate to supply the wants of five large towns, each containing 115,000 inhabitants, at a rate, including the allowance for manufactories, steam-engines, &c., of 10 gallons per day for each person. After persevering for a considerable time, the owners were compelled, at an enormous sacrifice, to abandon the design of sinking their pits in the place alluded to. And this must not be taken for a solitary example. At the Murton pits, four miles from Haswell, even greater difficulties were encountered. Although the sand there was only about a fourth of its thickness at Haswell, the water-feeders were nearly 8,000 gallons per minute; and, in order to force a passage, the owners were compelled to apply machinery, to the extent of more than 1,200 horse power. It is, therefore, manifest that an obligation to sink additional shafts would have the effect of closing some mines now in full operation, and yielding even the most valuable description of coal. It may also be observed, that as the shafts of a mine bear a very small proportion to the entire length of its air-passages, it is by the condition, as regards number and extension, of the latter, that the aggregate volume of air in circulation is mainly regulated. By enlarging the section of the air-channels, and by dividing or "splitting" the air, a practice which is now universal, the ventilating power of the shafts is brought into full exercise; and these arrangements, when combined with shafts, as now sunk, of larger sectional area, and with more powerful ventilating furnaces than in past times, have, in point of fact, realized the effect of additional pits, by shortening the run of the respective air-currents, and by assigning to each current the duty of ventilating a much smaller space of mine than formerly.

Your Committee allude, with great satisfaction, to the improvements just mentioned, which, in conjunction with other arrangements of a more detailed and practical

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* Your Committee have found that, in practice, upper seams are very little injured by the working of under seams first, even where a few fathoms only intervene. When a general subsidence of the strata takes place, in consequence of the removal of an under-lying bed of coal, this subsidence lowers a corresponding portion of an upper seam, but does not injure it materially, because, the upper bed being entire, its disintegration is prevented by the circumstance that one portion of it supports and prevents the displacement of another. The Committee must, therefore, be permitted to say, that, in their opinion, which is grounded upon experience, little, if any, coal is "lost to the country," by the actual methods of working practised in the counties of Northumberland and Durham.

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practical nature, have more than trebled the quantity of air circulating in the mines of this district. Much has therefore been done towards security, so far as that object is to be gained by a more complete system of ventilation; and it is gratifying to find, that with the progress of time, alterations are being made, not of a crude and imperfect nature, but really sound and beneficial in their character.

Having thus adverted to some preliminary points, with the satisfaction of finding that the practice of the district has been in unison with the opinions of Messrs. Lyell and Faraday, as expressed in their Report, your Committee will proceed to remark upon the most important topic discussed by those gentlemen, being that which relates to the ventilation of the goaves.

Some misconception appears to have arisen as to the extent of goaves, which, in point of fact, are not limited in their dimensions, even by an area of 100 acres (note, page 5), but ultimately come, by the continued progress of the pillar excavations, to be co-extensive with the tract of coal field which is being worked. It thus happens that there will be a greater or less magnitude of goaf, corresponding with the length of time a mine has been in operation, and with the quantity of coal extracted from it; and that, at last, the mine will consist exclusively of goaf in that seam, the coal of which has been entirely removed; such, in fact, being already the case with several old collieries. It must further be remarked, that there is not any certainty of an open communication between one part of a goaf, and another part of the same goaf: the contrary is, indeed, the rule in almost every case, as may easily be understood from the following considerations.

The immediate effect of the removal of a pillar of coal is to produce a fall from the roof, or bed of stone, resting upon the coal; and the cavity made by this fall of stone is necessarily of a conical form, the base being that of the coal excavated, and the height that at which the superincumbent strata receive support from the sloping sides of the cone. As the coal continues to be removed, the sides lose their support—the cone is extended; and this process goes on until the superimposed strata, no longer sustained by the converging sides of the cone, subside, and rest upon the broken fragments of the fallen stones, which occupy a much larger space than did the same rocks when in a solid state. The summit of the cone does not then continue to extend upwards; but, as the excavation progresses, the strata rest upon the mass of stones forming the goaf; and the upper portion of the goaf becomes nearly horizontal, or parallel with the lines of stratification. This is proved by the state of upper beds of coal, a few fathoms above the lower bed which has been already extracted. It is found that irregular subsidences have taken place, that the breaks in the strata are not very numerous, nor of the character of fallen fragments, but are similar to small slip-dykes, showing the subsidence of extensive areas at once. Under these circumstances, it cannot but be obvious, that in some parts the fallen mass must be crushed extremely close, and that in others, cavities may exist: the effect produced being, in fact, that of rendering the interior either, practically speaking, solid, or of dividing it into compartments, which are isolated from each other. It must not be supposed, that after the completion of the process just noticed, a passage will still remain open at the sides of the goaf; on the contrary, the unworked pillars do not stop the progress of the general subsidence in that direction, save in particular and exceptional cases; and the circumstance itself constitutes the difference between a subsidence of the upper beds, and an ordinary fall of fragments from them, in which latter state the Meadows goaf was seen, as your Committee understand, by Messrs. Lyell and Faraday. When a general subsidence takes place, as before described, the line of fracture extends in a direction receding from the goaf, and therefore overhanging the standing pillars; whence it follows, that the ruins of the overlying beds, between the fracture and the goaf, abut, or are jammed against the sides of those pillars.

Your Committee trust, that the description just given will show, with sufficient clearness, what is really the nature of a goaf; and that, in this ultimate state, its vacuities are either replaced by the subsidence of the upper strata, or, where cavities are contained in it, they are far from being necessarily in communication with each other; but, on the contrary, the inference to be drawn from observation and by deduction is, that they are isolated and detached. Thus gas is often to be found, not only at the rise edge of a goaf, but at its deep extremity, and along the

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lateral portions extending between the two. Your Committee, therefore, submit, that an apparatus of the nature described in pages 10 and 11, if placed at the upper edge of a goaf, could not be depended upon as draining it throughout its entire space; because there is not any certainty of a communication for the passage of gas to a fixed point at a distance. Hence, a very extended system of drainage would be required; and, in fact, it would be necessary, in order to ensure success in the operation, to have a separate apparatus at each avenue leading into the goaf, since an underflow of the goaf atmosphere might occur at any opening into the waste or into the working districts, supposing the inflammable gas to be incapable, as before explained, of making its way through the obstacles opposed to its naturally ascending tendency.

Further, to carry out, at Haswell Colliery, the first plan proposed, that of conducting the gaseous contents of the goaves to the upcast shaft by means of cast-iron pipes, 12 inches in diameter, and half an inch thick in the shell—assuming each of the 14 goaves throughout the mine to be supplied with a distinct main—would require rather more than twelve miles of pipes, and would cost, including the putting of the latter together, about 21,000 *l.*, if not considerably more, perhaps even double this sum, considering the difficulty of laying down such a length of pipes in the workings of a mine, and the unprecedented nature of the operation; and this calculation, it must be recollected, is based on the supposition, that each goaf has only one pipe; whereas it has been shown that a great number of branches, at the least, in connexion with the respective mains, would be required for every goaf in the mine. As relates to the current expense of maintaining the pipes, your Committee cannot venture to name any precise amount: they would, however, remark, that they can anticipate the extreme difficulty, if not impracticability, of keeping the goaf ends of the pipes in working condition, and that a fracture there, which is so likely to occur, would destroy the entire value of the apparatus. It may likewise be apprehended, that to keep such long ranges of pipes in thorough repair and air tight, especially in those most important parts of the range which are near the goaves, and where consequently the roof and floor of the mine are in motion, would be not only most troublesome and expensive, but scarcely, they believe, practicable. Moreover, the constant attention which would be required to keep in order the goaf terminations of the several ranges, must, without doubt, in so dangerous a situation, be attended with risk of frequent loss of life, from falls of the broken strata.

The second plan, by which it is proposed to discharge the contents of the goaf into some adjacent portion of the return air-courses, may be considered as superseding that part of the expensive character of the project which consists in an extension of the pipes to the upcast shaft. Still, in point of fact, the goaf termini, which would, in that case, remain as before, are the most embarrassing parts of the proposed arrangement; the same multiplied form of the apparatus would be there required, the same constant liability to derangement would exist, together with all that amount of complexity and difficulty which your Committee have endeavoured to explain, but which can be fully appreciated by those only who are intimately conversant with the nature of underground operations.

Your Committee, perceiving so many obstacles to be overcome in the execution of a project to which, nevertheless, they feel bound to give their candid consideration, have, not unnaturally, endeavoured to bring past experience to bear as a test of the practical value, in relation to the saving of life, of a plan for clearing the goaves of fire-damp, supposing such a plan to be as successful as the projectors could anticipate. The Committee accordingly find, that during the last 14 years, there have occurred, exclusively of the Haswell accident, 11 great explosions in the Northumberland and Durham collieries; and that these have happened, with perhaps one exception, though that one is of a doubtful character, where the respective mines were being worked in the whole,—that is, in those parts where pillar-working had not yet been commenced. It is, therefore, clear, that in at least 10 cases out of 11, during the period in question, the goaves have had no connexion with the origin of these accidents. Neither is this fact of difficult explanation; for goaves, guarded as they are by safety-lamps, and having distinct currents of air pressing their gaseous contents into the return air-courses, where no naked lights are allowed to enter, must be considered, and are proved by experience to be, the least mischievous districts of a mine, as relates to explosion.

In pages 7 and 8 an allusion is made to the state of the barometer, as connected with occasional sudden and temporary discharges of gas from the goaves. To

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To this cause its due importance must be allowed. No circumstance, indeed, is better known than the influence of atmospheric pressure upon the condition of mines as regards fire-damp and choke-damp; and it may also be remarked, that the range of the barometer is sensibly greater in deep mines than at the surface. This instrument ought, therefore, to be attended to, with a view to greater vigilance, and the adoption of increased measures of security, should such be required, when the mercury falls, and more particularly when its depression is sudden. But it must also be recollected, that the danger thus pointed out is one of those which are provided against by an active ventilation, and that an agent is thus constantly employed in preventing accumulation, by removing whatever extra portion of gaseous or inflammable product may enter the mine when the atmospheric pressure is diminished.*

The sudden issue of large quantities of fiery atmosphere, by reason of heavy falls of stone taking place in the interior of goaves, constitutes, your Committee apprehend, the principal source of danger in pillar-working. Yet they cannot perceive that the plan proposed by Messrs. Lyell and Faraday would remedy this evil. If the goaf end of the pipe were inserted to the height of four or five feet above the top of the seam (page 11), all the goaf space at a higher level than the summit of the pipe would remain unoperated upon, and its gaseous contents would still be liable to dislodgement, and issue from the cause assigned. Thus, the danger which is chiefly to be dreaded would not be obviated by the adoption, if this were practicable, of the apparatus recommended.

It will not be out of place to notice here the result of an investigation into the state of the Haswell goaves since the explosion. In consequence of reports arising, not unnaturally, out of the recent accident, that portions of the mine were in an unsafe condition, a close examination has lately been made, by a deputation of the pitmen of that colliery, into the state of its goaves, and of the Meadows goaf in particular, as regards fire-damp. Four days were employed in this scrutiny, an account of which is given in a report of the deputation, published in the local newspapers, and signed George Wilson, George Summerson, William Hall and Ralph Wheatman, hewers, employed at the colliery. With a view to greater precision, your Committee applied to the parties just named, for a statement of the heights, above the coal seam, at which they had tested, with their safety lamps, the condition of the respective goaves; and received from them an answer, which, along with the original report, is given in the Appendix, Nos. 1 and 2.

It appears, from these documents, that *no gas was detected in any of the fourteen goaves of the Haswell mine, even up to heights extending from five to thirteen feet above the top of the coal seam, at the highest edges of the several goaves.* Your Committee entertain no doubt whatever of the accuracy of these observations. The presence of an inflammable atmosphere would, of course, have shown itself, by filling the gauze cylinder of the lamp with flame; but, besides this obvious effect, pitmen are very well acquainted with the appearance caused by different mixtures of air and fire-damp upon flame, and can thus judge of the presence of inflammable gas, in proportions much below those required for explosion. Besides, a deputation from your Committee have been enabled to verify the statements in question, by investigating the condition of the Haswell goaves, and by bringing away portions of their gaseous contents for examination; and in no case did they find that an inflammable mixture was contained in the receiver, which was brought from the goaves, in the manner alluded to. More especially, air from the upper edge of the Meadows goaf, 13 feet above the top of the seam, showed no trace of fire-damp. When the goaves were thus examined, the barometer was at 29.27: according to an observation made a few minutes before the explosion of the 28th September last, it was then at 29.85.

Your Committee are well aware that the goaves of many collieries are not equally free from fire-damp with those of Haswell; but that, on the contrary, inflammable gas constantly exists, in considerable quantities, in the goaves of some mines, where the evolution of fire-damp is much greater than in Haswell. Your Committee

* A careful comparison has been made of registered barometric observations, with the accidents which have happened since the year 1805. The result is, that of 23 great explosions during the period in question, 12 have occurred when the mercury was either steady or rising, and 11 when it was falling. Several have happened when it was above 30 inches, and one only when it was below 29 inches; but the actual height is obviously of less consequence than the relative one, as compared with that which immediately preceded the respective explosions. The results just stated go to show, generally, that ventilation, of the customary degree of efficiency, is a safeguard against the danger arising from fluctuations of the barometer.

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Committee have, however, shown, that the actual state of goaves is incompatible with that required for the efficient working of the apparatus suggested by Messrs. Lyell and Faraday; and, having also duly considered and explained the extreme difficulties, expense, and almost, in their opinion, impracticability, of carrying into execution the plan recommended by those gentlemen, together with the extreme uncertainty of its success, they regret exceedingly that they cannot recommend it for adoption.

Towards the conclusion of the Report (page 12), a hope is expressed, that "some step may be taken without delay, with a view to afford a better education to the persons engaged in working in collieries;" and it is mentioned, that "at the late inquest, more than half the pitmen who gave evidence, some of them persons of great intelligence, and one master wasteman, were unable to write, or even to sign their names as witnesses."* The schools of mines and scientific establishments of France and Germany are also referred to, in proof of the careful manner in which professional persons of different grades are there instructed in those branches of knowledge which are connected with the art of mining; though the Committee will take leave to remark, that they apprehend the mining practice of those countries is in no respect superior to that of Great Britain.

It is quite correct that the officers of mines are, in this district, chosen from amongst the most intelligent and best informed of the pitmen themselves, even up to a high rank; and this is a boon of which that meritorious class of men are well deserving, and which your Committee believe they do not enjoy in foreign countries. It must, however, be remembered, that the subordinate officers in question are not the responsible managers of mines. Their occupation is entirely of a practical nature; and your Committee have found, from experience, that intelligent men of this class, knowing that their prospects in life depend upon assiduous attention to their duty, are the most to be depended upon for carrying into full and perfect execution the orders of their superiors.

Your Committee are duly impressed with the value of education to every class of the community; and they believe that, at almost all the collieries, schools are patronised by the owners, and that increasing care is bestowed upon the education of the workmen. They therefore cordially reciprocate the opinion of Messrs. Lyell and Faraday, that every attention should be paid to the improvement of the intellectual qualifications of those to whom any superintendence is entrusted.

In the concluding paragraph of the Report, it is said, that "there are here no conflicting interests to contend with, for the proprietors are always anxious to prevent explosions and accidents, not only by their feelings of humanity, but by a regard to the property they have at stake; while the viewers, underviewers and other officers are continually risking their own lives, and sharing every danger with the men."

With this statement, and more particularly with the tone in which it is expressed, your Committee, in common, they are sure, with all other members of the trade, entirely concur. Much good, it is hoped, may be done when the attention of eminent men is directed towards the prevention of pit explosions. The trade is deeply indebted to Messrs. Lyell and Faraday, for the labour and consideration they have bestowed towards the attainment of this desirable end; and your Committee trust, that those gentlemen will not give up the investigation of a subject, in relation to which, when its intricate practical difficulties come to be fully appreciated by them, their eminent acquirements may prove highly beneficial.

For the Special Committee,

George Johnson, Chairman.

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* This, it may be observed, is a misapprehension as relates to the case of the master wasteman, who is not only able to write his name, but is, in reality, a man of some general reading. The Committee may here take occasion to remark, in reference to the note at page 12, that the variable terms applied to the description of strata, in different parts of the kingdom, have often proved inconvenient and embarrassing, even to practical men; and it is therefore extremely desirable, as recommended in the Report, that some uniform mode of designation should be adopted. The local phraseology is, however, well understood in the different districts, and is often more significant of the working qualities than of the mineralogical or geological character of the strata. It is evident that a nomenclature, unless adopted universally, would not be attended with the advantageous results contemplated. Your Committee, however, are of opinion, that every assistance and encouragement should be given by the mining interests of this district towards the establishment of a general nomenclature, descriptive of the different strata of the coal formation.

APPENDIX.

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APPENDIX.

No. 1.

The Haswell Colliery Accident.

TO THE EDITOR OF THE DURHAM CHRONICLE

(From the Durham Chronicle of Dec. 27, 1844.)

Sir,

You will much oblige the workmen of Haswell Colliery by inserting the following report in your widely-circulated Chronicle, which was read on the 24th instant by their deputation, and generally received.

"Fellow-workmen,

"We, your select deputation, appointed on the 19th instant, to travel and examine all the waste and old workings upon this colliery, in consequence of the unpleasant reports then circulating regarding their condition, now beg to state how we have proceeded with each day's examination, and what is the result of our examination.

"First Day.—We carefully examined the working goaves in the Engine Pit; also the Old Northway goaf, the First Northway goaf, and the Old Southway goaf in this pit, the latter having been reported to be lying dead, that is, in an unventilated state.

"Second Day.—We carefully examined all the goaves and courses in the Eight-Board, Eleven-Board and Twelve-Board Ways in the Little Pit; also the farthest Northway courses, the Meadows Way goaf, the returns from the Brockley Whins Ways, and the courses in the Standage Way.

"Third Day.—We carefully examined all the goaves and courses of the Old West Ways in the Little Pit; also the goaf in the far West Way, belonging to the Engine Pit.

"Fourth Day.—We carefully examined the district upon the Eighteen-fathom dyke in the Engine Pit; also the broken workings of the High and Low Brockley Whins and Meadows Ways.

"Such is the way we proceeded each day with our examination, and we now desire to state what is our opinion, and the result of the same.

"First.—All the places that have been represented to you to be in a bad state are, upon our examination, in the most perfect order, both as regards good ventilation and good air-courses.

"Second.—We cannot help expressing our great satisfaction and astonishment at the quantity and perfection of all the air-ways in every district; also the great amount of good air circulating in them.

"Lastly.—We admit with greater satisfaction and astonishment, that during the whole of our examinations, both of the goaves and other districts, we have not detected the least indication of gas.

"Such we solemnly declare to be the true state and condition of the pits: together with our opinion, that every care has evidently been taken, and no expense spared, to perfect the ventilation of the mine.

"As witness our hands,

"*George Wilson,*
"*George Summerson,*
"*William Hall,*
"*Ralph Wheatman,*

"Hewers on the said Colliery."

No. 2.

Haswell Colliery.

13 January 1845.

Note, explanatory of the Report of George Summerson, George Wilson, Ralph Wheatman and William Hall, who examined the Haswell Pit, with a view to its ventilation and condition, as regards fire-damp, on the 20th, 21st, 23d and 24th December last.

"We, the undersigned, have to state, that in examining the High Brockley Whins goaf, we got to the height of 13 feet above the top of the seam; that in the Low Brockley Whins goaf we got to the height of eight feet; that at the high edge of the Meadows goaf we got to the height of 13 feet above the top of the seam; that in the Twelve-Board Way goaf we got to the height of seven or eight feet; that in the Eleven-Board Way goaf we got to the height of nine feet; that in the Eight-Board Way goaf we got to the height of eight feet, and that in the West Way goaf we got to the height of 12 feet.

"The foregoing comprise all the goaves of the Little Pit.

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"In the Engine Pit we got up to the height of six feet in the Midland Flat goaf; in the North East goaf we got up to the height of five feet; in the Old North Way goaf we got up to the height of seven feet; in the first North West goaf we got up to the height of eight feet; in the Old South Way goaf we got up to the height of 10½ feet; in the South West Way goaf we got up to the height of seven and a half feet, and in the High West goaf we got up to the height of seven feet.

"All the above heights are to be understood as being above the top of the seam, and at the rise extremity of each goaf.

"And we declare, according to the statement made in our report, and herein now repeated, that we did not find, in any of the cases mentioned, the least trace of fire-damp.

"*George Summerson.*
"*Ralph Wheatman.*
"*George Wilson.*
"*William Hall.*"

COPY OF THE REPLY OF MESSRS. LYELL AND FARADAY.

Sir, London, 27 March 1845.

In reply to your inquiry, whether we had any observations to offer to Sir James Graham, respecting a Report by the Coal Trade Committee, which you were so good as to send us, and which contained considerations and remarks upon our joint Report upon the Haswell accident, we may observe that, with respect to any thing which is a matter of opinion, we have nothing further to say, except that we are not aware of any part which we desire to change; but with respect to the proposition made for the ventilation of the goaf, a few words may be desirable.

On further consideration of the plan proposed, one of us sent a letter to the Editor of the Philosophical Magazine (who had published the first Report), containing certain results of trials and simplifications of arrangement, tending, as we thought, to facilitate the practical application of the plan; of which letter we beg leave here to introduce a copy:—

"To *Richard Taylor*, Esq.

"Sir,

"You have honoured the Report by Mr. Lyell and myself with a place in the Philosophical Magazine, p. 16, and this induces me to send for insertion, also, certain considerations which have occurred to me since the Report was written, and also, some practical results which were brought generally before our members here, at the last Friday evening meeting. I need hardly say, that the Report proposes to draw away the lower aërial contents of the goaf by an iron pipe laid down in one or other of the ways of the mine, and either entering into the return-way, or having a fanner or bellows, or other blowing apparatus upon it. The points I wish to speak to now are, first, the draught; and next, the nature and place of the pipe.

"By experiments which I have made with a small furnace flue, and pipes of six inches diameter and less, I am quite satisfied that such a draught as that of the return at the Haswell mine would be sufficient to effect that which we propose in the Report, without the use of any extra blowing or withdrawing apparatus; so that the plan is so far relieved from the necessity of keeping a man or boy working at such a machine.

"With regard to the pipe, I think that, instead of laying it down in the floor of the mine, it had better be hung up or sustained upon props in the open space of that way or passage which may be chosen for its direction. If then any derangement of position occur, it can easily be remedied. I have had pipes of six inches in diameter, made both of air-proof cloth and common sheet-iron; the former were kept open by whalebone rings run round them at equal distances of two feet, and answered in my trials exceedingly well. Square trunks, also, made by nailing four boards together with copper or iron nails, are easily available as tubes. Such tubes, it may be said, when placed as proposed in the air, would easily be deranged by falls. No doubt a fall might destroy a part of the tube, but if it did, there would be no great difficulty in restoring it; and further, if a judicious selection were made for the direction of the tube, there appears no reason why the roof over it cannot be as well and securely propped up as the roof of the mothergate, the volley-way or any other important part.

"Finally,

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"Finally, it is not necessary, on the principle proposed, that the goaf end of the tube should always be at the very extremity of the goaf towards the rise, but only that it should be three or more feet above its upper edge, so that a jud or two may sometimes be drawn in advance, before the goaf end of the pipe need be re-adjusted. Apparently there can be no difficulty in selecting the place of the goaf end of the pipe, so that there shall be no interference with the general plan upon which the coal itself is worked.

"I am, &c.

"Royal Institution, (signed) "*M. Faraday.*"
"20 January 1845."

This letter, published on the 1st of February, would have been sent to the Coal Trade Committee, had we been aware of the existence of that Committee, and it might, we venture to believe, have had some influence on their Report. The fair spirit manifested in that Report assures us that the trade are really anxious to know of and apply any means of doing good which appear to them practical; and we, on our part, think still, that the principle of our proposition points to a practical result. Any further remarks, therefore, that we feel called on to make will not be directed to the Report generally, but to the proposed method of ventilating the goaf.

With regard to expense, this does not seem very serious when wooden trunks are thought of as air channels, instead of iron pipes. Thus, in reference to the Haswell mine, where the accident occurred, the distance, on the official plan of the works sent in with the former Report, from the nearest part of the return-way to the highest point of the goaf at which the accident is believed to have happened, is 126 yards; or from the same point of the return-way to Williamson's Jud, the very place of the accident, 238 yards; therefore, a wooden trunk made of boards, nailed together, and 126 or 238 yards in length, would reach from the return-way to these places, and we suppose that, with all the labour of fixing, &c., the longest could not cost more than 75*l.* If men could go from eight to 13 feet upwards into the goaves, as mentioned in the Coal Trade Report, there does not appear to be much difficulty in elevating the end of such a pipe in the manner we ventured to propose, and the effect could not be otherwise than that on which we reckoned, a strong draught out of that part of the goaf into the pipe and return-way.

The Coal Trade Report says, that there are 14 goaves in the Haswell mine. We had only under consideration the goaves of the Little Pit, in which the accident occurred, and it will be seen by the plan already referred to, and attached to our Report, that these are four in number, and the impression was conveyed to our minds, at the time and since, by the arrows placed in various directions over them, to show the course of the ventilating air, that there was a comparatively free air-way from one part to the other of each goaf. If such be the case, we should propose, in accordance with the principle before explained, to have one wooden trunk extending from the nearest point of the return-way to the farthest, or Low Brockley Whins goaf, passing in its way near the upper edges of the other goaves, and having branches proceeding from it to each of these goaves respectively. This, by the plan, would perhaps require 546 yards of the wooden trunking (costing about 136*l.*), and that would be the whole apparatus necessary for the Little Pit.

The Coal Trade Report states, that goaves are often divided into portions not aërially connected with each other, and that all parts are not accessible. We cannot, therefore, doubt that such is the case. Yet, if goaves be dangerous, and if, according to our late proposition, the expense in many cases would be but moderate, there seems no reason to come at once to the conclusion, that because every part is not accessible, none should be protected against accidents.

In making these remarks, we still wish them only to be viewed as suggestions made to practical men for their judgment and trial, and we hope that they will look favourably upon, and in some convenient locality try the power of the principle by which only its economy, effect and applicability to practice can be decided. It is a truth well known to every experimental investigator of nature, by the tendency of his own mind in the creation and collection of facts, that the success or failure of such a proposition as that made in our Report, often depends upon the animus with which it is carried into practice. Our first announcement was, if literally followed, very probably impracticable; but it was more the ex-

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pression of a principle than a practice, and was the natural precursor of simpler views as respects detail; which again, we expect, would become still more simplified if finally carried into effect.

At p. 17, of the Coal Trade Report, the Committee express an opinion that the atmosphere above the goaf end of the pipe would be left unaffected by it, and that, therefore, dislodgement of gas from a fall within the goaf would still take place. It will be as well, therefore, to state, that fire-damp in a goaf vault is not exactly comparable to water in a pond, there being this great difference, that the gas continually tends to mingle with the air beneath, by a property peculiar to gases and vapours (expressed by the term "diffusion"), and so would, under such circumstances, be brought down to the level of the exit pipe. On the same property depends, in a great measure, the circumstance that a goaf which contains fire-damp one day, may be found perfectly free from it on subsequent days, that being the condition which the Haswell goaves themselves were in at the time of a more recent careful examination (p. 17).

The sole object of our visit to the Haswell mine and inquest (we being closely limited by our time and duties at home), was to inquire into the cause of the accident there, and to suggest, if we could, some means of preventing the recurrence of similar events. That accident, from all the information then obtained, appeared to be due to an explosion originating at a goaf, and there was evidence tending to show that a second goaf had assisted in increasing the fire. To the means of obviating such mischief, our Report was directed. Now it would appear, that goaves in general are not so dangerous, and that out of 11 great explosions that have occurred in 14 years, exclusive of the Haswell accident, the goaves had no connexion with the origin of the accident in at least 10 of the cases (p. 16). The consideration of these and other circumstances, such as the use of naked candles and gunpowder in the whole, where the gas is said most to abound, suggest the expediency of a body of evidence being collected together and put on record, respecting the casualties in mines, with descriptive particulars of the part of the mine where they have occurred, the state of the workings and of the ventilation. The publication of a detailed and accurate account of all such facts might afford the scientific public philosophical data for arriving at safe and useful conclusions, and the evidence thus obtained would be free from all suspicion of having been biassed by partial views and local interests, and that excitement which cannot but occur on the occasion of any very serious catastrophe.

Certain incidental observations in different parts of the Coal Trade Report, as at pp. 14, 15, &c., and the system now in course of adoption, of making the goaf central, and working the whole all round and nearly up to it, induce us to put forth the expression of a thought relative to ventilation generally, which has been in our minds from the beginning,—it is, that all the air which passes through the mine should pass through the goaf, *i. e.* that the goafs should be the beginnings of the return-way, the return way not being, as now, on the level and at the side of the workings, but over them and the goafs. This idea seemed at first sight objectionable, from the assumed breaking down of strata into goaf, and we now put it forth, not with any degree of confidence, but as a suggestion; for we have not had opportunity sufficiently to consider it in relation to the circumstances of the mine and the strata above.

With respect to the mistake into which we are said to have fallen as to the inability of a master wasteman to write, we can only say, that we rested on the certified evidence taken by the coroner at the inquest, in which the mark of the person, and not his signature, is used.

We have, &c.

S. M. Phillipps, Esq.,
&c. &c. &c.

(signed) *M. Faraday.*
Charles Lyell.

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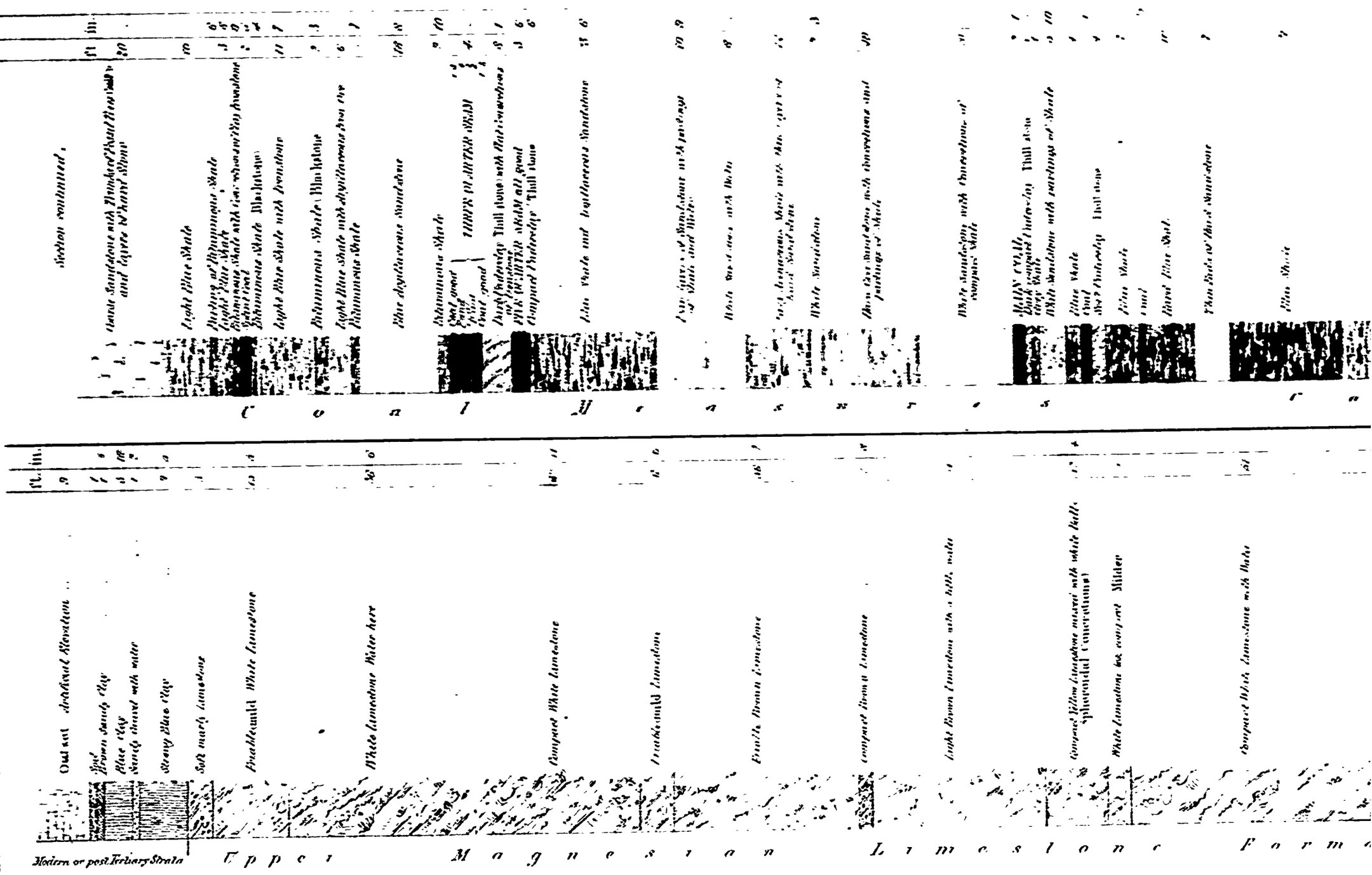
SECTION OF THE STRATA PASSED THROUGH IN SINKING TO THE

HUTTON SEAM IN THE HASWELL COLLIERY,

COUNTY OF DURHAM.



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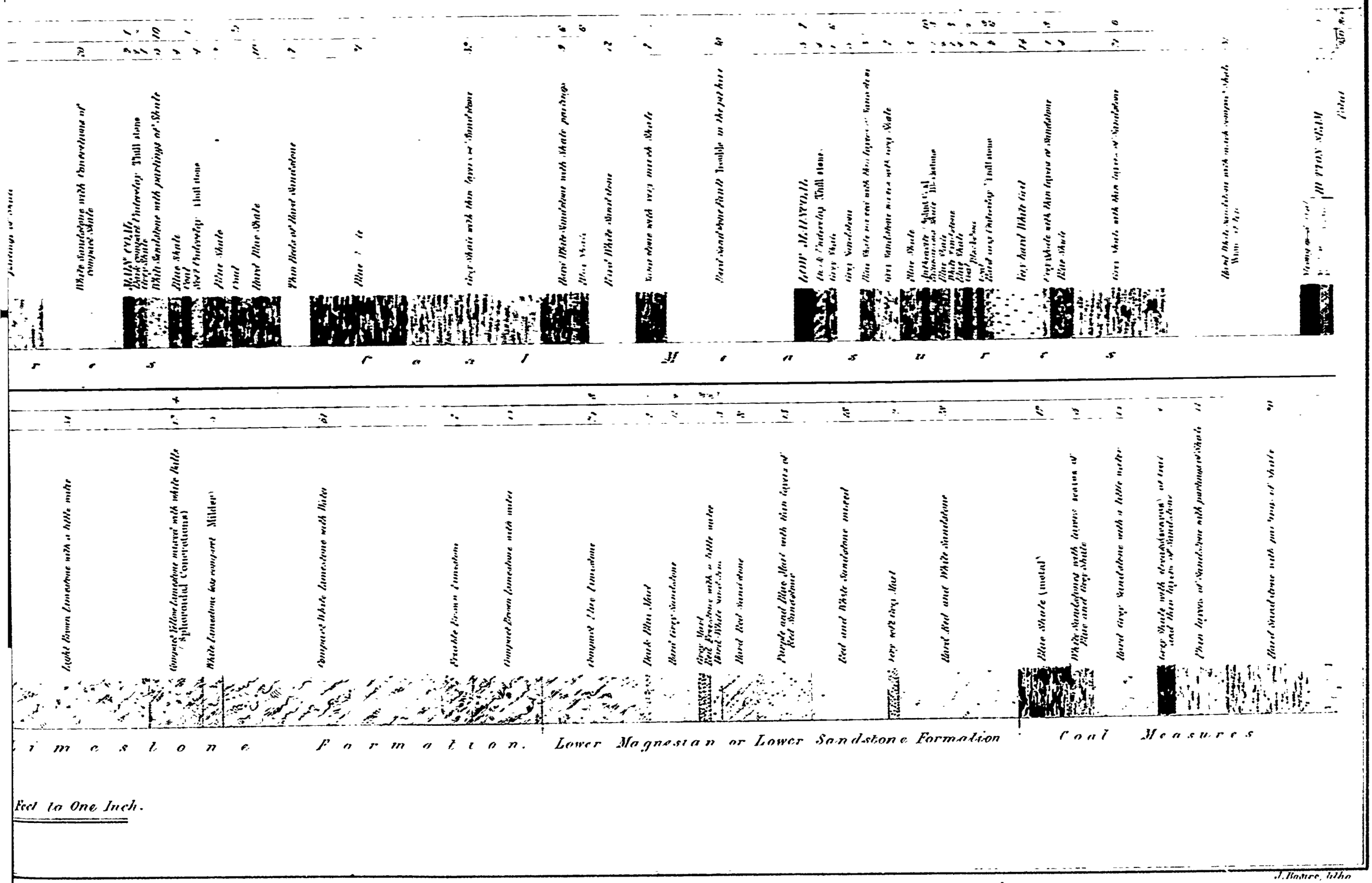
SSED THROUGH IN SINKING TO THE

THE **HASWELL COLLIERY,**

TY OF DURHAM.



232. Ordered by the House of Commons to be Printed 18th April, 1845.

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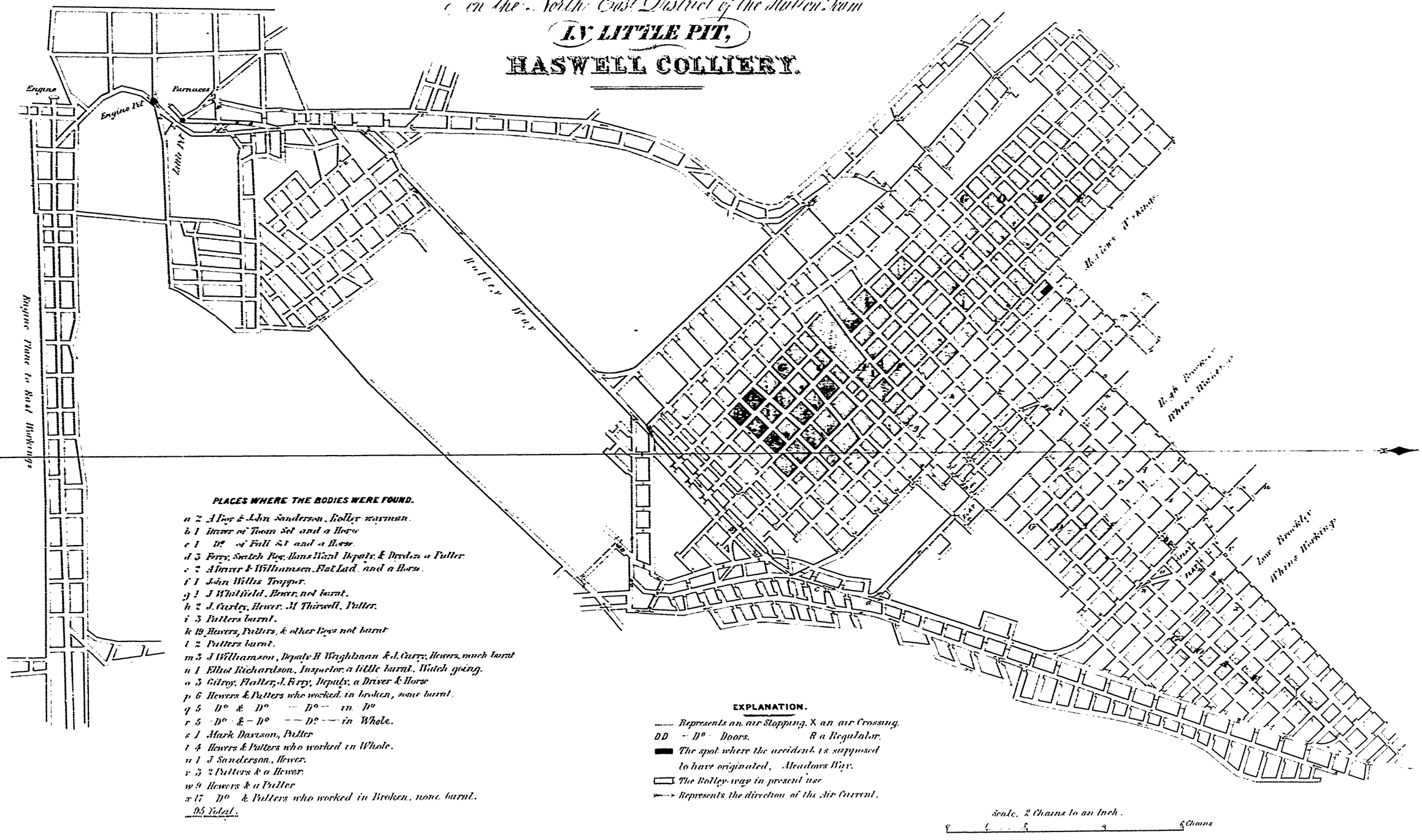
PLAN of WORKINGS

on the North East District of the Hutton Seam

IN LITTLE PIT,

HASWELL COLLIERY.



PLACES WHERE THE BODIES WERE FOUND.

a 2 *A Boy & John Sanderson, Roller-wayman.*
b 1 *Driver of Town Set and a Horse*
c 1 *Dº of Full Set and a Horse.*
d 3 *Ferry, Scotch Boy, Hons Road Deputy & Driver a Putter*
e 2 *A Driver & Williamson, Flat Lad, and a Horse.*
f 1 *John Willis Tripper.*
g 1 *J Whitfield, Driver not burnt.*
h 2 *J. Carley, Hewer. M Thirwell, Putter.*
i 3 *Putters burnt.*
k 19 *Hewers, Putters, & other Boys not burnt*
l 2 *Putters burnt.*
m 3 *J Williamson, Deputy H Waghman & J. Curry, Hewers, much burnt*
n 1 *Elliot Richardson, Inspector, a little burnt, Watch going.*
o 3 *Gilroy, Flatter, J. Ferry, Deputy, a Driver & Horse*
p 6 *Hewers & Putters who worked in broken, some burnt.*
q 5 *Dº & Dº — Dº — in Dº*
r 5 *Dº & Dº — Dº — in Whole.*
s 1 *Mark Davison, Putter*
t 4 *Hewers & Putters who worked in Whole.*
u 1 *J Sanderson, Hewer.*
v 3 *2 Putters & a Hewer.*
w 9 *Hewers & a Putter*
x 17 *Dº & Putters who worked in Broken, none burnt.*
95 *Total.*

EXPLANATION.

Represents an air Stopping. X *an air Crossing.*
DD *Dº Doors.* R *a Regulator.*
The spot where the accident is supposed to have originated, Meadows Way.
The Railley-way in present use
Represents the direction of the Air Current.

Scale, 2 Chains to an Inch.
0 1 2 3 6 Chains

Easter 1845

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HASWELL COLLIERIES.

COPY of the REPORT of Messrs. LYELL and FARADAY to the Secretary of State for the Home Department, on the subject of the EXPLOSION at the HASWELL COLLIERIES in September last; also, COPY of the REPORT addressed to the UNITED COMMITTEE of the COAL TRADE by the Special Committee appointed to take into consideration the said Report of Messrs. LYELL and FARADAY; and COPY of the REPLY of Messrs. LYELL and FARADAY thereto.

(*Mr. Manners Sutton.*)

Ordered, by The House of Commons, to be Printed,
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