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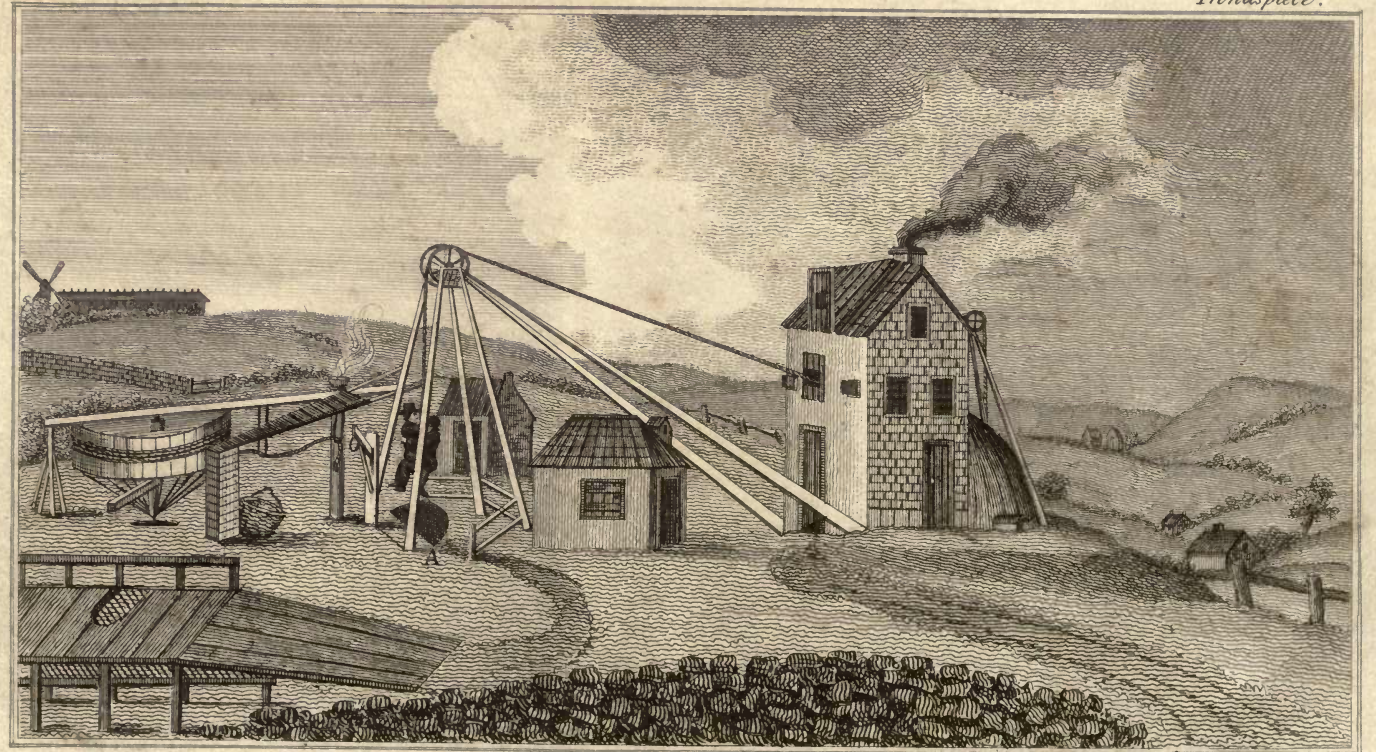


Middlemist, Sc.

Sketch of the Harrington Mill Pitt Colliery.

# A TREATISE

ON THE

# COAL MINES

OF

# DURHAM AND NORTHUMBERLAND;

WITH INFORMATION

RELATIVE TO

*THE STRATIFICATIONS OF THE TWO COUNTIES:*

AND CONTAINING

ACCOUNTS

OF THE

**Explosions from Fire-Damp,**

WHICH HAVE OCCURRED THEREIN FOR THE LAST TWENTY YEARS;

THEIR CAUSES,

AND THE

MEANS PROPOSED FOR THEIR REMEDY,

AND FOR THE GENERAL IMPROVEMENTS

OF THE

MINING SYSTEM,

*BY NEW METHODS OF VENTILATION, &c.*

BY J. H. H. HOLMES, ESQ. F.S.A.

WITH PLATES.

*LONDON:*

PRINTED FOR BALDWIN, CRADOCK, AND JOY,

47, PATERNOSTER ROW.

1816.

C. Baldwin, Printer,
New Bridge-street, London.

TO

HIS GRACE

THE

DUKE OF NORTHUMBERLAND,

F. R. and A. S. &c. &c.

ONE OF THE VICE-PRESIDENTS OF THE
SOCIETY OF ARTS,

AND

PATRON

OF THE

SOCIETY ESTABLISHED AT SUNDERLAND FOR
PREVENTING ACCIDENTS IN COAL MINES,

THIS BOOK

IS,

WITH THE GREATEST RESPECT,

MOST HUMBLY AND GRATEFULLY

DEDICATED BY

THE AUTHOR.

# INTRODUCTION.

IN offering this work to the public I am induced to anticipate many favourable results to the cause I have undertaken, as it was originally commenced under the impartial feelings of an individual by no means interested in the subject, beyond the comparative interest which men generally experience when any particular calamity perpetuates its effects by quick repetitions, and paints to our imagination the oppressive miseries of a poor and industrious people, who toil for the general good and use of society, and look up to their superiors for support and protection.

Under the influence of these sentiments, excited as they were by perusing in the public prints the dreadful accounts of explosions in coal mines, I was first induced to direct my attention to these dreary vaults; and if the impulsive sensations of humane anxiety were in the first instance the only stimuli to induce an intercession with national sentiment in behalf of the poor pitmen, and in the removal of old and fatal prejudices, I am happy to say that the impulse has proved the value of its anticipations, and progressively guided the eye of inquiry and research to the most extensive and desirable magazines of illustrative fact and interesting circumstance—to a gloom capable of being radiated—and to misfortune capable of being relieved.

Naturally anxious on the subject thus spontaneously interfered in, I waited with eagerness and attention for the gradual results incident to the question, and in the mean time sought to inform myself of every particular which might qualify the advance to more material facts.

In the lapse of intermediate time, and in the furtherance of an intention to proceed with perseverance, and interest Society in the cause of suffering humanity, the correspondence which forms part of this work was carried on; and although the greater part of it was private, and consequently unknown to the world, still I am induced to believe, from several concurrent circumstances, that the letters, which were presented to the public through the medium of a most respectable and well-conducted Newspaper,* did not pass without awakening in the minds of many intelligent people sensations of commiseration, and a desire to see further light thrown on a neglected subject, particularly with those who had fully considered the miseries resulting from the explosions of fire-damp in coal mines.

Satisfied of this, and additionally stimulated by every new account which presented itself, I gradually approached that collection of matter—that abundant stock of information

* The Morning Chronicle.

and circumstance, which can alone relieve the timidity so incident to the support of a point, where private interest, and obdurate custom, appear too bold for any reasonable hopes of success.

Under these considerations the obstacles which would otherwise intimidate the interference of mere argumentative humanity, appear but as the natural ascents to a great and commanding eminence—an eminence whereon the latent principles of science will mutually converge, and dissipate the gloom which still so unaccountably pervades one feature of our internal polity.

Conscious of the prejudices which obstruct the progress of humanity and improvement, it is with pleasure that I contemplate those benefits which may be expected to result to a certain class of mankind from the adoption of improvements, and the institution of regulations tending to destroy the baneful origin of all their calamities. That calamity from explosion has long been the destroyer of their happiness, will it is feared be but too strongly depicted in the long train of accidents and miseries presented in this publication, and which cannot fail to excite the most lively feelings in behalf of the poor sufferers, and the most anxious desire to see those plans adopted which would lessen their extent, and alleviate the distresses of poverty.

I have to acknowledge much assistance in the history of accidents from the numerous communications introduced in the periodical publication of Dr. Thomson, and in several other philosophical works; and in every other respect the utmost regard has been paid to authenticity, and the proper mention of those circumstances which elucidate and give interest to real misfortune, while they illustrate the extensive room for amelioration. And it is hoped their introduction, and the manner in which they are introduced, will be found strictly conformable to the most regular system which could be followed; as in their original recital, much assimilation of evidence, and much repetition of calamities in different places and at different periods, necessarily occur.

Actuated by the sentiments these statements produced upon my mind, I venture to anticipate from society at large that extensive sympathy and fellow feeling which can alone prepare the way to improvement, and establish the most approved means of security; and although much local prejudice, and the powerful opposition of self-interest, are always found where scientific inventions first display themselves, still it is to be hoped that many, who from a confined view of the subject either disapprove of any alteration, or passively exclude it from their considerations, will find such important facts to excite their feelings, and such an extensive field for the progress of science, and for the contributing greater means of happiness to a large body of poor people, as totally to surmount their objections, and awaken the concurrence of humanity.

The principal causes which have produced the melancholy accidents in coal mines will, it is presumed, form a serious but interesting history; and while the mind exercises its contemplations upon their dreadful extent, and the physical source from whence they have originated, it will instinctively imbibe those sentiments which, as a preliminary, are so necessary to remove the evil, and readily comprehend the great benefits which may be expected to result from the introduction of science where darkness and danger exist.

There is a benevolence in any new regulation which administers comfort to the distressed, which cannot be too much commended. Indeed the insufficiency of an individual pen to describe the virtues of improvement, and the merits of science, when exerted for the good of the community, readily adopts the eloquent and impressive language found in the works of an enlightened Divine, who, treating on science, thus expresses himself, "The second great end to which all knowledge ought to be employed is to the welfare of humanity. Every science is the foundation of some act beneficial to man, and while the study of it leads us to see the benevolence of the laws of nature, it calls upon us also to follow the great end of the Father of nature in their employment and application. I need not say what a field is opened to the benevolence of knowledge—I need not tell you that in every department of learning there is good to be done to mankind —I need not remind you that the age in which we live has given us the noblest examples of this kind; and that science now finds its highest glory in improving the condition, or in allaying the miseries, of humanity. But there is one thing of which it is proper ever to remind you, because the modesty of knowledge often leads us to forget it; and that is, that the power of scientific benevolence is far greater than that of any other to the welfare of society. The benevolence of the great or the opulent, however eminent it may be, perishes with themselves. The benevolence even of Sovereigns is limited to the narrow boundary of human life, and not unfrequently is succeeded by different and discordant counsels. But the benevolence of knowledge is of a kind as extensive as the race of man, and as permanent as the existence of society. He, in whatever situation he may be, who, in the study of science, has discovered a new means of alleviating pain or of remedying disease; who has described a wiser method of preventing poverty or of shielding misfortune; who has suggested additional means of increasing or improving the beneficial productions of nature, has left a memorial of himself which can never be forgotten, and which will communicate happiness to ages yet unborn."*

When the sense of Society and the opinions generally found in the minds of intelligent

* Allison's Sermons.

men are contemplated, the fear of obstruction seems to die away, and the grateful smiles of an industrious people suddenly radiate through a melancholy gloom, where fear and misfortune have continually resided.

I have long reasoned with circumstances, in order to discover the different tendencies of this subject; and, if not distinctly to turn argument into the focus of more enlightened discoveries than have hitherto aided the unfortunate and distressed, to palliate those things which have most materially retarded the growth of improvement, and to impress upon the minds of all intelligent men, that it is their duty, when science provides any additional plans for the security and happiness of society, to support its establishment by raising the voice of reason and humanity in support of its adoption.

In order that nothing may be wanting, which the ideas of limited ability suggest as useful in the cause, and which by its interest may at once please the imagination and engage the mind, much regard has been paid to the historical and topographical relation of the points best calculated to elucidate every circumstance; and in providing for this, all matter has been considered which assimilates with the subject. As I feel myself upon interesting ground, where abundance of information presents itself, I have carefully selected that which brings its own recommendation, and presents the most satisfactory association of intelligence and fact.

Many notes and elucidations are introduced, which probably may by some be deemed unnecessary; but my object is to make every thing as intelligible as possible, and rather study the convenience of those readers to whom the explanations may be desirable, than expose them to the trouble of references which might be difficult, and with which the philosophic memory is generally supplied.

The number of different theories prevailing relative to the internal formations of the earth, have produced a great number of very interesting and curious theories upon their original concretion. But the arguments in support of the different theories have necessarily supported themselves upon the constructions which the imagination of theorists have put upon the evidence of their inquiries.

A brief account of some of them is introduced in this work, not only as interesting, but as forming the parent matter for every investigation of its local branches. And certainly it is from the individual examination of the different mineral formations that we must expect to travel by degrees to some more certain conclusions upon this great and important question. Werner, Jameson, Cuvier, Kirwan, Thomson, Berzelius, Accum, Kidd, Sowerby, Buckland, Longmire, and others, have illuminated this path of philosophy; and society is indebted to each for his researches and discoveries.

Exclusive of the knowledge of origin, there are a number of circumstances in geology and mineralogy, which intimately unite with the welfare of the nation, and which must render the investigation of individuals at all times not only interesting, but valuable. There is a new field for learning, an extensive laboratory for philosophy and science, and a world of chemical and crystalline beauties in the bowels of the earth, which promise new subjects of examination for ages yet to come.

I am happy in expressing my acknowledgements of most valuable information from the works of the gentlemen I have named; and do not hesitate to acknowledge that it is from those sources that I have in a great measure satisfied and informed myself as to the general subject of this publication.

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## LIST OF PLATES,

### WITH DIRECTIONS TO THE BINDER.

Part of DURHAM & NORTHUMBERLAND, with the COLLIERIES, &c.

# TREATISE

ON THE

# COAL MINES

OF

# DURHAM AND NORTHUMBERLAND.

## CHAPTER I.

*General Description of the Coal District of Durham and Northumberland.—Soils, Mountains, Rivers, &c.*

THE county of Durham, which has been the principal theatre of calamity from explosion, has been long famed for its valuable mines of coal, lead, and iron; its extensive quarries of marble and free-stone, and its important manufactories of every species of hardware; its founderies, lime, brick, and tile-kilns. Indeed such is the extent and flourishing state of commerce, mining, manufactory, and maritime consequence of this county, that it very deservedly claims the attention of both the curious and the learned, the statesman and the historian, the geologist and the traveller.

This county is supposed to have been included in the territories of the Brigantines, (or Highlanders,) which extended over Durham, Yorkshire, and some part of Northumberland; and though different writers have varied in their opinions upon the subject, we have Camden, with many other eminent historians, to support the fact of its having been included in the Brigantine territories. When the island was subdued by the Romans, and when they began to establish themselves in provinces, this county was included in the division *Maxima Cæsariensis;* and afterwards, on the establishment of the Saxons, formed part of the kingdom of Northumberland, with which it continued connected until the heptarchial divisions of the island were united under Egbert.

Durham is a county-palatine possessed of many very valuable privileges, which are supposed to have originated in the grant made to St. Cuthbert, the apostle of the north, by Egfrid, king of Northumberland, anno 685, of all the land between the rivers Wear and

Tyne;* to hold in as full and ample manner as the king himself held the same, which was afterwards confirmed by king Henry I. to the then bishop of Durham, and ultimately by the parliament of Edward VI. The extensive privileges, however, secured by these different acts of confirmation have since that time been much abridged, and necessarily yielded to the different policy of the nation,† though many exclusive privileges are still retained, nor can any abrogation of their limits be traced as injurious to the general welfare and importance of the county.

Hills and mountains form the general aspect of the country, and in many places give a very noble and romantic effect to the scenery. The western angle is bleak, naked, and barren, being intersected by a ridge of mountains called the English Appennines, though they do not particularly deviate from the more bold

* It is called by the monkish writers, with other bordering counties, "the land of St. Cuthbert," or "his patrimony." *Camden's Britt.*

† Time insensibly produces mighty changes in all earthly things, and under the best modifications of social polity accidental circumstances will arise to exact aberration from the declared principles of its primitive settlement. *Sedgwick on Blackstone*, p. 73.

and steep eminences of a rocky country; various streams issue from the eastern side of these hills, and flow towards the sea, while ranges of smaller hills branch from this district and spread over almost every part of the county.

The soils and various strata, which are so interesting in this county and on the eastern coast of Northumberland, have long been known to the world for their richness and value; but the rapid improvements in geology have not advanced without greatly illustrating the hidden stratifications, and pourtraying to scientific curiosity the extensive and pleasing phenomena of their mineral formations, the principal of which are lead, iron, coals, marble, and grind-stones, with the common and magnesian lime-stone.

In the banks of the river Tees the *Belemnite, Trochitæ, Entrochoi, Asteriæ,* are found, and likewise in several other parts of the county: the lead mines produce considerable quantities of spars, both opaque and diaphonous. In the coal mines near Durham a black opaque spar was found, beautifully fluted and about three inches in diameter, intersected at intervals of about one inch and a half with a joint at which the columns easily divide. The honeycomb spar likewise abounds; and the stalactical spar, icicle, or dropstone, presents itself in many lime-stone quarries, and in the rocks on which the ruins of Barnard-Castle stand.*

The principal rivers are the Wear, the Tees, and the Derwent, which added to the Tyne furnish the most desirable means for facilitating the exportation of minerals and merchandize, from this part of the country, across the boundless deep, to the ports of Europe, Asia, Africa, America, or any other parts of the known world.

The Tyne, which is in Northumberland, is formed below Newcastle of the South and North Tyne. The South Tyne rises behind Crossfell, and the North Tyne commences on the borders of Scotland: the two branches join near Nether Warden, and afterwards receive the Dill, or Devil's Beck, near Corbidge, and the Derwent near Leamington. The mayor and corporation of Newcastle have been conservators of this river with increased privileges

* Barnard-Castle was founded by Barnard, son of John Baliol, who came into England with the Conqueror. It was a very extensive structure, situated on a rock; and its remains are said to cover about six acres and three roods of ground. *Crosby's Gazetteer.*

since Edward II. and have jurisdiction to high water mark on both sides from the sea to Hedwin Streams, above Newbourne.

The Wear rises in the great wilds of Stanmore, wherein the counties of York, Cumberland, Westmoreland, and Durham, nearly unite, and flowing considerably northward of the Tees crosses the county and falls into the sea at Sunderland, having Bishop-Wearmouth and Sunderland on the south side, and Monk-Wearmouth on the north. This town used formerly to be of some importance in a military point of view, and was several times in possession of the Danes. It does not retain many vestiges, however, to distinguish it from a populous village. The church is very ancient, and was the first glazed in England.

The Tees rises in the same district, and flows in a south-east direction for near thirty miles to Sockbourne, when it turns suddenly and falls into the German Ocean near Hartlepool.

The Derwent rises still further north in the same range of Moors, and, pursuing a course nearly parallel with the Wear, passes the wild and mountainous tract on the northern borders of the county, till it falls into the Tyne near Smalwell, and finally disembogues itself into the German Ocean at Shields.

## CHAPTER II.

*Coal Mines.—Formation of Coal.—Number of Seams.—Dislocations of Strata.—Boundaries.—Independent and Secondary Formations.*

THE Coal Mines being the principal point in question, and the amelioration of the misery which has of late so widely extended itself for want of possible remedies being adopted, it may not be improper to commence with the origin and chemical nature of coal, and with the seams or strata in which it is generally found, before the minutiæ of circumstances are entered into.

According to the opinion of most modern mineralogists, there are three different kinds of coal formation entirely different from each other; and as the knowledge of this must be at all times interesting, and conduce to the improvement of society, it cannot emanate in a more applicable shape than from a work entirely connected with its uses. The true coal formation consists principally of extensive parallel strata of coal, covered by strata of shale, containing impressions of vegetables, and not unfrequently the remains of fresh-water shell fish, with those of animals. Under each stratum of coal is generally found a stratum or layer of greasy indurated clay, called by the miners *clunch*, and usually destitute of those organic remains that characterize the shale. In some cases the seams continue for a great distance with a regular dip, and rise: in others they may be represented by muscle shells inverted one into another, and having the open side upwards.

The seams of coal are for the most part separated from each other by beds of various-coloured sand-stone, of clay, of bituminous shale, of ratchil, or rubble-stone of a soft decomposing clay, porphyry, or grunstein, locally termed rotten-stone, of argillaceous iron ore, of marl, and of secondary lime-stone.* There does not appear to be any uniform system in the plans of nature as to the arrangement of these strata in regular alternations; but sometimes one, sometimes more, interpose themselves between the seams of

* Much interesting information on the causes which produced the different formations in general will be found in Cuvier's Theory of the Earth.

coal, while in several instances part of these formations, particularly lime-stone, are not to be found.

The number of seams of coal in any particular formation is likewise uncertain and variable, though according to the calculations of experience it does not often occur that more than three or four are found worth working. The uppermost is in general shattery and very much mixed with earth and pyrites, except in some few cases, where very thick beds of sand-stone intervene. The seams generally run in a slanting direction, and are sometimes nearly vertical, but in most cases have an inclination of from one in five to one in twenty; and it may be inferred that the formation of the coal strata depends in a great measure upon the rocks or strata by which they are surrounded: the parallelism of coal seams is admirably preserved.

The strata are frequently intersected by cracks or breaks, which are filled with gravel or sandstone, and sometimes with a sink or bending, locally denominated *troubles*. Water generally finds free passage through the breaks, and in the course of time, by decomposing the adjacent strata of earth, clay, &c. causes immense fissures through the beds of different formation, until arrested in its course by some hard and impervious stratification.

Mr. Bakewell made some very interesting investigations relative to coal, but they were not thought sufficiently concise. Various other geologists have thrown further elucidation upon the subject; and there is no doubt from the great attention which has lately been paid to it, but that the secret beauties of nature, which have so long remained in darkness and obscurity, will in future form new and highly interesting subjects for philosophy and science.

The boundaries of any particular formation cannot be exactly defined; but from the most correct examinations which have been made, it appears that the whole of Durham and Northumberland is occupied by three distinct formations. These two counties form a triangle, having its apex at Berwick-upon-Tweed, and its base upon the river Tees. On the east it is bounded by the sea, on the north by the river Tweed, on the west by Scotland and Cumberland, and on the south by Yorkshire. Its greatest length north and south is eighty-eight miles; and its greatest breadth, from Crossfell in Cumberland, which forms part of the formation of these counties, to Hartlepool, is about fifty-two miles.

The three formations of Durham and Northumberland are, 1st, the independent coal formation; 2d, the second or Newcastle coal formation; 3d, the magnesian lime-stone formation.

The independent coal formation extends more or less over both counties, and has its greatest inclination towards the east, rising pretty regular in angles of from 35° to 75° westwards; it is supposed at its greatest dip to be 459 fathoms in thickness, and contains many alternations of different strata, the chief of which are, lime-stone, slate-clay, and sandstone: it is found, more or less, over the whole of the two counties, and is supposed to pass under the Newcastle or secondary coal formation; it is likewise found in North and South Wales, in Shropshire, and near Bristol; in most instances it may be depended upon near the primitive and transition rocks. In some instances it is found after the secondary lime-stone. Mr. Goodchild sunk a bore near his quarries west of Sunderland, in order to discover if any coals were deposited underneath. After trying to a great depth, the argillaceous shale which generally accompanies coal was found, and next came the regular coal strata; but the investigation ended here, as the expense of sinking shafts, &c., would have been too great, while seams nearer the surface are workable. But the most certain indications of the independent coal strata are the impressions of vegetables in the shale, or the tenacious blue clay, into which shale decomposes. Considerable quantities of good coal are found north of the Cocquet and west of Bywell-on-Tyne, with the exception of the porphyritic and grauwacke mountains forming the Cheviots.

From the best information which can be obtained, there does not appear to be more than six or seven beds in this formation.

The second, or, as it is called, the Newcastle coal formation, does not extend so far as the independent, but is pretty well ascertained to commence north at Morpeth, and having its west boundary in a line from thence south to Castle Barnard. From Morpeth it strikes out towards the sea; and continues along the coast to Teignmouth, where its east boundary cuts across the country to the river Tees, about fifteen miles from the sea; so that this angle of the county, formed from the three points of Teignmouth, the mouth of the Tees, and part of the river Tees, where the coal formation commences, is of recent formation, and consists principally of magnesian lime-stone, blue lime-stone, and clay.

The number of beds in the second coal formation is uncertain; but it is supposed to contain about twenty, though there are only six of any note, and only four worth working, which are the following.

1. The "Five Quarter," which upon an average taken from the centre of the formation at Harrington, about two miles east of Painshir-Hill, lies about eighty fathoms below the surface, and is three feet six inches in thickness. The coal in this stratum is of an inferior quality to that of the other seams, except about ten inches of the upper surface, which is of a very superior quality, and much used in forging; the remainder is mixed up to a certain extent with better coals, or consumed by the poorer classes of people.

2. The High Main which runs about eleven fathoms below the Five Quarter seam, and averages about six feet in thickness.

3. The Maudlin Seam, lying thirteen fathoms below the High Main, and about four feet six inches in thickness.

4. The Hutton Seam, lying twenty-four fathoms below the last mentioned seam, and

about three feet two inches in thickness; this seam is, in many places, quite worked out.

About Newcastle the mines have a great number of seams, and we have accounts of some containing fifteen or sixteen; but many of them constructed of such very indifferent coals, or otherwise so unfit for use, that they have no particular claim to attention. St. Anthon's colliery, situate three miles east of Newcastle, is supposed to be one of the deepest in the kingdom, and to contain sixteen beds or seams, although there are not more than four of them worked.

And in the Montague Main colliery, situate three miles west of Newcastle, there are fifteen seams of coal, four of which only are workable.*

* For explanations of machinery, and the rationale of working a mine, see Encyclopædia Londinensis, Art. Coal.

## CHAPTER III.

*Inflammable Air of Mines.—Analysis of Coals.—Soils intervening with Coal Strata, &c.*

WHAT makes the working of the Tyne and Wear collieries more dangerous than those of any other district is the great quantities of gas which unites or generates in their formation, and becomes liberated in the working. It generally confines itself to the roof of a mine, or otherwise forces into the fissures or breaks of the superincumbent strata; so that by this means, unless some agency is used to dislodge and force it into the atmospheric current (which cannot be done in the presence of lighted candles), the inflammable air becomes rapidly accumulated.

The discovery of this inflammable quality in coal gas is not of very ancient date, as there does not appear any decisive account of it before 1739, when Dr. Clayton described its inflammability in a paper to the Royal Society, wherein he mentions the produce upon analysis to have been an aqueous fluid, a black oil, and an inflammable gas.*

The great quantities of gas contained in the Newcastle coals, more than those of other parts, has been clearly demonstrated by the experiments of the Bishop of Llandaff, Kirwan, and several other eminent philosophers. The Newcastle and Whitehaven coals possess nearly the same properties, as Mr. Kirwan has shown by analysis, viz.

| Whitehaven. | | Newcastle. | |
|---|---|---|---|
| Charcoal ....... | 57· | Charcoal ..... | 58 |
| Bitumen ....... | 41·3 | Bitumen ..... | 40 |
| Ashes ......... | 1·7 | Earth, and metallic matter and sulphur . | 2 |
| | 100 | | 100 |

These coals differ essentially from most others, and contain a greater quantity of bituminous matter than either the Cannel or the Kilkenny coal, which partake of a much greater carbonaceous composition.

The oil which it gives out on distillation is

* For the mode of analyzing coal see Dr. Henry's Elements of Chem. vol. ii. p. 433.

of three different kinds; and this liquid production, though not precisely the same in its nature, is generally given out from all coals in similar proportions, or one-eighth of the quantity analyzed.

One portion of the liquid is a tenacious oily fluid, transparent, of a reddish or red brown colour, and more or less translucid; it is of an inflammable nature, and on exposure to the air becomes resinous.

Next is a more watery fluid, or aqueous ammonia, charged with oil and transparent: it is either quite colourless, or of a dilute yellowish colour: it is very inflammable, and burns with a brilliant blue yellow flame: by exposure to the air it is partly volatilized, and leaves a residuum very much resembling the tenacious oily fluid. When combined with concentrated sulphuric or nitric acid, this product is converted into a solid resinous matter soluble in alcohol.

The third product is a kind of mineral tar, being much thicker than either of the others, and of a dark brown or black colour. This is one of the solid bitumens, and is obtained in great quantities by distillation of the Bovey coal, and a similar species of coal found near Cologne, which is greatly bituminized. The Bovey coal is formed of trees, reeds, rushes, and other vegetable substances embodied together in the alluvial earth, having very distinct impressions of trees, and being wholly of a ligneous and fibrous texture.

This coal is found within one foot from the surface, and in the whole alternations of its strata does not exceed seventy-five feet in depth. It is curious that the Bovey coal becomes less bituminized in its descent, as the lower seams approximate nearer to the slate-coal; it is called the compact carbonated coal by Kirwan, the common brown coal by others.

There is a manufactory on the Wear, a short distance from Sunderland, belonging to Messrs. Featherstone, for the purpose of decomposing the coal and extracting from it the coal tar, petroleum, &c., and ammonia; it is similar to the one erected at Colebrook Dale by Lord Dundonald. A lamp-black is likewise obtained here in the same way as at the manufactory in the county of Saarbruck on the Rhine.

It is from the second formation of Durham and Northumberland that most of the coal is exported to London and other parts of the kingdom; the independent coal being for the most part applied for home consumption, on account of its inferior quality.

Sand-stone, slate-clay, or metal-stone formations of different distinctions alternately intervene between these formations of coal; and dykes to a considerable extent traverse it in all directions.

It is curious that on the north side of the dyke called the Great Dyke, the beds are thrown down ninety fathoms: its direction is N.N.E. and S.S.W.; it enters the sea about three miles north of Shields, and runs westward and S.S.W. through the whole formation. Besides this there are some other dykes which have claimed the particular attention of geologists, though no certain theory has yet satisfactorily accounted for their existence.

## CHAPTER IV.

*The Second, or Sunderland and Newcastle Coal Formation.—Third, or Magnesian Lime-stone Formation—and Dykes.*

THE second, or Sunderland and Newcastle coal formation is supposed to be about fifteen miles by twenty, making a superficial area of 300 miles, each mile containing about 4,645,000 cubic yards, or tons, (as each cubic yard is calculated to contain one ton of coal:) of this from one fourth to one sixth is appropriated to pillars and walls for supporting the mine, and the annual consumption amounts to about 3,100,000 tons.

The third formation is the magnesian lime-stone, which is found with different variations all along the coast of Durham, breaking off at the Tyne. It is intercepted for about twenty miles on the coast of Northumberland by the coal formation, and is only found in very inconsiderable quantities to the north. Its principal range is from Teignmouth to Durham and Hartlepool; and although the exact depth cannot be defined, it is not supposed to exceed thirty-five fathoms.

There is much difference in the qualities of the lime-stone in different parts of the county of Durham, upon which geologists have expended much experiment, and produced many enlightened chemical elucidations. It appears however that, after the magnesian lime-stone, blue lime-stone occurs near Sunderland for about sixty-four feet; and after this alternations of dark slate-clay and blue slate-clay for about forty fathoms; then comes green or whin-stone for a considerable depth, and ultimately the coal formation.*

The lime-stone rocks about Sunderland are probably more curious than any other part about the formation, particularly at Building-Hill, where it is found imperfectly crystalline, and of a dark yellow or ochre colour, in some places dividing into small cells, united with each other, from whence it has been called the honeycomb lime-stone.

Numerous basaltic blocks are found scattered about in the surface and under the soil, as observed by Mr. Bakewell, and are very similar in appearance to the large masses of

* See page 11.

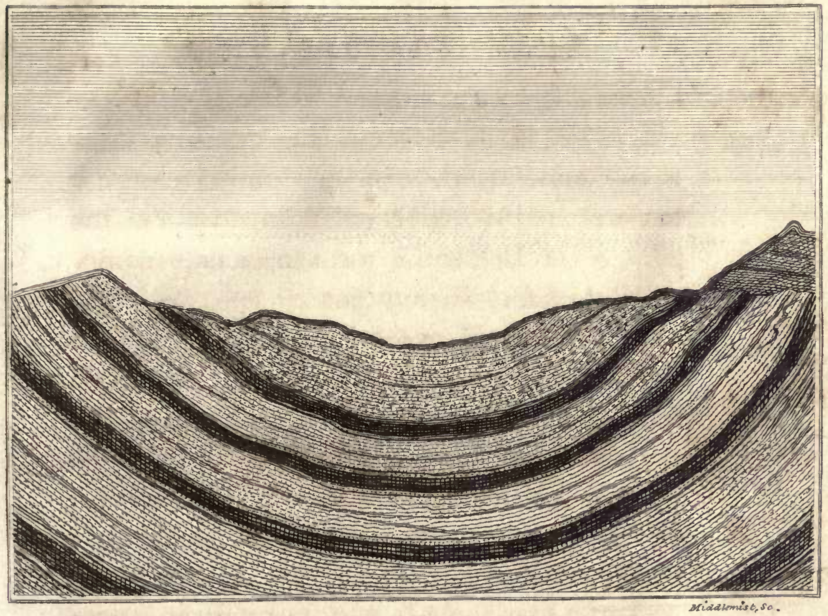
calcerated matter under the east cliff at Brighton. I have examined the lime-stone about Sunderland, and can only refer my readers to Mr. Bakewell's treatise on the geology of England * for a more explanatory account. Dr. Clanny made some very interesting investigations on a lime-stone rock in the vicinity of Sunderland containing marine impressions, and which Mr. Bakewell is inclined to consider of subsequent formation; Dr. Clanny communicated the result of his inquiries through the medium of Thomson's Annals, in August, 1815.

Various specimens of the different strata may be examined on the coast, as the perpendicular aspect affords a complete section of the whole. In some places near Sunderland there appears to have been a sinking in of the strata, as the parallelism is destroyed, and one series dips to the south-east, while the other dips north-west, and giving passage to water in the line of their junction. (See plate III.)

The lime-stone formation contains the impressions of fish to a large extent, and various other productions of the sea.

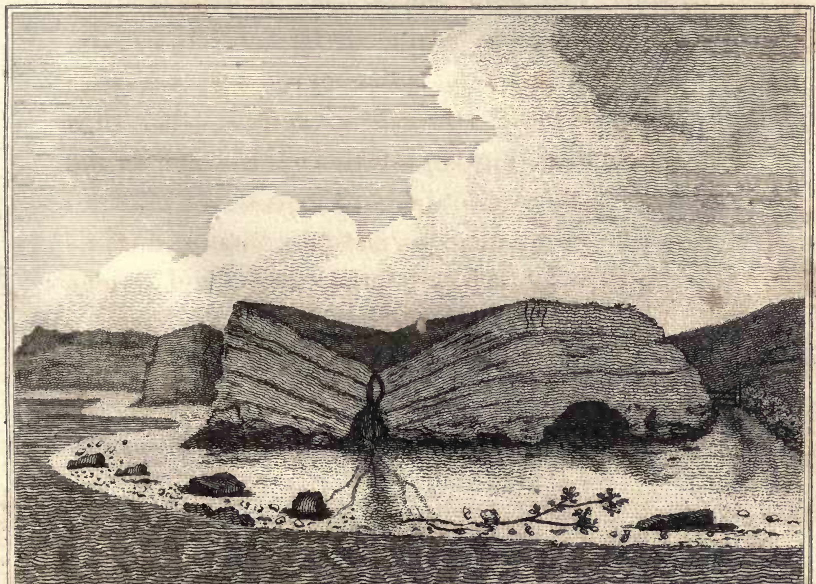
The dykes, which rise from an unknown

* See Appendix to his Geology, note on p. 353.



Middlemist, Sc.

Independant Coal Strata, in a curving form.



Singular Contortion of the Limestone Strata, on the Coast near Sunderland.

depth to the surface, are various in their qualities, and are distinguished under the names of the whin-dykes, stone-dykes, clay-dykes, rubbish-dykes, and slip-dykes.

The whin-dykes are formed of basalt,* or whin-stone, (one of which occurs at Coaly Hill, near Newcastle,) which, according to some theories, is supposed to have issued hot from the bowels of the earth; indeed this idea is much strengthened by the coals on each side being reduced to cinder, and continuing more or less burnt or scorched to a considerable distance. The most striking instance of this phenomenon appears in a dyke passing from Ayton in Cleveland, by Bolam, which is seven miles and a half north-west of Darlington, in a right line to Cockfieldfell, in the county of Durham: it is of a black basaltic nature, and is quarried for the purpose of mending the roads, making the firmest foundation possible.

The stone dykes are filled with a variety of imperfect materials, which in general are both hard and dry, and separated by fissures

* According to Werner, basalt is confined to the Floetz-trap, or secondary trap formation. It occurs in vast mountainous beds, mostly of a conical form, in strata, in banks or dikes, and in veins, and almost always accompanies coal. *Aikin's Chem. Dict.—D'Aubuisson.*

running in horizontal and longitudinal directions.

The clay-dykes, which occur in greater quantities than any other, are formed of very dry indurated clay, which is impervious to water.

The rubbish-dykes are composed of sand, pebbles, and clay, apparently swept in from the surface, and give free admission to water.

Slip-dykes derive their name from the probability that they were formed by large masses of strata slipping from their original position, and in the coal formation appear to have caused a complete dislocation in the adjacent stratifications, as considerable quantities of different substances are mixed confusedly together. These dykes are denominated downcast or upcast, according to their relative position when approached by a miner.

In the limestone formation these dykes are filled with metals and beautiful spars.

## CHAPTER V.

*Deposition of Coals.—Their Duration.—The Origin of Coal.—Its Gases.—Accumulations of Fire-Damp in the Tyne and Wear Collieries.*

IT is difficult to ascertain where beds of coal are deposited, unless there appear some signs on the surface, or from fragments scattered abou in beds of clay, though the true foundation may generally be depended upon after the secondary or blue lime-stone formation.

Mr. Bakewell, in his Geology of England, is inclined to believe that the coal strata do not extend to any considerable distance beyond their known limits; and observes, "that our prosperity and greatness as a manufacturing nation, in a few centuries, when the present mines are worked out, will depend upon its determination." * Dr. Millar, in his edition of William's Mineral Kingdom, gives a still more desponding account, as to the duration of coals, particularly in Scotland, near

* Bakewell's Geo. p. 351.

Edinburgh. The result will of course remain for future ages to investigate: but when geologists advance theories of such vast importance, it becomes a government, in the furtherance of every consideration which is to hand its foresight and permanent regulations down to posterity, so to employ the evidence of research in regard to mineral sources of wealth, that any improper waste may not be made, for want of its interference, to innovate more than is necessary upon those resources whereon a country's affluence and happiness must through all ages depend.

And although Dr. Thomson, whose eminence as a philosopher and a chemist justly entitle him to rank amongst the first in Europe, calculates upon a supply for one thousand years,* (inclusive of the time the mines have been worked,) yet the probability that this may not ultimately occur, united with the sentiments expressed throughout the whole of that learned gentleman's writings on coal mines, gives an assurance that he would perfectly concur in this regulation of legislative caution, and in the necessity of government paying some attention to the lives of the persons employed in working them.

* See Annals of Philosophy, Dec. 1814, p. 411.

It has been supposed by some writers that, if a line be drawn from Sunderland across the country to Bristol, all counties both in England and Scotland to the westward will be found to contain coal, until interrupted by a line drawn from the south of the Tay, opposite Dundee, along the Ochill-hills to Stirling, which they considered as the northern boundary; but this is not correct, as coals have been found in Sutherlandshire.

The origin of coal has for a long time occupied the attention of our most able philosophers, chemists, and naturalists; and combines such subject of research, and such sublime indications of providential exactness and economy of nature, that whoever employs the powers of contemplation and inquiry upon it, is necessarily improved and delighted with the study.

That it has a vegetable origin, and springs from the concretion and bituminization of vegetable matter, has been so strongly argued that it appears to supersede the idea of volcanic origin. In support of this may be advanced the ligneous texture traced in the most compact species of coal, and the regular transitions of bituminized wood through pitch-coal and slate-coal into glance-coal, which is devoid of bitumen, and combined with a proportion of earth.

This coal yields carbureted hydrogen gas of much less density than that obtained from other coals.* The number of theories however upon the origin of coals are yet very numerous, and leave much room for further investigation.

Coal, when decomposed by heat, gives out acidulous water, oily bitumen, charcoal or carbon, carbureted hydrogen, and carbonic acid; and as these are the principal bases of its formation, the researches of philosophy converge in their examination, and point out the extreme necessity of science and caution in the working and management of collieries.

The principle most destructive to the security of coal mines, and the lives of the miners, is the inflammable air, fire-damp, or carburetted hydrogen gas, which consists of hydrogen holding some carbon in solution; and, according to Dr. Thomson, contains three-fourths of its weight of carbon, and one-fourth of hydrogen. This is contained in every stratum, and liberates itself from the secretions of nature in

* Dr. Henry's Elements of Chemistry.

great quantities; and though many opinions prevail relative to the manner in which carbureted hydrogen is generated in a mine, one alone exists as to the destruction it causes when exploded. There is no doubt that it proceeds from the beds of coal in the greatest measure, and from the rents or fissures wherein it is frequently pent, and either exudes in gaseous volumes through the coal, or bursts out in streams of foul air, so that the miner is generally exposed to the greatest danger even in the common working of a colliery, although hardiness and habitude remove fear, and even in many instances caution, far from his considerations.

Mr. Dalton has shown (see his work) that the fire-damp of mines is the same as is produced in wet marshes; and society are indebted for a corroboration of this opinion to the valuable experiments of Sir Humphrey Davy,* who has elucidated its many peculiar qualities, and shown the great degree of its inflammability.

Very few mines are so free from gas as not to be in some measure dangerous; for the at-

* See his Paper as printed in the Philosophical Transactions for 1815, and in Tilloch's Philosophical Magazine for January 1816.

mospheric current passing through occupies the middle region of the workings, while the fire-damp, from its specific lightness, ascends and continues on the roof, and may be found in almost every part of a mine, as I have myself ascertained by holding up a lighted taper and watching the flame, which, on immersion in small quantities of the fire-damp, appears to have a yellowish semi-circle over the top.

The carbonic acid gas occupies the floor, and is only dangerous when its quantity becomes so great as to affect the respiration, as at the Hepburn Colliery; and in case of explosion of the fire-damp, the carbonic acid with the common air is so much expanded as to sweep every thing before it.

The mines on the Tyne and Wear are considered in a peculiar degree dangerous, from the quantity of gas yielded by their coal; indeed the many accounts of devastation which have recently occurred in this district are unequivocal proofs in corroboration of the statement. When any quantity of gas escapes from a rent or fissure, its blast is always most powerful on the first liberation, and gradually becomes less until the whole is spent out: should nothing occur therefore to ignite it in the first instance, it may be carried off by good ventilation; but should this be deficient, it may explode on ignition when the whole has broke forth into the mine, as the accumulation would be too great, and overcharge the atmospheric air.

There is much difference in the appearance of gas-yielding coal; but, generally speaking, the Durham and Northumberland coal yields abundance: and at this time much danger is suspended over these immense works, from their astonishing extent, and the great increase of inflammable principle which this extent naturally produces. In part of the Hutton Seam, for instance, which has been worked out, the gas has become so powerful that nothing will contain it; on this seam being worked out, the shafts and staples * were stopped up to the next seam above it, by means of strong scaffolding, clay, straw, earth, &c. seven fathoms in thickness, and the water suffered to drain into it as an old waste. The water has now accumulated in considerable quantities, and having

* A kind of smaller shaft cut through from one stratum of coal to another in different parts of a mine, for the purposes of ventilation, and for the passage of miners. I descended one of these by means of a rope ladder with wooden staves, and which was hung on a post at the top of the staple; the bottom of this staple was 125 fathoms from the surface.

forced the foul air to the upper part of the rise, begins to compress it too much, which causes the fire-damp to force its way back through the waters; and, extraordinary as it may appear, through the whole substance of the scaffolding. In one part of a mine which Dr. Clanny and myself descended, a bore had been made through the scaffolding of three inches in diameter, in order to liberate the gas below more freely; and it is greatly to be feared, from past circumstances, that no mode of ventilation can be adopted which will sufficiently guarantee the security of the mine and the miner: for it is not a subject which gives time for deliberation; but if any thing occurs to obstruct this ventilating medium, when an extensive eruption of gas breaks upon the light, it communicates to all parts of the mine around, and in one moment rears the terrific aspect of volcanic convulsion and death; or, as expressed by a little alteration of a passage from Thomson:

> Here terror holds his unrejoicing court,
> And through this sombre hall the loud misrule
> Of driving thunder is for ever heard;
> Here the grim tyrant meditates his wrath,
> Here arms his fires with all subduing strength,
> Bursts the strong hold which earth to nature gave,
> And rears a tomb where once a people lived.

When the gas escapes only in regular and moderate quantities, the miner may explode it as he goes on, without producing any other effect than a pleasing phosphoric phenomena in the working, or a flash like the flash of a musket. But this, after being practised for years, unfortunately strengthens the idea of security, and the mind is incapable of informing itself what hidden reservoirs may be broken into in the future progress of a mine. A fact so simple, and yet so incontrovertible as this, can but impress every one with conviction, and produce the natural inference, that the most desirable and most valuable improvement in a colliery would be afforded by an invention to counteract this operation of nature.

The real origin of gas, however, still forms a subject for the inquiries of philosophy. As no conclusive evidence has ever yet established a certain cause, some ascribe it to the gradual decomposition of coal, which in consequence gives out its carburetted hydrogen, or inflammable air; others, who suppose that the formation of coal was produced by the decomposition and concretion of vegetable substances, infer that it originates from the exhalation of putrefying animal and vegetable matter in the stagnant water of coal mines; others, to the effect of iron pyrites, which, it has been observed, produce a decomposition of the water, and by uniting with the oxygen become sulphate of iron or green vitriol, while the hydrogen is liberated in a gaseous state. Most probably the whole of the above principles concur in producing the gases of a mine; but these points still remain undetermined,* and also the exact manner in which gas is given out or separated from the coal. At all events it appears evident that the process of nature is continually at work, and does not depend at all upon the working of mines, although by their penetration into the earth it is afforded a means of escape, when it would otherwise either in its more condensed state have concreted to some earthly substance, combined with other matters in the formation of new stratifications, or in its gaseous state have sought the rents and fissures of the earth, and there accumulated.

It is very ably argued by many writers that there is a natural volcanic principle in the earth, which, if it cannot obtain vent, will in the course of time either produce earthquakes or violent eruptions of fire and lava. How long a period of time might be required for this

* Memoirs of the Wernerian Society for 1808-9-10, page 504.

process to accumulate sufficiently for such an effect is difficult to ascertain; but it might probably be ascertained that the earth, having been supplied with openings in those parts where the most combustible principles were collected, had ceased to vibrate upon her poles from earthquake, or form new surfaces by eruption.

Having gone thus far in the regular gradation of the subject, it will be necessary next to give a short outline of the commencement of mining. This, however, cannot attain the exact point of origin, as there does not appear any certain record to proceed upon, nor does antient tradition afford much assistance: there is little doubt, however, that the Romans were acquainted with the use of this fossil when in Britain, but to what extent is very uncertain.

Indeed the extension of the coal trade to its present importance has proceeded rapidly within the last few centuries, as the general use of wood fuel till within a very short comparative period clearly demonstrates that our forefathers did not participate so much in the internal provisions of nature as ourselves. Many circumstances may be found to corroborate the evidence of coal being known at a very early period, but no particular mention occurs of coal in the county of Durham until the grant of King Henry III. to the good men of Newcastle of a license to dig coals in a place called Castle-field, and the Forth.

In 1245 mention is made of the ways of persons employed in digging, and from hence proceeds the most certain information relative to mining. There is no account of coal mines in Scotland till the grant of one at Pittencrief, in Fifeshire, to the Abbey of Dumfermline in 1291. In 1306 they appear to have been generally introduced into London, and shortly afterwards mention is made of exportations in exchange for foreign merchandise.

In the charter granted to Sunderland by Bishop Morton in 1634, the articles specified for exportation are sea-coals, grind-stones, rub-stones, and whet-stones; and shortly afterwards Sunderland assumed an appearance of rising consequence, which created much jealousy amongst the Newcastle owners.* Notwithstanding this, however, they have mutually advanced in wealth and trade, and at this time

* As there are many publications containing the details of history in regard to the coal trade, particularly Brand's History of Newcastle, it has not been thought essential to the object of this work to enter fully upon it.

wear a very striking feature of rising importance.

The conveniences for carrying on the coal trade, the perfection of the machinery, and the extensive range of waggon-ways, are truly astonishing; amongst the most admirable contrivances I must number the staithway, nearly adjoining on the south side of Sunderland bridge. A short distance up the river a deep ravine branches, in a very striking and romantic manner, towards the south-east. On one side of this ravine a series of warehouses have been erected, in which large quantities of coal are deposited; and from them a staith, or waggon-way, is erected, supported by long wooden pillars, and which descends in an angle of about thirty five degrees through an arch cut in the opposite rocks, and then continues to run on a level but elevated platform along the side of the river.

This staith is so constructed that, when a waggon loaded with coals descends on one side, it pulls an emptied waggon up on the other. The ship to be loaded is placed immediately under the elevated platform, when a trap-door is opened and the bottom of the waggon being let down, the coals descend through a trough into the ship, in some cases the waggons themselves are lowered all together, by machinery, from the platform.

It will next occur to recite the unfortunate history of explosion, in order to impress more strongly the necessity of legislative interference. Indeed the great interests connected with the question, the fame of England in her improvements, and the mass of human life depending upon security, imperiously claim the direct attention of a watchful and benevolent government.

As the short space of three years has furnished a melancholy series of misery and distress, it would be unnecessary to look any further back for accounts, were it not material to prove that these accidents are not the mere upshots of an unfortunate period, but the regular calamities incident to the accumulation of inflammable air, and to the want of proper information relative to the mines.

Unfortunately no regular statement can be traced from whence to elucidate the immediate consequences and distresses of the several explosions, until about 1812.

## CHAPTER VI.

*An Account of the different Explosions from June* 1794 *to October* 1813, *containing those that have happened at Harraton, Washington, Lumley, Hepburn, Oxclose, Felling, Harrington, Collingwood Main, and Fatfield.*

IN the year 1812 society were presented with that excellent medium of philosophic intelligence, Dr. Thomson's Annals of Philosophy, from the pages of which, and the aid of considerable local information, the present statements are enabled to assume a character of authenticity and descriptive fact, which alone entitles them to public consideration.

The explosion at Felling, in 1812, appears to have been the first introduced into any general publications, but antecedent to that period a long train of misery is furnished from 1794.

As no detailed account can be obtained, it will suffice to state that, on June 11, 1794, an explosion took place at Harraton, situate on the banks of the Wear, opposite Lambton Park, the seat of J. Lambton, Esq. which killed twenty-eight people.

February 7, 1798, another explosion took place at this time at Washington, a populous village about six miles from Newcastle, which killed seven persons.

October 11, 1799, another occurred at Lumley, a short distance from Lumley Castle, the seat of Lord Scarborough, which killed thirty-nine persons.

Another, October 6, 1805, at Hepburn main, on the south bank of the Tyne, about halfway between Shields and Gateshead, which killed thirty-three men and boys.

Another at Oxclose, Nov. 29, in the same year, which destroyed thirty-eight persons.

After this period more detailed particulars occur; and it is unnecessary to present any thing more than the simple fact, to show the true extent of these calamities. But the reflective mind will contemplate with regret the long train of attendant miseries entailed upon explosions; while a reference to the maps of Durham and Northumberland will point out the comparatively small district which has been subject to these repeated melancholy occurrences: and the reader will discover in the perusal of the following statements, that a second explosion took place at Hepburn in 1814; so that by a common calculation of probabilities, it may with considerable certainty be anticipated, that, unless some preventive is adopted, a short lapse of time will present more repetitions of explosion, or include the names of mines hitherto fortunate in their escape.

*Explosion at Felling.**

In Felling parish there are several beds which have been progressively worked for many centuries, some of them being now nearly excavated.

In October, 1810, working commenced on a seam called the Low Main; and being in the proprietorship of liberal and wealthy persons no expense was spared which could enhance the improvements of the mine, or tend to the security of the pitmen.

The most approved methods of ventilation

* There is an exception to the general parallelism and inclination of strata in this mine. "A bed of schistus called the Heworth Band commences nearly under the highway from Newcastle to Sunderland, and gradually increases southward in the form of a wedge, dividing that which in the river Tyne is one seam of coal into two distinct seams, which at the Wear are many fathoms asunder. The wedge consists of sand-stone and schistus." *Picture of Newcastle.*

according to the present system were adopted, and every species of mechanical apparatus attached to the colliery combined in the general perfection, and regularity proceeded upon. Notwithstanding this, and in spite of every precaution which was adopted, the pit called the Brandling Main exploded in May 1812; and on the twenty-fifth of that month the surrounding neighbourhood was thrown into the utmost terror and confusion by its tremendous burst. The fire broke out in two discharges from one of the working pits, which were shortly followed by another from a second pit. Terror and dismay spread in every countenance, and the most agonizing fear took possession of the poor creatures who had relatives employed in the mines.

The deep caverns, where the explosion first vented its fury, confined the eruption too much for its utmost noise to be heard on the surface; but for half a mile round the trembling vibrations of the earth proclaimed the occurrence before the sound escaped, and for four or five miles an alarm was created by the slow and hollow rumblings in the air. Immense quantities of coal, pieces of wood, and dust, drove high into the atmosphere, and the lacerated remains of several bodies were thrown up the shaft. The scene was dreadful; and for a time the spectator beheld himself close to Etna or Vesuvius. Darkness and misery reigned around, the roads and paths were covered in all directions with pieces of coal and coal dust; every species of machinery about the shafts was, with little exception, blown to pieces or set on fire; and the Chapelry of Heworth, situate near the mine, was enveloped in darkness.

No sooner was the explosion heard than the wives and children of the pitmen ran to the working pit, where a scene of distress presented itself which it is impossible for language to describe; and though a sympathetic heart will strengthen its imagination upon an occurrence so dreadful, still it must fall short of the original picture. Wives crying for their husbands, children for their parents, and others for some fond relative or friend, form the scene before us.

Every apparatus from whence assistance could before have been expected was rendered totally useless by the convulsive eruption; and it was not until some secondary means were arranged that any steps could be taken for ascertaining the extent of the calamity. When this was accomplished, out of one hundred and twenty men and boys employed in the mine, only thirty-two were rescued alive, three of whom afterwards fell victims to the shatters and scorches they had received. The joy of those who saw their relations raised as they imagined from the tomb may easily be conceived; but nothing can describe the frantic horror and wretchedness of the poor creatures who, after seeing all brought up who could be saved, did not behold amongst them the husband, father, brother, or son, they sought.

After the blasts of explosion had in some measure subsided, and the shafts became more clear from the smoke and dust which issued through them, a number of intrepid and humane people volunteered to descend in order to ascertain whether any more could be found in existence. But after several fruitless attempts, during which they suffered the effect of another partial explosion, and run great danger of suffocation from the overwhelming quantities of choak and fire-damp, they were compelled to ascend without being able to afford any consolation to the distracted people who anxiously waited their return.

Despair now knew no alleviation; and those who could not number their relatives amongst the few saved gave way to the most distressing and melancholy grief. Still when the first emotions had subsided, and the mind became absorbed in the fixed gloom of its anguish, hope presented one forlorn ray in which to venture another trial. This, however, was unavailing; when, insensible to the firm philosophy of stronger minds, they turned the poignancy of their feelings into distrust and imputation upon the proprietors and viewers of the mine.

Notwithstanding this, the owners, after willingly offering to adopt any means which might be suggested as best applicable to the distressing circumstance, were compelled, when the mine had remained three days in a state of complete suffocation, totally to exclude the atmospheric air, and thus extinguish the fire. In two days, however, the immense weight of clay and other materials thrown into the pit, and suspended by ropes and scaffolding, broke from their hold and precipitated to the bottom; a second scaffolding was erected which shortly shared the same fate; but the third which was made upon a more substantial principle answered every purpose, and continued to exclude the air until the mine was reopened.

This was effected, after a variety of preparations, on the 7th of July. On the pits' being pierced, one of them emitted a thick volume of vapour which gradually diminished in its force and blackness, and by the following morning had so much decreased as only to resemble a stream of smoke. Here again another scene of misery and distress presented itself: for, notwithstanding the time which the mine had been closed, the remembrance of some instances where men had subsisted for thirty or forty days upon candles and horse-beans, led many to believe that their relatives might still be restored to them. They assembled in great numbers in the hopes of a miraculous deliverance being effected; some out of curiosity, some from their sufferings, and others to create distrust and confusion, by acrimonious and malignant observations, formed a numerous but wretched assemblage.

Early on the morning of the 8th of July, one of the pits was descended by Mr. Straker, one of the viewers, and Mr. Anderson, with several other persons, for the purpose of examining the mine, and to ascertain whether any of the poor sufferers had by the remotest possibility preserved their existence. The dreadful dislocations which nature had sustained, the dreary and terrific aspect of all they beheld around them, united with the horror-inspiring remembrance that they were in the tomb of death, gave a transient chill to their imaginations; and intrepidity appeared faultering under the united effects of fear, darkness, and doubt. At length one body was found, which increased the horrors of their situation; and the speechless agony of their minds for some time paralyzed all exertion: but in a short time they were animated to proceed. The body was put into a coffin, a supply of which had been lowered down the shaft, and was drawn to bank * from above, the sad prognosticator of what was to come.

But the misery of this scene was not confined within the bowels of the earth; it had extended its range far in the neighbourhood. What must be the sensations of a humane mind on beholding ninety-two coffins piled in heaps at a joiner's shop, and conveyed from thence in cart-loads to the shafts of the mine? On their approach the shrieks and lamentations of the women and children was truly distressing; but grief had now become too strong to waste itself in expression. A silent, fixed, and wretch-

* *To bank* signifies the act of ascending from the pit to the surface, or sending any thing from below to day; thus, if the gas in a mine is excessive, and rushes up the shaft, the miner describes it by saying, " *she came out to bank.*"

ed gloom absorbed all speech, and the mind recoiled from the contemplation of dead bodies; many of them returned to their houses, while the remainder paced in solitary anguish near the pit. Such indeed was the effect of explosion and putrescence,* that few of the bodies could be identified by their relatives, unless some clue existed in their clothes, tobacco-boxes, or other collateral assurances.

It was not until the first of September that all the bodies were found; and to describe the numerous instances of horror, of mutilated beings, and distracted families, which occurred in the mean time would be impossible. Suffice that, to those who delight in wandering through fields of desolation, through the gloomy darkness of earth's deep caverns, and amidst the martyrdom of human life, this was indeed the sepulchre of contemplation. Masses of rock hurled in every direction, waggons shattered and twisted in every shape, mutilated horses and dead bodies in every di-

* The state of the mine after the explosion, and after the atmospheric current was excluded, must have been horrid; for the oxygen would be entirely consumed by the inflammation of the gases, and leave the pit filled with nauseous and expanded volumes of choak-damp and hydrogen.

rection, were the subjects which convulsed nature had provided.

A more detailed account of the proceedings of this event will be found in the Philosophical Annals of Dr. Thomson, who has not failed to give publicity and strength to every circumstance which has a tendency to amend the evils, and draw the public mind into commiseration with the unfortunate sufferers.

The cause of this accident, like many others, remains doubtful; but there is little reason to suppose any other, than that it was occasioned by a contact of lights with the fire-damp or carbureted hydrogen gas.

The above explosion destroyed altogether about one hundred persons, leaving forty-one widows, and one hundred and thirty-three children.

### *Explosion at the Harrington Mill Pit.*

On the 10th of October in the same year another destructive explosion occurred at the Harrington Mill Pit, situate about five miles from Sunderland, which destroyed twenty-four men and boys.* This accident, it is pretty well ascertained, was occasioned by the lights.

* It was in this mine, and near to the spot where the

In stating this explosion, it occurs in common justice to humanity to mention the exertions of Mr. Patterson, an engineer to the mine, and Joseph Gleghorn, one of the workmen, who immediately after the first burst of the inflammable thundering, descended the pit, and by the promptitude of their measures, and the activity of their dangerous exexertions, saved many poor creatures from a miserable death.

*Explosion of the Collingwood Main Colliery.*

The next considerable explosion, which revived the remembrance of the horrors and distresses at Felling and Harrington, occurred in the Collingwood Main Pit. This colliery is situate on the River Tyne, a short distance south-west of North Shields, and was in considerable perfection as to its working, and the means adopted for securing it against the accumulation of choak * and fire-damp.

men were destroyed, that Dr. Clanny and myself experimented upon his lamp amidst inflammable air.

* Choak-damp, or carbonic acid gas, is double the weight of common air, which causes it to sink towards the floor and spread in the bottom of the mine: it is fatal to respiration. Carbureted hydrogen, or fire-damp, is ten times

In the case of this explosion, as in many other instances, all precautions proved unavailing and ineffectual, for want of an insulated light. The fire-damp rushed on the candles, ignited, and in a few minutes tore the mine to pieces, by which eight of the workmen were killed, and two severely wounded.

It must here be remarked in corroboration of the evidence that, notwithstanding the utmost perfection of the ventilating system (at present attained), no security can be permanent if the possibility of communicating ignition to the carbureted hydrogen gas exists; for, in this instance, not only the proper avenues to the workings, but the current of ventilation, were obstructed by means of a sinking in of part of the mine.

This by the miners is denominated a *creep*,*

(and upwards) lighter than atmospheric air, and ascends to the roof of the mine, having the purer air between it and the choak-damp. But although they rise and fall according to their specific tendencies, it does not follow that they remain unmixed, but it is most probable that they are liable to mutual penetrations, which are produced in a greater degree when worked upon by an active agency, and, we may naturally suppose, are lessened in the absence of an evolutionary power.

* When working one of the seams in the Harrington Pit, a *creep* of this kind occurred, which caused a rent

and is occasioned by the pillars, left for the support of the mine, giving way, or forcing themselves into the clayey stratum underneath. An obstruction of this kind drives all the fire and choak-damp from that part of the mine where it happens, to other parts, where it accumulates in great quantities; and if a candle happens to communicate with the fire-damp, the large portion of it, and the mass of choak-damp which expands by its inflammation, produces the most destructive consequences.

Many people are frequently suffocated after an explosion by the carbonic acid gas, or, as termed by the miners, *surfeit*, or *after damp*. This is powerfully expanded during the inflammation of carbureted hydrogen gas; and as the carbureted hydrogen on explosion immediately collapses into half its original bulk, the choak-damp, being expanded and agitated from all quarters by the heat, substitutes the partial vacuum, and in fact constitutes for a time the only vapour in the mine.

When a mine is at work, all the old workings are closed by trap doors,* having boys,

through the whole upper strata and alluvial earth to the surface, though near 100 fathoms in thickness.

* These doors are of different dimensions, according to the situation they are in, or the necessity of admitting

"trappers," to open them when necessary. This is to prevent the accumulations of inflammable air contained in those parts from breaking upon the miners. But when the convulsive power of an explosion demolishes these doors, every secretion is opened, and every collection of gas liberated, and either produces second, sometimes third explosions, or overcomes all animal respiration, by the suffocating effects of the carbonic acid; so that unless the pitmen who happen to be in a distant part of the mine can obtain a sufficiency of atmospheric air, they are suddenly and unexpectedly enveloped in the vapour, and suffocated under all the agonies of their situation, under the despair of being for ever cut off from their wives and families, and under the conviction that they are the martyrs of neglect and prejudice.

Scarce had the public feeling subsided on this dreadful calamity, when the meteor of misery was lighted up in another part of the country, and humanity again stigmatized by its own inactivity.

horses or only men. Some of them, which Dr. Clanny and myself passed through, were not much above three feet square, made tolerably strong, and to fit close in the frame.

*Explosion at Fatfield.*

Several minor explosions had occurred at different periods in the mines at Fatfield, a small village pleasantly situate on the banks of the Wear, about nine miles from Sunderland, by which a number of men were killed.

Notwithstanding these repeated accidents, and although Dr. Clanny's lamp was then invented, the facility with which other workmen were found caused the old course to be pursued, and the system which so fatally demonstrated its insufficiency still to go uncorrected.

Thus on the 28th of September, 1813, prejudice was presented with another sacrifice of human life, by the destruction of thirty-two men at this explosion; thus was England deprived of a portion of her subjects, and the surrounding society again involved in distress by the calamity, by the misery and want, of families, and by the wretchedness which every where presented itself.

In other respects no care or caution was wanting in the working of the mine: the old workings were well secured, and the ventilation comparatively good; but a stone falling from the roof carried along with it a quantity of fire-damp, which, coming in contact with the candles of the miners, immediately exploded, and communicated through the whole region. What further proof can be necessary that many lives would be saved if the lights were secured from such contacts; and as the means of such security is discovered, society ought not to rest until they are adopted.

Imagination, when unassisted by scenery, cannot sufficiently impress upon the mind the effect of these occurrences. I will, therefore, repeat the description of this explosion, as given by a lady who took an airing in the vicinity of the mine shortly after it took place.

Having proceeded within about a mile and a half of the mine, she alighted from her carriage and walked the remaining distance: in a short time the painful scence of wretchedness presented itself, and on approaching nearer she beheld several houses having their doors open and filled with mourners but just returned from following some poor sufferer to the grave. They appeared neatly clad in the sable tributaries of death, and were sitting around their tables silently cherishing the anguish of their hearts. Being at a loss to find the mine, she anxiously sought some habitation which misery had not altogether occupied, in order to be directed in her way; but the work of destruction had been too extensive, and if expectation for a moment gained hope from the appearance of a closed door, it was soon converted into horror, to see it open and let out other processions of death.

At length a young woman came up and inquired whether the lady wanted any thing: on being told that she wanted to find her way to the mine, but was fearful of asking on account of their melancholy engagements, the girl pointed to the road, and immediately burst into tears. Can the human mind contemplate this, and see in it only a small portion of the misery these calamities have occasioned, without feeling how imperiously every individual is called upon, as a Christian and a fellow creature, to step forward and avert the danger which still impends over the miners.

But as those who are not well acquainted with a coal mine will be at a loss to trace the different operations alternately alluded to, it will not be uninteresting to introduce a detailed account of its interior, and relieve the imagination for a time from reflecting upon these multiplied calamities.

To approach the subject however through its respective gradations, and to account, as far as the evidence at present before us will enable me to do, for the existence of the minerals which abound in the earth, and which constitute the original temptation to mining, I have briefly canvassed over the theories of the most eminent naturalists and geologists, with such observations as are suggested by my own judgment.

# CHAPTER VI.

*The Theories of Burnet, Descartes, Whiston, Woodward, Buffon, and others, on the original Formation of the Earth, and the Causes of Stratification, &c.*

THE theory of the earth and of stratifications having of late become very extensive, it may not be uninteresting to digress a little into the more general information upon this head; as the coal strata form one amongst the innumerable mineral productions, for which theorists have so much difficulty to account.

Out of the many different theories which have been advanced relative to the origin of rocks and stratifications, it is almost impossible to decide upon any one as firmly conclusive in its evidence.

The latitude which has been given to supposed causes, and the immense chaos of conception which presents itself to the imagination of a theorist upon earth, has not failed to produce some extraordinary works upon this important subject; and we are still bewildered by the contradictory evidences which arise from the different theories.

Burnet, who wrote about the year 1680, endeavoured to assimilate the formation of systems with the doctrines of Scripture; and so shaped his arguments that no evidence might militate against Creation being the work of a great and omnipotent Being.

He supposed that the earth in its original form was smooth, and devoid of the irregularities which now exist; that it was of a spherical shape, and formed a solid incrustation over a fluid mass within. He then goes on to account for the irregularities which have subsequently existed, as arising from the general deluge, which, according to his theory, was produced by the heat of the sun penetrating the surface and, expanding the waters within the incrustation, caused them to rush out in immense torrents and form our present oceans; that this revolution having produced partial vacuums, the outer shells fell in, and by this means our present mountains, hills, and valleys, were made.

The theory of Descartes was very similar to that of Burnet; but the probability appears so very distant, and the imaginary evidences upon which it is attempted to be substantiated are so irreconcileable with the common contemplation of the subject, that, however we may admire the fertility of imagination and conception in the ideas of these writers, it is difficult to consider their ideas as sufficiently corroborative of the fact.

Whiston and Dr. Woodward follow much in the same train of argument with Burnet and Descartes; the former making some difference in the relation of his theory to Scriptural passages, and the latter differing with Burnet upon the principle of the earth's regularity and smoothness: for though Burnet ascribes the origin of rivers to aqueous condensations in the polar regions, Dr. Woodward endeavours to prove that the rivers could not exist without the presence of mountains.

The theory of M. de Buffon is not supported by the reasonable suppositions and moderate evidences of the former, but combines such an irreconcileable number of improbabilities, that it is almost impossible to give him credit for any thing more than having in this instance liberated his imagination to the most unbounded extents of both time and creation; and yet Demaillet was of the same opinion.

M. de Buffon supposed that, at a period as far back as 75,000 years, a violent concussion took place between the sun and a comet, by which a considerable portion of the former was struck off and carried into the regions of space, and being in a red hot liquid state disunited, became cool, and formed into the several planets.

It does not appear however that the earth, as one of these planets, became cool for 20 or 22,000 years; and that condensation of water did not take place until the end of 25,000 years, nor was it completed until the further elapse of 10,000 years; after this he allows the creation of shell-fish, and that the various strata of the earth were formed in the bosom of the waters. At the expiration of about 50,000 years, he supposes the waters to have receded, and the valleys to have been occasioned by the different currents which carried on a regular system of calcareous formations, and formed the alluvial beds from the attrition of their operations. He dates the creation of man about 6000 years back, and accounts for the existence of animals by supposing a quantity of living atoms capable of producing new species, and of perpetuating those already in existence.

This theory certainly appears extravagant, and yet such is the field for imagination that several other eminent philosophers and naturalists have entertained similar notions.

Mr. Kirwan is of opinion that the globe to a certain extent was originally liquid; and that the different mountains and rocks, both stratified and unstratified, with valleys, &c. were produced by the evolution of the earth upon its axis, when its upper menstruum was in a state of solution.

Dr. Hutton does not appear to give any elucidation as to the manner in which the earth and sea were originally produced, but ascribes the formation of hills and valleys to the perpetual operation of rivers and currents in general, which carry along with them the soil, over, and through which they pass, and ultimately lodge it in large accumulations in the ocean, which become consolidated into strata by the action of subterraneous fire.

Every day certainly presents us with innumerable instances to prove the operation of water upon the soil through which it passes, and the encroachments made upon one coast, while, by the same process of nature, simultaneous lodgments are made upon another; and if we consider the perpetual revolution of the earth upon its axis, and the effect of the immense bodies of water which are continually rolling about, from the equator to the poles and from the poles to the equator, we shall be less astonished at the idea of long periods of time producing wonderful and sublime changes in the appearance of our planet, and in the nature and form of its rocks and stratifications.

The theory of Dr. Hutton is further corroborated by the alluvial formations in many parts being of different constituent materials; some spaces of them being hard, calcareous, and rounded, while other parts are in their native roughness; others are partly deprived of their angular edges, and become in some measure rounded, though partially as if brought from graduating distances, inferior to the distance from whence the rounded pebbles had been brought.

Besides these theories we have those of Bertrand, Humboldt, Werner, Saussure, Cuvier, and Bakewell, and lately some very interesting papers have appeared in Thomson's Annals, written by Mr. J. B. Longmire, on formations and their different phenomena. Mr. Longmire has classified the primitive formations under new names, according to their being stratified or not; calling those formations which are not stratified "concrete," and those that are stratified, of the primary formation, "concrete earth, stone," or whatever other matter of which they are formed.

The eminent French naturalist Cuvier enters very minutely into the examination of the organic system of nature, and ascribes the different formations of the earth to the united operations of fire and water. He is clearly of opinion that the whole of what Werner describes as secondary formations* has been formed since the creation of fishes or animals, and that the primitive rocks were formed before the animal creation. In support of this, he advances the fact of the primitive rocks not having any organic remains or impressions of shell-fish in their strata, and the obliquity with which they pass under rocks of the secondary formation. He explains the manner in which thaws and rains operate in forming

* "Primitive" and "secondary" are names given by modern naturalists, according to the Wernerian system. The primitive formations are those devoid of organic remains or marine impressions, and are considered as being formed antecedent to the secondary, which are characterized by organic remains, marine impressions, and vegetable matter.

new alluvial matter, and with rivers, in the progressive course of time, change the forms of rocks, of coasts, and valleys.

The ground of this theory appears to be more generally supported than any other, and at once opens to the imagination a striking and wonderful sublimity in the plans of nature. If we contemplate the slow, though progressive revolution of systems, if we unite with them the frequent and extraordinary effects of volcanic eruption, the mind is lost in its ideas of an original Creation, and calculates in vain to discover the embryo of Nature.

We can only depend however upon our own powers of judgment, and the additional means of evidence which are furnished us, for the reconciliation of these theories to our individual suppositions.

It appears most probable that the different strata have been formed by the mutual cooperation (under various circumstances) of decomposition in the internal laboratory of nature and volcanic eruptions; that subterraneous fires forced a passage through the superincumbent strata, and created a series of formations by the lava, which, descending from the crater, or mouth of the volcano, formed into pyramidical laminæ: supposing these eruptions to have been periodical, depositions of alluvial matter, which in some cases might by compression become concrete and consolidated, would take place, and produce alternations of soil and strata.

It is observed in many mountains, particularly the Brocken mountain, in Hartz Forest, Lower Saxony, that the bed which forms the base of the strata in the surrounding valley is at the summit the uppermost stratum. This is supposed to be occasioned by a subterraneous matter, intensely acted upon by heat, having forced its way through the several strata when in a liquid or tangible shape, and thus caused the elevation of the lower stratum, and rent the upper ones asunder. This will be better understood by laying four or five elastic planes one upon another, fastened down at each end, and then force a conic substance underneath up the centre, until the point breaks through or penetrates the whole of the planes.

Is it not however equally probable that an eruptive mass might for a time accumulate itself into a conical mountain; that by becoming cool it would concrete until its central region was again dissolved by heat, and emitted fresh eruptions of lava, forming new layers round the original cone, and so, by alternate cessations and eruptions, produce many and different substances? This is the more probable from the extremities being thinner and more shattery than almost any other part. These alternating strata have in general the remains of shell-fish imbedded in them, from whence is deduced an idea of their having been originally horizontal; but, according to the theories of Burnet, Descartes, and Demaillet, these materials might have been deposited during the earth's immersion in water, so that what would be contradictory in one theory is reconciled by another.

But as it is not my intention, or the object of this work, to expatiate fully upon the origin of rocks and minerals, I hope the explanation of such parts as relate to coal will be found satisfactory, according to the information we have upon the subject: I shall now therefore proceed in what relates to it alone.

Whatever were the original causes of the stratifications within the earth, it is certain that they possess an astonishing resource of different minerals and fossils, in which the researches of chemists and mineralogists are daily discovering some new principle—some new cause for admiring the wonderful works of a great and beneficent Creator.

These valuable productions of nature gradually drew the attention of mankind to explore the inner regions of the earth, and accelerated the progress of mining to its present state.

# CHAPTER VIII.

*Right of Digging for Coals.—Mode of Tenure.—Sinking of Mines.—Method of Boring, &c.—Draining.—Process of Mining.—Description of Workings.*

HAVING thus delineated the various opinions in regard to the collective and parental formations of nature, and having in a former part explained the causes by which coal is produced, it will be unnecessary to dwell any longer upon that subject. I shall now therefore proceed with the original and individual branch which has occupied so much of my attention.

The right of digging for coals seems first to have been granted to bodies corporate, ancient baronies, and the heads of religious institutions, as we find in the middle of the thirteenth century, from which period a regular history may be traced of their progress. From these grants emanated the collateral tenures by homage or fee, until the extermination of the feudal laws substituted new modes of tenure; and they are now held in right by the lord of the manor, who either lets the working of his mines upon lease, or works them himself; and is liable to be sued for damages in case they are worked beyond the boundary of his surface rights, and by a recent case tried at Newcastle, His Grace the Duke of Northumberland *versus* Grey, it was decided by the Court that the lord of the manor has no right to break through the soil, without first obtaining consent from the owner of the freehold or copyhold.

In many parts of the kingdom the rent is regulated according to the quantity of coals *won* up the shaft; but in the Tyne and Wear collieries the rent is regulated by the quantity of coals led away from the pit, which causes the immense accumulations of screened coals, which are found at almost all the pits in this district.

Mines are generally let upon lease when not worked by the owner, with very express conditions in regard to the interests of the proprietor, and seldom give him any further trouble than the settling or renewing his lease; but as the proprietors are generally persons of considerable influence and intelligence, there is no doubt but the national feature which accidents in collieries have assumed will awaken in their minds a very strong desire to support any improvement which may lessen the extent of these calamities, and place coal mines upon a systematic and respectable establishment.

Too much cannot be said in praise of the Honourable Washington Shirley, and Messrs. Fereday and Smith, who, as extensive coal proprietors, and aware of the injury done to society by old and fatal customs, have laudably stepped forward to encourage improvements, and ameliorate the situation of miners.

It is sometimes very difficult to ascertain where beds of coal are deposited; and before the present simple method of boring was discovered, the proprietors used sometimes to lose considerable sums by erecting machinery, and sinking pits, where ultimately no coal could be found. This in a great measure arose from comparing the different strata near the surface, with the strata alternating down an adjoining shaft, which in some instances may be relied upon; but in case any dislocation or slip has disturbed the uniformity of the strata below, this speculative method may prove abortive.

When a section of the different strata is presented by the perpendicular bank of a river or ravine, the method is still more obvious; but when these advantages cannot be found, a criterion is formed from the general rules of formation. Coal is seldom found under mountains of solid lime-stone or sand-stone; but in ground of secondary stratifications coal seams are more generally found. Water-springs frequently pass through the coal strata, owing to its porous nature, and by this means cast up small fragments which are pretty certain indications.

When the general indications of coal are sufficiently strong to be relied upon, the pit is sunk without further delay; but when this is not the case, boring is resorted to: this simple invention has been long in use, and affords the most effectual method of discovering coals.

Boring is accomplished by means of strong iron rods from three to four feet long, and about one inch and a half square, with a screw at one end, and a matrix at the other, by which the length is increased as the bore penetrates further into the ground. At the bottom of the rods is a chisel about 16 inches long, and at the top the upper rod is fixed into a piece of timber to give weight to the fall, and to enable the workmen to produce a rotary or boring motion, by which method the bore penetrates through the hardest stratifications, and on fixing a kind of scoop to the lower end, the pulverized matter is brought from the bottom, by which means the nature of the strata is discovered. It is usual to bore three holes in order to certify the uniformity of the strata; and these being made, where the shafts are afterwards sunk, serve as draining sluices to carry the water down the mine.

Some objections are made to this method, from its not being able to bring any thing up of a more substantial nature than pulverized coal or dust, mixed with water, which might be fritted off from some casual layer of coal in the passage of the bore; but it does not appear that any very great inconvenience results from this.

Mr. Ryan has however invented a method by which whole blocks may be severed from their stratum and brought to the surface, which, if applicable, would certainly be a great improvement.

The mines are drained by means of subterraneous sewers cut from the lower stratum to some practicable level, and thence carried off: otherwise, when no level can be found, by means of engines * to draw it up, through a

* Water-engines for coal mines were invented by a predecessor of the first Earl of Balcarras, who had a patent for twenty-one years from James VI., anno 1600. *Brand's History of Newcastle.*

shaft sunk for that purpose at the lower end of the dip.

When a seam of coal is in work which happens to be above another some time worked out, the waters are easily drained off by suffering them to descend and accumulate in the old wastes of the lower seam; and it is this circumstance which renders it so necessary to have correct records of the boundaries, as should they be broken through, the adjoining mine is deluged and the workmen drowned.

During the progress of cutting a shaft through the soil to a stratum of coal, machines are erected above the pit, and every apparatus provided which may be necessary to the ultimate process. When digging commences in a district where no pits have before been sunk, the change of aspect is surprising: the immediate vicinity is soon covered over with machinery, huts, and different habitations, and the country intersected with staiths or waggon-ways.

The miner, having come to his stratum, digs first to the bottom, and then proceeds to work his way through it; in the higher seams the coals are drawn by horses from the hewers to the shaft in sledges, and in the lower ones they are drawn in the same manner on *trams*,*

* *Tram* is a kind of basket made very large and strong, and fixed on a sledge for the purpose of being drawn.

pulled with two small cords by a boy before, and pushed on by a boy behind.

It has before been stated in what manner the coal-seams alternate at different depths under one another. When the shaft is sunk far enough for the first stratum, the working of it is proceeded upon, but only in a partial degree, as it is found necessary to intermix the coal from the different deposits before they are sent away for consumption. Having worked a passage in several directions, and established the rudimental basis of a mine on the one seam, the shaft is carried down to another, and so on through the whole course; at the same time staples are sunk in different directions from the workings of one seam to the workings of another. These are a kind of smaller shaft, or well, for the purpose of facilitating the works of the miner, and to regulate the currents of atmospheric air, so that it may traverse all parts with ventilation: in consequence of this the staples are generally at the head of a working, or otherwise close to a

An ingenious plan has lately been introduced into a mine near Cheney Row, by Mr. Patterson, an engineer. By this plan several horses are dispensed with, and the sledges are worked to certain distances by means of machinery affixed to the steam-engine on the surface.

stopping, which prevents the air from passing, and drives it down the staple.

The shaft is a perpendicular drift, being sometimes made semi-elliptical at the mouth by means of boards; a few yards down it becomes perfectly circular, and is in general from eight to ten feet in diameter. It is cased by stone walling for about eighteen fathoms down, or until the stone work can rest upon solid rock, when it is continued by being cut through the consolidated strata, and opens to the workings of the mine through strong arches. On getting to the bottom of a shaft the appearance is truly grotesque and dismal; rugged roofs supported by pillars or walls left for that purpose, and just shown by the miserable light of a miner's *low*,* is all that exists for examination.

In some parts the workings are very low and narrow, compelling the miner to creep through them; in other parts they are sufficiently high for a person to walk erect, and are frequently enlarged by sinkings in of the stratum or shale above, which is afterwards

* The *low* is locally a very small candle, which the miner fixes in a piece of soft *clunch* or clay, and carries between his fingers, on his hat, or fixes on the coal, according to circumstances.

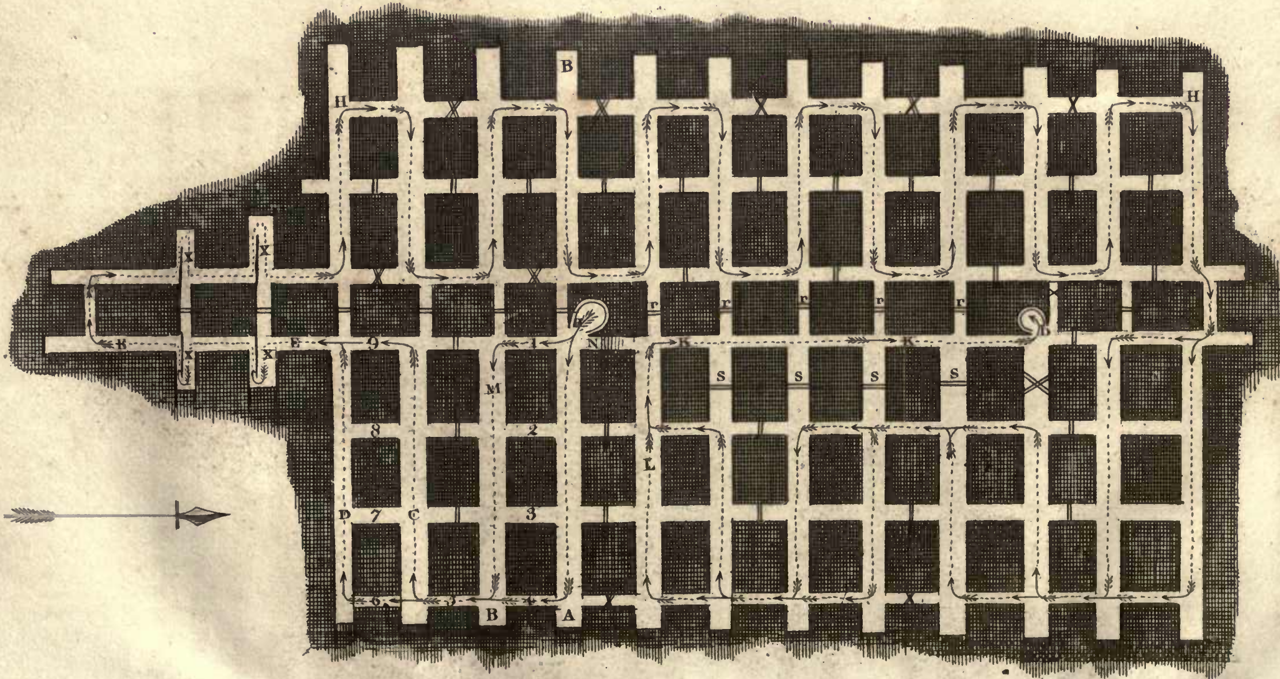
removed or piled up in walls for the support of the mines. This produces many curious specimens of natural roofs and domes, according to the fall of the upper stratum. In some parts there are large areas propped up by great numbers of wooden piles, which not unfrequently appear bent or cracked in the middle from the great pressure of the upper strata.

The ordinary mode of working a mine is in parallel passages called boards, about four yards wide and eight yards asunder. These are connected by headways, which are smaller passages, at right angles to the former and twenty yards apart, thus leaving strong pillars of coal to support the roof of twenty yards by eight. The headways and boards are drawn at right lines through the whole extent of the mine.

# CHAPTER IX.

*Present System of Ventilation.—Its errors.—New Methods by Mr. Ryan, and Lieut. Menzies.—Steel-Mills.*

AS the seams of coal generally extend a great way in their natural inclined or horizontal position, a great number of workings, or as they are termed "boards or gates," progressively branch out from one another so as to form an immense number of dark passages, through every one of which, while working, it is necessary according to the present system of ventilation that a current of air should pass, in order to carry off the accumulations of vapour or fire-damp. This is accomplished by means of a stream of air which descends the downcast shaft, and passes through the workings until it finds the upcast shaft through which it ascends. It is usual to have a large furnace within about twenty yards of the upcast, occupying the lower half of an enlarged working, and always kept up to a certain standard of heat. The other workings of the mine are so formed as to concentrate just before they come to that in which




Middlemist, Sc.

Workings of a Mine to exhibit the method of Ventilation.

the furnace is kept, and by this means the current or draught of air is accelerated through the mine, from the downcast towards the upcast shaft.

When the coals are hewn out of a board, and its remaining open can answer no immediate purpose, it is usual to close it by stoppings or folding doors, so that the current of air may pass on to other workings.

Mother-gates are the principal workings which branch from the shafts in right lines, running south, east, north, or west; but as a better idea will be formed of the system now in use by a sketch representing the principal workings, &c., I have availed myself of one introduced by Mr. Buddle in his pamphlet on the Ventilation of Mines, and which delineates the method invented by Mr. Spedding of Whitehaven, to whose memory the owners of mines are much indebted for his ingenious discoveries. (See Plate IV.)

The double lines ═══ show the air-stoppings, or doors erected for the purpose of preventing the air from passing into any working when not necessary. The single lines —— show the brattices, and the darts ↳ ⟶ and dotted lines.......

the current of air passing from the downcast shaft through the mine to the upcast shaft where it ascends.

*a* the downcast pit, *b* the upcast pit, *a A* the east mothergate, *B a* the west mothergate from the downcast pit *a*. By tracing the darts it will be seen that the current of air from the bottom of the downcast pit *a*, first passes along the east mothergate *a A*, and the adjoining south board *M B*, to which it has free access through the holings or walls, 1 2 3 4: it then passes through the holing 5, called the air-wall, into the boards (workings) *C D*, having free communication between them by the holings 6 7 8 and 9.

After passing the boards *C D* it enters the head-ways *E E*, in going along which it ventilates the boards *F G* by being forced into them by the brattices *X X X X*, when the current of air sweeps the boards by two and two as above described: this is called double coursing; but when it is thrown down one board and up another, as it is from *H* to *H*, it is called single coursing.

The remaining part of the ventilation back to the east mothergate *a A* is in double courses. The current of air is at last discharged out of the first board *L*, north of the east mothergate *a A*, into the headways *K K*, along which it is forced by the boards and stoppings *s s s s*, and the stenting stoppings *r r r r r*, to the bottom of the upcast shaft.

Should the main stopping *N* be blown out, every working of the mine would be left unventilated, except the headway *K K*, along which the current of air would pass directly from the downcast to the upcast shaft. Nor could this be remedied until the stopping *N* was replaced, leaving all the workmen in other parts of the mine, particularly where the fire happened, to be suffocated by the choak and fire-damp.

It may be necessary to remind the reader that this plate is merely sketched to elucidate the lines of ventilation according to the present system, and the variety of boards or workings, as it would otherwise carry with it too great an appearance of regularity and precision.

The floor of the mine is one continued course of rugged substance, and, when passing from the downcast shaft towards the upcast shaft, continues to ascend according to the rise of the coal stratum: its sides and roof are equally rugged and irregular, and the whole presents the most solitary and dismal aspect possible to conceive.

By means of the foregoing system, ventilation is now carried on through a mine in such force as to drive off great quantities of inflammable air; but it sometimes and frequently happens that the gas collects too rapidly, and exceeds its proportion of atmospheric air until it attains the firing point, when, should the flame of a candle be introduced, the carburetted hydrogen in combination with common air immediately explodes; so that the greatest danger at all times to be feared is the light.

The distance between the shafts is from one-half to two-thirds of the working; and according to the mode of coursing the air, as in the present system, a space of five hundred yards square, having the current of air passing up and down its workings, would require the ventilating medium to traverse eighteen miles. The different methods hitherto used of propelling the air through a mine appear to have been miserably defective. The practice of forming a current by means of a stream of water forced down the downcast pit not only renders one shaft useless, but causes an amazing expense for labour, &c., to drain the mine. The air-pump has likewise been found insufficient; and the method of accelerating a draught by means of a furnace near the upcast shaft is very dangerous, as the furnace forms the lower part of a cylinder, through which the atmospheric and consequently noxious airs of a mine must pass, and frequently explode.

Mr. Buddle has stated in his pamphlet that, in case of danger, the furnace may be extinguished, but I fear the inflammable air would travel rather too quickly, as, exclusive of the men having to scramble to the furnace, a fire like that used in ventilation would require a full half-hour to be extinguished. The air in the present system has likewise to ascend and descend up one working and down another alternately, owing to the coal strata dipping to the south-east, and by this means suffering the lighter fluid or carburetted hydrogen to be perpetually seeking rents and fissures for accumulation.

Much destruction has been occasioned by reason of the present system of ventilation not being able in its best state to carry off the fire-damp, which accumulates in the breaks or, as called in Staffordshire, "pot-holes" of the roof. The manner of dislodging this is not less singular than dangerous. The part where it accumulates being previously cleared of all the men, except those employed in this hazardous service, a candle is fixed to a pole (this apparatus is called a "fire-line"); and the men, having guarded themselves as much as circumstances will admit, plunge the candle into the explosive mixture, which immediately inflames with a tremendous report, and not unfrequently kills all the men, and destroys great part of the mine. Indeed the number of men lost and injured by these casual accidents is enormous; and, including the great explosions, there are not less than one thousand lives lost annually by explosion in Great Britain, and seven or eight thousand burnt or otherwise destroyed.

From the above circumstances, society have just cause to rejoice at the numerous improvements lately proposed in ventilating mines, and at the indefatigable attention paid to the construction of a secure lantern by Dr. Clanny, and the subsequent attempts of Sir Humphrey Davy, Dr. Murray, and others; in the hope that some of their plans will ultimately lessen the extent of those dangers which have hitherto caused so much destruction.

Whatever may be said of the steel-mills, they are certainly inadequate to the security necessary in coal pits, as the small scorified substances which are visible on the inflamination of carburetted hydrogen gas would no doubt explode from their scintillations, and communicate explosion to the surrounding mass: exclusive of this the steel-mill is extremely expensive, and yields but a very insufficient supply of light.

This instrument has in many cases great advantage over the common *low* or candle, but none whatever to recommend it in preference to the lamps now invented. Its construction is very simple, consisting of a wheel with a zagged periphery which strikes upon common flint, and thus produces whilst at work a continual luminous circle, varying in brilliance or the colour of its sparks according to the prevalence of carburetted hydrogen or carbonic acid.

But if a proper system of ventilation were once introduced, all the danger would be removed; and although Mr. Buddle considers the present system as beyond any further improvement, I have much pleasure in referring my readers to a most ingenious plan by Lieut. Menzies, published in Thomson's Annals, p. 283, April, 1816.

Mr. Menzies has taken up the subject on its proper ground, and endeavours to facilitate the purification of the mines by simple and incontrovertible means rather than by the complicated agencies now in use. He has considered the inclination of inflammable airs to ascend rather than to be compressed; and has assimilated this quality with the general dip and rise of the coal strata.

Upon this principle Mr. Menzies proposes to have the upcast and downcast shafts at certain distances, the downcast being made at the lower end or dip of the strata, the upcast at the upper end or rise, and so regulating the cross boards and workings that every facility may be given to the current of air passing through the mine; at the same time that the workings may be freed from any blower or accumulation of gas, by closing up the lateral doors and stoppings along the rise of the working, and suffering a current of air to take its natural course from below; and instead of having rectangular passages Mr. Menzies has substituted oblique boards, passing between the parallel workings, which, considering the course of the air and the levity of the gases, are much better calculated than any other for carrying off the fire-damp.

I cannot help remarking upon one observation of Mr. Menzies, which, from what I know of him, I think must have escaped his serious consideration. After urging some simple means for forcing out the foul air, he says, (p. 298,) "Why should not operations so simple and so highly important be executed on Sundays, while labour of other kind is suspended." I contend that there is no necessity for such a measure: the coal proprietor ought not, more than any other person, to innovate upon the laws of religion and morality; and I see no reason why operations so essential to their interest, and the security of the mines, should not be performed on proper days.

### *Mr. Ryan's System of Ventilation.*

In the beginning of May, 1816, Mr. Ryan presented a paper to the Society of Arts, with certificates on his system of clearing mines from fire-damp and foul air, and which were referred to a committee of that honourable and learned society.

After the subject had been under consideration for one night, and was adjourned to another meeting, one of the members requested my attendance to hear the question discussed. Through the medium of this indulgence I had an opportunity of seeing Mr. Ryan's system elucidated by experiments before the Society, on models prepared for that purpose. Numerous certificates were read by the chairman from gentlemen of the first respectability in the coal-trade of Staffordshire, and several letters from Dr. Gray, Dr. Clanny, and Mr. Burns, members of the Society for preventing Accidents in the Northern Collieries.

The testimonies produced by Mr. Ryan,

and the efficacy of his system, were corroborated by the personal and highly respectable evidence of the Honourable Washington Shirley, and of several other gentlemen practically acquainted with the subject, whilst the philosophical principles of its operation underwent the most scrutinizing though liberal discussion of the committee.

By permission of the chairman I was allowed to express my sentiments at length upon the subject, and to ask such questions as I thought necessary to be brought before the society. The rejection of Mr. Ryan's plans in the North seemed to indicate that there was some deficiency in them which was not made public, and probably this barrier would not have been overcome even by the multiplicity of satisfactory testimonials which were produced from Staffordshire, had not the prejudices and mistaken interests which coalesce in the North been fairly laid open.

I entered upon the subject as well as upon the comparative systems of Mr. Buddle, Mr. Ryan, and Mr. Menzies, at considerable length; and the committee, feeling the importance and great interest of the question, gave it the fullest latitude, and, after a long sitting on Tuesday evening the 7th of May, it was adjourned to Thursday the 9th.

The system again underwent on this night a long and animated discussion, during which the committee scrutinized every branch of its principle, and ultimately concluded with a resolution unanimously agreed to, expressive of the philosophical principles and superiority of Mr. Ryan's plan over those now adopted, and voting a premium of one hundred guineas as a reward consistent with the sense entertained by the Society of its merits.

On the question being brought forward before the general ordinary meeting of the Society, the gold medal was added to the above premium, in consideration of the great importance of Mr. Ryan's system.

Mr. Ryan considers that, according to the present system of ventilation, much coal is lost from the circumstance of the pillars being left much larger than is absolutely necessary for the support of a mine, in order to give strength to the stoppings, which in the system now used are very numerous, and, according to Ryan's plan, totally useless.

He proposes to work away nearly all the coal, and support the roof by pillars of timber; and in situations where there is no danger from a waste above the seam of coals at work, from buildings, or otherwise, to draw away the supports left at some distance behind the part where the men are employed hewing, and by this means let the mine creep and entirely close the excavation.

His principle of ventilation acts upon the known specific levity of the carburetted hydrogen, causing it to occupy the roof of a mine, from whence he proposes to draw it by appropriating a separate headway or gas tube of about four feet square, communicating directly from the upcast shaft to the most elevated part of the coal seam.

This gas headway he makes the first working in a mine, and carries it through the stratum immediately above the coal; and as the working proceeds a communication is made from the several parts of a mine to this headway, which is holed into at certain distances as the stratum of coal is hewn away. By this means an aperture is always presented to the light air or fire-damp floating on the roof to make its escape; which that it will do, when the gas tube is made into a partial vacuum by the heat of a steam furnace at the bottom of the upcast shaft, is clearly demonstrated. This will be further elucidated by nearly filling a decanter with water and inverting its mouth into a bason filled with the same. Let a long glass tube or syphon pass through the neck of the bottle nearly to the top, and then pour some oil into the water just under the mouth of the bottle: the oil being the lighter fluid immediately ascends to the top; and the air being drawn out of the tube so as to produce a momentary vacuum, the oil immediately rushes down and is discharged.

Mr. Ryan proposes to have the steam-furnace about twenty-five yards horizontally from the bottom of the upcast shaft. He found that in a door fixed at the upper part of a gas head-way where a great quantity of gas was accumulated, an aperture of only two inches in diameter was sufficient vent for the foul air to pass through. There is no doubt but that the adoption of this system, from its philosophical principles, would lead to much improvement and economy in the working of a mine: in several instances this beneficial effect has been produced, and the Honourable Washington Shirley informed me that he supported Ryan's plans merely from motives of humanity, and his conviction of their superiority over any other.

It is much to be regretted that the mines are not under such a state of regulation that improvements might be made in them without the projector having to contend with all the local prejudices and objections of persons immediately connected in their working. Until this is the case we must not expect to see any perfection in mines, as their better regulation depends upon the total removal by some means of the fire damp, which might probably be accomplished by the combination of chemical investigation and mechanical ability.

The Netherton and Buffery collieries in Staffordshire are now ventilated according to Ryan's system, and, from being the most dangerous mines in that part of the kingdom, are now the most secure; but such was the extent of prejudice amongst the viewers and undermen, that all the benevolent attentions and authority of Mr. Shirley were insufficient to procure Ryan satisfactory trials, until he compelled obedience by discharging his men, and sunk a new pit for experiments in the cause of humanity.

Having thus delineated, as far as circumstances require, the internal structure of the earth, the feature which coal wears in this structure, and the interior of a mine, with the mode of working and ventilation, I now proceed to finish the accounts of explosion and other accidents originating from a want of proper management in collieries, and trust the reader will find himself better acquainted with the subject, and proceed through the remaining statements with more satisfactory information.

# CHAPTER X.

*Continuation of Explosions,* viz. *at Felling, Hepburn, Leefield, the Success Pit, the Tyne Main, Sheriff's Hill, and Newbottle Collieries, with the dreadful Inundation of the Heaton Pit, including from* 1813 *to* 1816.

## *Felling.*

BY a reference to the date of the former explosion at Felling, it will be found that scarcely a year intervened before this mine was again visited by the destructive arm of death, which on December 24, 1813, destroyed twenty-three men and boys: exclusive of this, twelve horses were killed, and twenty-one workmen escaped with more or less injury.

Unfortunately there seldom remains any clue whereby to ascertain the exact cause which produces the explosion, as the poor workmen who are pursuing their labours nearest to the point of inflammation seldom escape to give evidence of the fact.

It is presumed however, from a concurrence of circumstances, that this explosion was occasioned by the inflammable air igniting at the crane lamp in the south headway, as many persons, the mine, and materials, were found dreadfully shattered on the outer side of the stoppings, whilst those on the inside were killed by the choak-damp, which rushed in to form an equilibrium after the inflammation of the gas.

In no instance whatever has a stronger proof occurred of the inadequate security afforded by ventilation than in this mine. It was reported to be more perfectly ventilated than any other; but notwithstanding this, one momentary operation of combustible union destroyed all the plans and improvements of the colliery.

*Hepburn*

Was the next mine which exploded, and did not so much abound in the supposed advantages of the Felling pit, being in a very indifferent state of ventilation and abounding with old wastes. The excavated workings were full of inflammable air, and nothing but absolute disregard to common humanity could have induced the owners to work this pit in the state it was in; and although every exertion has subsequently been used to improve the state of its interior, the fate of Felling is a melancholy beacon against trusting too much to visionary securities.

The means of ventilation certainly are now in a very high state of improvement; but the most eminent ventilators will concur in stating that, unless nearly the whole of the fire-damp can be removed, other requisites are necessary for permanent security.

The explosion of this mine * happened on May 12, 1814, and destroyed Mr. Mole, the underviewer, besides ten pitmen, who left nine widows and twenty-seven children in the utmost misery and distress.

There is one part of the workings at Hepburn colliery which has for a considerable time baffled the skill of every person employed; and other parts, which at much risk the owners are enabled to work, cost them about sixty pounds per month in producing a sufficiency of light from steel-mills, which are very liable under some circumstances to produce explosion.

I believe it would be almost impossible to keep any lamp burning in some parts of this mine now at work, as the prevalence of carbonic acid is so very great, that combustion

* For former explosion, see p. 40.

could not be supported. Fire-damp likewise exists in great quantities; and as the principle which generated so much gas still continues to increase the accumulation, there is no doubt but it will cause the working to be relinquished in a very short time.

Mr. Ryan descended one of the shafts of this colliery some time in the latter end of November, 1815, with a supply of atmospheric air to support respiration, whilst he examined the state of its interior, in expectation, from the accounts that had been given him, that the noxious vapours were formed chiefly of the carburetted hydrogen; but the experiment had nearly cost him his life, owing to the immense accumulations of carbonic acid or choak-damp.

### *Leefield.*

On September 9, 1814, another explosion occurred, at Leefield colliery, situate on the Wear, about ten miles south-west of Sunderland. It was occasioned by breaking into an old working, which had long been excavated and formed itself into a magazine of carburetted hydrogen gas. By this explosion luckily no person was killed, though the whole of the workmen employed were much injured.

Unfortunately, however, a second explosion occurred in this mine on the ninth, by which four persons were killed, one of them leaving a wife and seven children, and another a wife and five children, to bewail their untimely end.

### *Heaton Inundation.*

I have before remarked on the great evil which exists in this district from the extent and situation of the old wastes, which according to the present system of management are in every way dangerous; for they either become the receptacles of water, or otherwise fill with inflammable air, and which on being broken into from any other mine invariably prove destructive. It is this circumstance which daily increases the necessity of securing, not only to ourselves but to future ages, correct records of their situation and boundaries, the want of which, and the consequences resulting from the ignorance of them, are strikingly illustrated by the melancholy catastrophe which happened in this pit.

Heaton colliery is situate about three miles from Newcastle on the road leading to Shields, and cannot escape the notice of a person travelling that way, and is one of those worked only by one shaft, which is made to answer the double purpose of upcast and downcast, a system of cruel and inhuman economy which frequently produces the greatest of calamities.*

The depth which the seam in work lay was about one hundred and ten fathoms, and proceeded under the wastes or excavated workings of an upper seam, which had for some time been closed up, and were filled with accumulations of water and inflammable air.

The water, having found some rent or fissure passing partly down the strata which intervened between the two seams, is supposed to have gradually decomposed the remaining distance, and ultimately on May 3, 1815, about four o'clock in the morning, forced its way through the roof of the lower seam, and quickly rose to the height of twenty-four fathoms.

The pitmen, having no means of retreat except the single working shaft, were forced to seek refuge in the higher parts of the mine; but the tremendous deluge which rushed through the yawning apertures met no impediments, and in two days the water had attained the height of thirty-one fathoms and con-

* See Sheriff Hill colliery, p. 103.

signed seventy-five men and boys to eternity, besides destroying thirty-seven horses. But it is to be lamented that even this dreadful sweep did not end the work of misery, as twenty-five widows were deprived of their husbands and the means of subsistence, and about eighty children robbed of their fathers.

I believe the greater part of these waters have since been drained off at great expense, and an immensity of labour. The jury, which sat over the first body found, gave a verdict satisfactory to the management of the mine previous to the accident. It might be good according to the present system, but that this requires amendment, and might be much improved, there is little doubt of.

Subsequently to the above verdict juries have been summoned over other bodies which were found dead in this colliery; and from the evidence produced before them it appears that many of the poor sufferers who escaped to the higher workings must have subsisted for some time upon horse-flesh, candles, and horse-beans, as part of a dead horse was found near them, and but few candles were left, although a considerable supply had been received just before the accident.

## *Success Pit.*

Although the dreadful accident at the Heaton colliery happened at a period so little distant from the present, still it did not end the history of distress; for while the inhabitants of the two counties were yet intent upon the miseries occasioned by the inundation of the Heaton pit, they were roused into increased anguish by the explosion of this pit on Friday, June 2.

The Success Pit is situate near Newbottle, on the left of the road leading from thence to Cheny Row, about six miles from Sunderland, and exploded about half-past four in the morning without leaving any possible means of ascertaining the cause, as every person on the spot where the explosion occurred was destroyed. It is supposed however, from recent examination, to have been occasioned by the workmen breaking into an old working from an ignorance of their proper boundary.

In an instant fifty-four human beings were shattered to atoms, and the thundering of the earth tolled the dismal knell of despair to their unfortunate wives and families; the explosion laid all waste around, and the overwhelming currents of atmospheric air,* choak, and fire-damp, which rushed from every quarter to fill up the vacuum, soon completed the horrors of the scene. Scarce a vestige of the mine in its winning (or working) shape could be found: seams of coal were rent asunder, pillars hurled from their station, and the roof lowered in many places to the floor; a waggon with a team of horses and the driver were dashed to pieces; and out of seventy-two persons employed, besides the fifty-four killed at the instant, and the waggoner, two suffered death by suffocation, and the remaining fifteen were severely hurt or wounded; some of them only surviving until they had reached the surface, when the atmospheric air became too powerful for their exhausted condition.

Thus in the short space of a month one hundred and thirty-two poor beings were awfully destroyed, and near three hundred widows and children left to all the horrors of beggary and starvation.

It is a reflection which makes the humane mind look with indignation on the unpardon-

* A curious account of the effects of air rushing into the vacuum occasioned by an explosion, appears in Phil. Trans. abridged by Drs. Hutton, Shaw, and Pearson, vol. xiii. page 432.

able lethargy of every person concerned in this trade, and of society in not actively proceeding to get such regulations established, and improvements introduced, as would lessen the extent of these accidents; and though the fund established for the relief of sufferers by explosion, &c. may palliate, it by no means extenuates the blame of cruel inattention to the security of the miner. Means of this kind would be much better employed in preventing causes for their application, than in dispensing relief, which must first be qualified by death and despair; and I most sincerely hope, when this publication and the statement it contains have attracted public attention, that government, the society established at Sunderland for the prevention of accidents in coal mines, and of which His Grace the Duke of Northumberland is Patron, and Sir R. Noel President, with the owners, viewers, &c. will mutually concur in adopting plans for the removal and prevention of these accidents.

*Tyne Main.*

Another explosion occurred on Monday the 5th of June, at the Tyne Main colliery, situate near to Gateshead Park, the property of

Cuthbert Ellison, Esq. which severely scorched one man, without doing much further damage.

### *Sheriff Hill.*

On the 27th of July, the Isabella Pit of this colliery, situate about four miles from Newcastle on the road to Durham, exploded, by which ten men and boys were killed.

Another accident of a very different nature happened at this mine in December last, owing to its being worked by only one shaft. The shaft was divided into three parts by means of boards or brattices fixed longitudinally down it; and to prevent them taking fire from the heat of the furnace, which cast up one of these partitions, a current of water was kept constantly flowing down on the brattices: by some means however this was stopped, and the brattices got dry, when they shortly took fire below; the ventilating medium became deranged, and the workmen finding the want of air rushed to the pit: five of them however lost their way, or took a different rout, and were never heard of more; the remainder were saved with much exertion. The brattices continuing to burn set fire to the coal-beds, which continued burning for a considerable time.

Immediately on being made acquainted with this accident, Mr. Buddle the viewer, who I understand is one of the proprietors, hastened to the spot, and too much cannot be said of his humane courage in being lowered down the shaft, although the brattices were on fire, in order to render every assistance in his power.

*Newbottle.*

On Monday the 31st of July, another species of accident, of a very serious nature, occurred at the Newbottle colliery, situate about six miles from Sunderland; and although it may be reckoned amongst those casualties against which there is no guarding, still it shows the extreme necessity of protecting a class of people who are exposed to such manifold dangers.

A new steam engine had been erected at the shaft of this mine, which had just commenced winning, and forms an apex with the Success and Harrington Pits. A great number of persons, principally workmen in the mine, assembled to witness its first operation, when the boiler being overheated, fifty-seven persons were instantly destroyed by its explosion.

## CHAPTER XI.

*On the Means of affording a secure Light in Coal Mines, by Dr. Clanny.—Correspondence with the Editor of the Morning Chronicle, and with Dr. Clanny.*

THE quick repetitions of the latter accidents, and the sensation produced throughout the kingdom by their publication in the newspapers, gave rise to the following correspondence; and every heart must concur with me in paying a tribute of public respect to the philanthropic exertions of Dr. Clanny. He had witnessed the effect of these accidents; he had professionally attended to the sufferers; and, without any other motive than humanity in behalf of the miners, he exerted himself more than six years back to prevent explosions from fire-damp, and has ever since paid the most zealous and friendly attention to their cause; and though the result has not been what might have been expected, still his claim continues not only undiminished but increased. The subsequent inventions have arisen from his exertions in keeping the subject alive; and whatever may be the merit of Sir Humphry Davy, Dr. Murray, and others, it is only just to give Dr. Clanny his due, and leave the rest to comparison.

Society are likewise much indebted to the Editor of the Morning Chronicle, in so readily facilitating the appearance of the letters in his very excellent and independent paper, which contributed in no small measure to awaken the public attention, and agitate a subject so long neglected.

It will be necessary, properly to elucidate the whole subject of lighting the mines, to transcribe Dr. Clanny's paper in 1813 to the Royal Society,* and which I have his permission to do. Previous to his lamp being described to this learned body, it was experimented upon in a very satisfactory manner, by Dr. Wollaston, Sec. R. S., Mr. Allen, F. R. S., Mr. Pepys, F. R. S., and professor Berzelius, of Stockholm.

* Phil. Trans. for 1813, part ii. p. 200.

" *On a Steady Light in Coal Mines, by W. R. Clanny, M.D. read to the Royal Society, May*, 1813.

" The many dreadful explosions of fire-damp, or inflammable air, which have occurred in the extensive and well-regulated coal mines in this district in the course of nine years, during which I have resided in the county of Durham, have often excited my most serious attention; and latterly these explosions have caused the death of so many industrious people, that no individual possessed of common humanity can look on the subject with indifference.

" Though the improved methods of ventilation have been attended by many solid advantages to the proprietors of coal mines, it is nevertheless worthy of remark, that the increased frequency of explosions clearly demonstrates that ventilation in this case has been no preventive.

" Ventilation undoubtedly supplies atmospheric air, but it cannot obviate those inundations of inflammable air (if I may be permitted the expression) which, rushing from the old workings and caverns of the coal mine, overwhelm every thing before them. It is evident that ventilation, even in its improved state, has afforded no relief whatever; and here the apparatus which, *in the first instance,* I have the honour to lay before the Royal Society, will be found to afford a good light unaccompanied by danger.*

"It very frequently happens that accumulations of carbureted hydrogen gas, mixed with atmospheric air, take place in the wastes or old workings of the coal mines; and though much precaution is used for keeping this inflammable air confined to its proper places, by means of partitions and folding-doors, nevertheless, when by carelessness or accident the air comes into contact with any ignited substance, an explosion generally takes place.

"These explosions happen when the pitmen are occupied in heaving out the coal at the *workings,* should they chance to open a cavern of unmixed carbureted hydrogen gas. This gas, for the most part being pent up in a condensed state, rushes from a chasm, and forming what is locally denominated a blower, it suddenly mixes with the atmospheric air of the mine, and, surrounding the lights of the

* See Thomson's Annals, and Tilloch's Phil. Mag. for June 1813.

pit-men, an explosion follows, commensurate with the quantity of hydrogen gas, which is frequently very considerable.*

"The great danger of these explosions, even when every precaution has been taken, is manifest by their frequency, and indeed it may be expected that an explosion will take place by means of a lighted candle the instant that the hydrogen gas amounts to one-twelfth part of the atmospheric air present, and that a similar effect will follow at all proportions from one-sixth to one-twelfth.

"When ventilation, by the methods in general use, is found insufficient to carry off the fire-damp as it arises in coal mines, large pumps are employed at the top of the shaft for that purpose, which are worked by steam-engines. So frequent and instantaneous are the changes in the proportions of inflammable air from accidental circumstances, that it would be impossible at all times to ascertain, by a chemical process, at all parts of the mine when danger is impending; for frequently the greatest differences of proportions exist at the same time in different parts of such extensive works

* The account of the explosions as contained in Dr. Clanny's paper is here omitted, as they are described more fully in the foregoing pages.

as coal mines. In fact, the miners know from the appearance of the light of their candles * when the proportion of hydrogen gas is such as to threaten an explosion; hence they carefully watch each other's candles, that they may desist in time and escape instant destruction.

"The excavations of coal mines are much greater than they are generally supposed to be; in some collieries they are continued for many miles,† forming numerous windings and turnings, along which the pit-men have frequently to walk for forty or fifty minutes before they arrive at the *workings*, during which time as well as when at work, they have no direct communication with the surface of the earth, but are entirely at the mercy of their greatest enemy, the inflammable air. This circumstance *first* impressed me with the idea, that the light by which the pit-men were to work might be insulated.

"I was well aware that no preparation of

* See Observations of J. B. Longmire, on the Means of detecting Carbureted Hydrogen Gas, or Inflammable Air in Coal Mines. *Thomson's Annals*, 1815, p. 332.

† Mr. Buddle, in a letter to Sir R. Milbanke, President of the Society for Preventing Explosions, &c. (See First Report) says that he has known the distance which a current of air has to pass through a mine to exceed thirty miles.

phosphorus could supply a sufficient light for the purpose; an observation equally applicable to the miserable scintillations of steel-mills (as they are termed) which have often exploded the inflammable air of the coal mines.

"I find it needful here to remark that, as far as applies to myself, the idea of insulating the light, and also the plan which I have adopted of carrying this plan into effect, by the construction of the apparatus or lamp, are perfectly original. This lamp may be managed with the greatest care by any boy of common understanding. It is so strong, that should large pieces of coal fall upon it, they cannot in the least injure it. Nor is there any chance of its being upset by any accident, as it may be worked at the very bottom of the mine, and it is likewise conveniently portable.

"The combustion of the candle within the lamp is supported by the ordinary atmospheric air of the coal mine, which is supplied by a pair of common bellows, through a stratum of water below the candle; at the same time a portion of the air, already in the lamp, is driven through another stratum of water above the candle; and thus the air supplied may explode within the body of the lamp, without communicating the effect to the air in the mine, however highly it may be charged with carbureted hydrogen gas.

"The moment the air enters into the lamp it comes in contact with the candle, and consequently, upon all occasions, a *small portion* only of the air can be exploded, instead of the whole contents of the lamp; by this means several obvious advantages are secured. The air, passing in a brisk current from below upwards close by the candle, carries the snuff with it, so that the light is always clear and steady.

"I may also remark that, wherever a person can exist from a sufficiency of atmospheric air, this lamp will afford a safe and abundant light from one candle only, for the space of five hours at least. This lamp will in all probability be found very useful in the powder magazines of ships of war and of forts, as also in those places where gun-powder is manufactured; but this observation is merely thrown out for the opinion of those who are more conversant upon such subjects."

## DESCRIPTION OF THE LAMP.

The plate given with the above paper being different to the lamp in its present modified state,

Fig. 1.
p. 113.

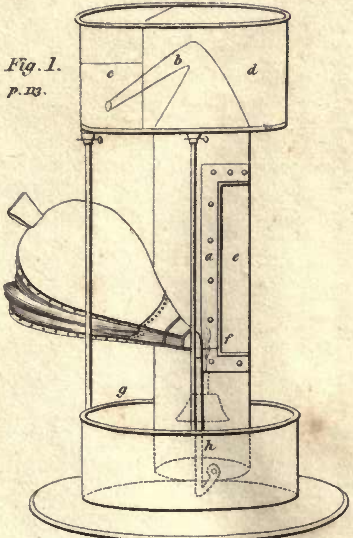


Fig. 2. p. 210.

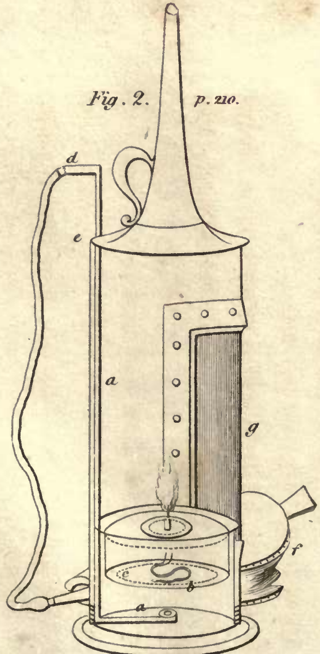


Fig. 3. p. 210.

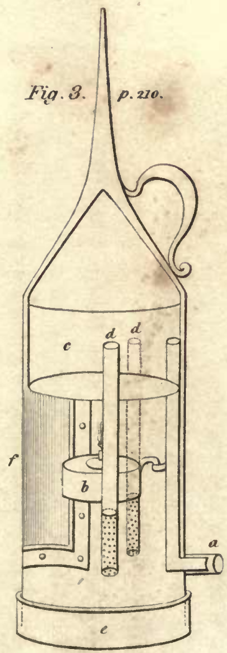
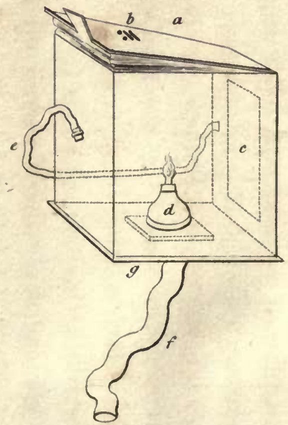
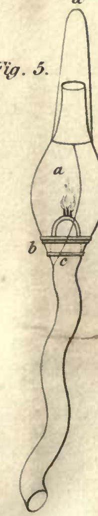


Fig. 4. p. 186.



Mr. Brandling's.

Fig. 5. p. 187.



Dr. Murray's.

Fig. 1. 2. & 3. Dr. Clanny's Lamps.

I have omitted giving a figure on the original plan, but present a sketch upon the improved construction.

Plate VI. Fig. 1, represents the lamp as it now is ready for use.

*A*, the body of the lamp, constructed of copper or block tin.

*B*, a conical tube which carries off the air (deprived of its oxygen by combustion) through the water in the cistern *C*.

*D* is a cistern containing water to keep the lamp cool if necessary.

*E*, the window of the lamp made of very thick glass.

*F*, the candle supported upon a tin stand.

*G*, a cistern containing water through which the air is forced by the bellows.

*H*, a tube from the bellows which conveys air for supporting the combustion of the candle.

An elastic tube may be fixed to the valve of the bellows in case of necessity, by which to draw atmospheric air from any distance to supply the lamp.

No other invention whatever can equal the security of this lamp; and although others may be more applicable, from the necessity of having a person required constantly to work the bellows, still I am of opinion that its great use and security will prevail in the investigation of dangerous mines, indeed in the investigation of all mines, as its portability and other recommendations are now beginning to be approved by viewers and practical men about collieries. I will now proceed with the correspondence which originated from the accidents before described.

## LETTER.—(No. I.)

"*To the Editor of the Morning Chronicle.*

"Sir,

"The melancholy explosions which have recently occurred in the coal mines, and by which so many families have been involved in distress and want by the loss of their principal supporters, induces an anxiety in my mind, to know whether, in any of the mines which have exploded, Dr. Clanny's insulated lamps have been used, as a theoretical knowledge of their construction strongly suggests their great utility in preventing explosions from inflammable air.

"I trust that the general interest which is felt in any subject so replete with public calamity will be an excuse for thus trespassing on your columns; and, as the principal remedy against similar catastrophes depends upon the exclusion of the inflammable air contained in old workings from accidentally bursting upon the lights of the pit-men, and the exclusion of any excessive inflammability which may accidentally occur in the ventilations of the mine, I can but regret that, if they have not been adopted generally, a more extensive application is not made.

"In them the light is perfectly insulated, and cannot come in contact with any air except what is conveyed in by the bellows from the common air of the mine, or with pure atmospheric air by means of an elastic tube. And whatever inflammable mixture may pass through the tube into the lamp, it may explode as it becomes exposed to the heat, without communicating the effect to the air in the mine, however highly it may be charged with carburetted hydrogen gas; as on entering the lamp the air passes from the tube into a stratum of water, and undergoes the same correction in ventilating from above to the mine.

"I have no motive for extolling the apparent advantages of this invention but what would occur to every person desirous of avert-ing a repetition of similar accidents, as those which of late have so extensively occurred.

" 6, *Craven Street*, " J. H. H. Holmes."
" *July* 12, 1815."

## LETTER.—(No. II.)

" *To the same.*

" Sir,

" I have to express my obligations for the insertion of my letter relative to the explosion of coal mines, and which originated from motives of common humanity, blended with a very strong desire to know whether the invention so apparently beneficial as Dr. Clanny's lamp had been used, or whether any effectual remedy had yet been ascertained for these dreadful accidents.

" In consequence of its insertion, two gentlemen waited upon me this morning, who are connected with a society * for preventing accidents of this nature, and for propagating scientific improvements in these subterraneous habitations of man. And as some, although a very inadequate return for your attention, I

* The society for preventing explosions, &c. in coal mines at Sunderland.

take the liberty of exposing upon a broader base the opinions which this information have given rise to; and as it may hereafter lead to a desire on my part to elicit the case through the medium of your excellent paper, I cannot justify myself in common etiquette, without previously acquainting you, what, from mere curious observation, should convert my pen into active exertion.

"By an estimate drawn up from the most concise information that can be had, it appears, that, within the last three years, not less than four hundred lives have fallen sacrifices to explosions; about three hundred to casual explosions and accidents, incident and unavoidable; and three hundred and twenty wives and children (I quote from memory) reduced to parochial dependance, or absolute distress.

"I am not aware that this estimate includes the late extensive explosion which killed above one hundred and thirty people, but those contained in the estimate happen within a circle of not more than ten miles in diameter.

"The prejudices of owners, viewers, and others employed about the mines, have hitherto much cramped the progress of improvement, and precluded any actual observations being made, which might tend ultimately to establish means of safety; but it is to be hoped that the alarming extent of these accidents having now assumed such a national feature of calamity will prepare the legislature for encouraging the efforts of philanthrophy, and enabling persons with sanction and authority to penetrate the gloomy regions of a coal mine in search of experiments, and in the adoption of improvements.

" Villages nearly depopulated, and starving families, are the effects of these disastrous occurrences; and the increase of pauperism in this case must always exceed its due proportion, so long as private prejudices are enabled to frustrate public improvements: and it ought to be considered that the interest or the prejudices of any individual person, or class of people, ought not to militate against the preservation of general equability and public security.

" I write this as a private letter, but subject to your better judgment in regard to any other use. I am informed that a more accurate report, up to the present time, will shortly be obtained, when some active steps will be taken for penetrating the gloom of subterraneity with experimental inventions.

"I have the honour, &c.

"6, *Craven-street*, "J. H. H. HOLMES."
"*July* 17, 1815."

## LETTER.—(No. III.)

"*To the Editor of the Morning Chronicle.*

"SIR,

"A short time after its publication in the Morning Chronicle, I read the letter signed J. H. H. Holmes, bearing date July 12, 1815. Not having the honour of an acquaintance with Mr. Holmes, and being desirous that this humane gentleman, and your readers, should have replies to the queries which Mr. Holmes has made in his letter concerning my apparatus for lighting collieries, I shall with your permission endeavour to supply the requisite information through the same desirable medium.

"Mr. Holmes commences by observing, 'that the melancholy explosions which have recently occurred in the coal mines, and which have involved so many families in want and misery, induce an anxiety to know whether

Dr. Clanny's insulated lamps have been used in any of the mines where these dreadful accidents have occurred, as a theoretical knowledge of their construction strongly suggests their great utility in preventing explosions from inflammable air, &c.'

"My lamp has not been employed in any of the mines in which these dreadful accidents have happened, and I have much pleasure in stating that no accident can occur when it is used in the manner directed: nor is this theoretical; for more than half a dozen of the first philosophers of the present age have seen the lamp experimented upon with inflammable air, and have observed that there was not the slightest chance for explosions occurring in those mines where it is used. Of course I do not consider myself at liberty to publish their names, but shall leave them with you, Mr. Editor, for your satisfaction.

"Since the publication of my paper, "on the Means of procuring a Steady Light in Coal Mines, without the Danger of Explosion,'* I have made some important additions to the apparatus:—1st, The candle may be lighted within the body of the lamp, even in those places where the atmosphere is highly charged

* See page 107.

with inflammable air; and should the candle be extinguished by any accident it may be lighted again in the same manner with perfect safety:—2dly, This apparatus is now so constructed as to be conveniently portable:—3dly, The apparatus may be carried in a train or wheelbarrow, and will, by the circumvolutions of the wheel, supply itself with air for the combustion of the candle, without any person touching it.*

"It is well known that the miserable scintillations of steel-mills have several times caused explosions in coal mines, and these mills are considerably more expensive than my apparatus; for the prime cost is about one guinea each, and I am credibly informed that it requires the constant employment of one workman to keep six steel-mills in repair; while on the other hand my apparatus will last fifty

* The second of these additional improvements Dr. Clanny certainly has carried to an admirable extent; but the first and third have been altered since he became acquainted with the interior of a mine, &c. The rugged and, in some parts, confined boards of a mine are but ill calculated for the circumvolutions of a wheel attached to machinery; and the miner would never attend to the re-lighting by phosphorus. Its present portability however comprehends all advantages.

years, requiring no repair, and the present cost will not exceed two guineas and a half.*

"It has been more than once urged that ventilation properly conducted will do every thing. I grant that by *proper* ventilation several accidents might be prevented. But where is the colliery that is properly ventilated? Independently of this, explosions have generally arisen from the following causes, in which ventilation, even in its improved state, cannot be considered as a preventive; for, from the present state of the collieries, considering their extent and the time they have been worked, the uncertain information as to the extent or limits of old collieries, on all sides, of which no information can be obtained, besides the incertitude which prevails for want of maps and records, no secure plan of ventilation can be followed up in most of the mines in this district; and consequently explosions under the present state of affairs must increase, provided my apparatus be not in use, particularly the following case as hinted at above.

"When the plan of a colliery is abstracted or lost, as I understand to be the case in a

* They are now made of copper for thirty shillings, and may be had of block tin for seventeen.

very considerable explosion which took place a short time ago in this district; when by accident or carelessness the pit-men work into old workings where inflammable air has been accumulating for many years; or when they "hole" into another coal pit containing inflammable air, or open into a natural reservoir of inflammable air, by which a blower is formed; when sudden eruptions of carburetted hydrogen gas unexpectedly mix the whole circumambient air up to the firing point; when the barometer stands below 29°, and the wind is south-east,* the atmospheric air becomes

* The mines and old workings, in some instances, are provided with cast-iron gas pipes, carried from the mine up the shaft to some yards above the surface. These pipes continually give out a very strong current of gas, except when the wind is a little to the north-east, or when round in any point from north to north-west. In this case, instead of the gas issuing up and making the pipes quite warm, it drives down and causes the pipes to be cold. The warmth however may in some measure be accounted for; as the pipe I examined was carried up the upcast shaft, consequently the gas became heated at the bottom near the furnace, and this communicated an excess of heat to the pipe. When the wind is north or north-west, the atmospheric air descends, and prevents the warmth of the lower part from ascending. This phenomenon is owing to the heaviness of the atmosphere in one case preventing the current of gas from ascending, and its lightness on the other suffering it to escape.

too light to sweep off the increased discharge of inflammable air which then issues out of every part of some mines; where the inflammable air prevails between the workmen and the upcast shafts, and a fall of stones or other causes occur to force back the atmospheric current towards the downcast shaft.

" In several coal mines ingenious methods are used for exploding the inflammable air as it accumulates; this plan undoubtedly has much merit, but in the cases stated above, it does not apply so well as we could wish, as it is intended for general principles.

" It is requisite to state that there are three classes of persons concerned in collieries:—the owners, who in general are persons of large property, and for the most part understanding very little of the detail of business, or the method pursued in carrying on their works; the chief viewers and under-viewers, to whom every thing is entrusted; * and the pit-men, or miners, who perform all the labour, and on whom destruction falls. They are a very honest and industrious class of men.† Many

* See Phil. Mag. May 1815, p. 377.

† From the observations I have been able to make on the habits and characters of miners in general, I find them a very industrious quiet people, perfectly subservient in every respect to their viewers or other masters; and

men cannot bear instruction from others, particularly if they belong to another class. Habit, prejudices against any thing which may appear new or upon scientific principle, and self-sufficiency, have had their share in refusing my apparatus for two years, though I defy any man, or any class of men, to find fault with it in any particular.

"And any copper-smith may make a thousand of them at the above price.

"W. Reid Clanny,
"M. D. and M. R. I. A."

"*Sunderland*,
"*Aug.* 1, 1815."

## LETTER.—No. IV.

"*To W. Reid Clanny, M. D. &c.*

"Sir,

"Not having the honour of your acquaintance, I hope I shall be excused in presuming

amongst them there are many who, though illiterate characters, are possessed of much scientific practical knowledge, and wonderful natural ability. If therefore the mines were put under a proper management, and every one enabled to communicate his ideas (which at present they dare not do), I have no doubt but that, whatever improvement was projected, it would be much facilitated by their local information.

upon the publication of our respective letters in the Morning Chronicle, for the reception of this letter, and for the appreciation of those circumstances which have resulted from my first statement. At the same time I must apologize for taking the liberty, unauthorized, of using your name in a public print; but as it was only in such manner as was connected with your own invention of an apparatus which possesses general utility, and ought to claim public attention, I hope my anxiety to question, whether on the one hand it had been used? and if not, on the other, why not? will be deemed justifiable by you, and afford an excuse for the liberty.

" A day or two following the publication of my letter two gentlemen called at my lodgings, who stated that they were connected with a society which had in view the alleviation of accidents in coal mines, and the propagation of improvement for preventing explosions. From them I received an expression of thanks for having in some measure brought the subject before the public: we had much conversation upon this important topic, and they expressed an intention of waiting upon me again when they had received reports from the North, with conclusive information respecting the present state of the mines, and the extent of calamity recently experienced.

"A statement brought up to a late period, but anterior to that, was shown to me, and which, from its alarming extent * of distressed families and individuals, strongly urged the necessity of some authoritative interference. Indeed it appeared in the contemplation of these gentlemen to prepare grounds for a petition to parliament, and which I conceive would be the most proper and most effectual remedy. Still there are many matters to be considered, and many interests connected, in shaping the manner in which this remedy should apply e'er it comes before parliament, as it would be necessary to lay the grounds of a petition upon such a basis that the evidence of no particular prejudice, or any particular interest, should be able fatally to oppose; and this I presume will be best done by showing the extreme necessity of making local prejudices—beyond what are just to be admitted—and private interest—beyond what it is proper to protect—subservient to the general safety, happiness, and interest of the community.

"For, however extensive the fund may be

* See page 117.

which the owners, &c. have provided for the alleviation of distress occasioned by explosion * and other accidents in mines, this says nothing in regard to the sacrifice of human life; and so long as the lives and the social ties of existence (which I presume exist in the breasts of miners and their families as in others) are a subject of national consideration, an anxiety must be felt for their fate.

"This would be better elucidated and produce greater conviction if laid down in a more extensive form than my ability or the length of my paper will allow. Suffice that the destructions which are caused can alone be prevented by the application of such measures as are found best and most certain to obviate accidents; and certainly, as your lamp appears to possess this efficacy, it ought to be a matter of serious public consideration to see it more generally adopted.

"I fully anticipated all the local objections,

* This fund does the owners and agents much credit, as it evinces their humane wishes to ameliorate the sufferings which habit and custom have led them to believe are unavoidable, and strongly induces an opinion in my mind that it only requires proper elucidations, and a conciliation of interests, to unite them in the general adoption of scientific improvements and preventions.

and indeed several unavoidable ones which you quote in your letter, from some conversation I have had with a gentleman from the North, whose ideas and imaginary interest joined with a connexion in some collieries evidently calculated his opinions to give me every information which may be expected to oppose scientific improvements, and to support old and obstinate prejudice.

"The fact is that the greatest extent of accidents which occurs arises from those causes which your lamp is calculated to prevent; consequently it becomes a question whether, because it is beyond the power of human invention to prevent them all, this invention shall be excluded because it will only prevent the greater part.

"I think it necessary, as an apology for any error in my arguments, to state that my information is for the greater part theoretical, which, connected with the youth of my experience, will I trust be admitted in excuse.

"6, *Craven Street*, "J. H. H. Holmes."
"*August* 8, 1815."

## LETTER.—(No. V.)

"*From Dr. Clanny.*

"Sir,

"I was honoured by your letter under the date of the 8th of August, for which I beg to return you my most sincere thanks. I should have replied sooner had not a pressure of professional engagements prevented me.

"I rejoice to find that my conduct has met your approbation, and that so young a person dedicates his hours to the relief of suffering humanity. Before I took the subject of explosion into consideration, the very editors of provincial newspapers were afraid of publishing those accidents lest interested persons might be offended.

"I fell upon a direct method of making these explosions public by procuring their insertion in the Annals of Philosophy, edited by Dr. Thomson; and from this scientific journal they were copied into other journals: and thus originated the establishment of a society for the prevention of those accidents in this town. I beg to draw your attention to the above-named journal, article "Explosions in Coal Mines," and likewise to an observation of Mr. Bakewell, in a late Number of Tilloch's Philosophical Magazine.*

* Mr. Bakewell, in his observations on the geology of Northumberland, concludes his letter in the following terms: "The limits of the present letter will not allow me to enter into the subject of the explosions in coal mines, but I think it proper to add that I perfectly agree with what Dr. Thomson has said respecting the management of these mines, and the too great apathy shown by many proprietors to the waste of human life which annually takes place. I was informed that, in two years, *six hundred persons were destroyed* in different coal mines of the Tyne and Wear. By one explosion ninety-two persons were killed in the mines of Mr. Brandling (Felling) in 1812, and the very week before the first meeting of the society established at Sunderland for preventing these accidents, twenty-three men and boys lost their lives in a pit belonging to Sir Ralph Milbanke.

"At the request of the latter, and the Rev. Dr. Gray of Sunderland, I attended that meeting; but I saw with regret that the good intentions and exertions of the gentlemen most active in its establishment were viewed with jealousy by some of the coal agents and proprietors, as interfering with the rights of private property, and tending to alarm the workmen. By the request of one proprietor the number of lives lost was erased from the resolutions for fear of giving offence. I took the liberty of observing 'that if all had been done which circumstances permitted to prevent those fatal accidents, no one could be offended by a plain statement of facts; and in order to meet the difficulty fairly, and interest the public in promoting the object of the society, it was necessary that

"The gentleman who called upon you accompanied by a friend would in all probability be Mr. Wilkinson of the Temple, (it was:) who has interested himself much, and with him originated the idea of the above-mentioned society. I assure you that nothing can be more dreadful than the present state of our coal mines, and the evil *must* increase. I feel hurt at the conduct of the viewers, as they sacrifice every good principle at the mercenary shrine of self-interest, and willingly see hundreds of their fellow creatures hurled into eternity, rather than encourage any plans which might militate against their pecuniary remuneration.*

the nature and extent of the evil should be fully known.'

"To render the mines secure would be attended with additional expense and labour, but the evil is of such magnitude that if the remedy be not applied it would claim the serious attention of the legislature." *Tilloch's Phil. Mag.*, No. 202, p. 96.

* By reference to the matter of fact, though it must be allowed that new improvements which change the habits of the poor must at first expose them to temporary inconvenience and distress, against which in fairness it is the duty of society to defend them, yet the invariable results of such improvements is always to better the condition of mankind. *Accum on Gas Lights.*

"In Thomson's Annals, Tilloch's Journal, and in all the Reviews which have reviewed the Philosophical Transactions, and in short every journal which has had occasion to mention my lamp, you will find most flattering accounts; at least they have been so to me.

"The question is simply this:—A good diver may bring up an article from the bottom of the sea with risk of his life; but since the invention of a diving-bell, which is not only safe but may be extensively employed, no person who can use the latter plan would ever think of attempting the former: just so with the lamp and the candle, and steel-mill. I have often volunteered to go into the worst parts of a mine with the lamp, but was always referred upon some frivolous pretence. 'Give us this day our daily bread,' appears to be engraven upon the hearts of those whose interest is bettered by a continuation of the danger, as what lessens the fears of the coal owners must, or rather may, lessen the salaries of the agents.*

* However extraordinary this opposition may appear, it certainly does exist to a great and unpardonable degree, as I have witnessed at more mines than one, when the engineers would not suffer any experiment to be tried on the

"Your observations in regard to the establishment of funds for the relief of the families of the sufferers is perfectly correct and just.

"*Sunderland*, "W. REID CLANNY."
"*Aug*. 17, 1815."

## LETTER.—(No. VI.)

"*To William Reid Clanny, M.D. M.R.I.A.*

"SIR,

"I am much gratified by the receipt of your obliging letter of August 17, as it assures me I have not interfered in a subject without the approbation of the parties from whence its cause emanates, and as it affords me additional criterions and information relative to the calamities of subterraneous explosion.

"It is to be regretted that obstinate prejudices and private interests should so extensively bear down improvements tending to the safety of mankind and the amelioration of misery; but so it is, and whether ultimately a good or an evil to society I know not. Suffice, that through almost every gradation of moral

surface, nor any gas to be taken, not because they were themselves averse to improvements, but because as they said, "If we do, we are certain to lose our places."

order this unnatural opposition presents its friendless steep, and can only be overcome in its local operation by awakening the public and more extensive voice of the nation to penetrate the gloom, and surmount the difficulties, which exist in any of its internal parts.

"Explosions in collieries are calamities which must necessarily increase, unless some means are adopted to remove the principle which most extensively produces the effect; and it is a fact which must be obvious to the commonest reason of our nature, that in this instance every day accelerates the growth of danger, and every new coal pit is the port-hole to new calamities. It is a philosophical and a chemical fact,—a common and simple demonstration,—that, as mines increase, the womb of the earth becomes more charged with accumulations of water and of inflammable air. The extent of recent explosions, and the inundation of Heaton, is a proof that all the plans of the present system, all the schemes of the owners or viewers, are insufficient to counteract the inbreak of the one, and the eruptions and explosions of the other.

"I am obliged by the references contained in your letter, and be assured that no exertion of mine shall be wanting to establish the rights of humanity, and to raise the voice of reason and public feeling above the narrower interests and prejudices of those parties who so readily feed upon the danger which hurls hundreds of their fellow creatures to misery and destruction; and if the solicitation, 'Give us this day our daily bread,' applies with a few interested individuals, what multiplied distresses may we see opposing it in contemplating the want and desolation from whence their profits originate.

"6, *Craven Street.*" "J. H. H. HOLMES."

## LETTER.—(No. VII.)

"*To the Editor of the Morning Chronicle.*

"SIR,

"The attention of the public having been drawn to the desolating effects of explosion in coal mines by my letter on the apparent merits and nature of Dr. Clanny's lamp, inserted in your excellent paper on the 12th of July, and by that gentleman's subsequent letter in the same of August 5th, containing answers to my queries, with general elucidations relevant to the application of his apparatus, the causes (generally) of explosion, and the prejudices which oppose the more extensive introduction of improvements.

"I will again beg leave to trespass upon the same desirable medium, in eliciting some further facts upon this subject, and pointing out from the information I have obtained the extensive danger still impended over the inhabitants of the Northern mines, and more or less over every mine throughout the kingdom.

"It is not any personal motive which induces me to rest so much upon Dr. Clanny's lamp, as I have not the honour to possess that gentleman's acquaintance, further than from the correspondence arising from the publication of our respective letters; but from the assurance I feel that no invention yet in being is calculated so greatly to diminish the recurrence of explosion as his insulated lamp, I naturally advocate its adoption upon this principle; and if I may be permitted to presume upon the conclusions arising from his writing, I feel no hesitation in ascribing the production of the apparatus in question, not only to the genius of a philosophical and enlightened mind, but to motives of the most pure and benevolent philanthrophy, which, awakened by the dreadful miseries so frequently occurring in the neighbourhood of his residence, sought to lessen their extent by the discovery of a preventive.

"And yet how frequently it occurs, as in this instance, that while philosophical benevolence is secretly planning for the good of society, local prejudices and private interest are accumulating an almost insurmountable barrier of obstacles and objections, to retard their progress.

"But surely the fatal effects produced by this dangerous principle have now assumed too terrific and bold a feature, not to claim the attention of the legislature, which alone can ensure their remedy, and sanction the introduction of such means as are best calculated to guard against accident, and secure the lives of many hundred subjects and fellow creatures —I mean the legislative authority, which, whilst it wisely regulates the preservation of all public and individual rights throughout the nation, will not, I trust, heedlessly wave its protection over the shafts of a mine, without descending to its more obscure caverns, and securing to its occupiers all the care and attention of a generous and benevolent government.

"It is necessary to consider that the continuation of the risk attending upon the bad state of the mines, and the not adopting some secure means for preventing the fatal effects which result from penetrating old wastes, constitute a great obstacle to the introduction of philosophical preventives, by the enhancement it gives to the salaries of the viewers and other persons employed. But I trust humanity will so far intercede, as to produce an effectual counterbalance to this consideration, from the great encroachments upon human happiness, which is the certain result of its continuance.

"Dr. Clanny, in his letter to me, very justly observes that the calamity must necessarily increase, unless means are generally adopted to secure the lights from the sudden and unforeseen eruptions of inflammable gas; as the mines near Sunderland are in a most dangerous state. It is a fact, which must strike home to the reason of every impartial being, that from concealed inflammability,—from the accidents which may occur to destroy the ventilation,—from the uncertainty in regard to surrounding wastes,—and from the regular accumulation of danger, should be drawn the inference, whether any human caution, unassisted by a counteracting principle of chemical or scientific certainty, can or cannot remove the greater dangers, and reduce the swelling miseries.

"To remove them all is impossible, but

to remove the greater and most destructive part is desirable. The fund which the owners and agents have raised for the alleviation of distress from explosion, &c., is a strong testimony of their humane intentions, and argues that, the minor obstacles to improvement being once overcome, their concurrences would facilitate its propagation. But unfortunately it is not exactly this class on whom proceeding depends, but upon the viewers, who systematically oppose the introduction of invention, or the illustration of experiments; and even the owners must be aware that, although their benevolence provides in some measure for the support of the distressed miners and their families, it does not guard against the terrific havoc of explosions, or the destructive effects of subterraneous inundation; either of which at one effort hurls hundreds to eternity, and leaves a monument of public misery in the irreparable desolation it creates.

"Shall then this honest and industrious class of people be the sacrifices of private interest, or be excluded from the law of protection and the means of security?

"6, *Craven-Street*, "J. H. H. Holmes."
"*Aug*. 22, 1815."

After these letters it almost appears unnecessary to dwell any longer upon the subject; but the ground is new, and society have never before been presented with a complete work upon the state of these extensive coal mines, nor ever before been sufficiently informed of the extent of accidents. Under these considerations, therefore, every thing must be interesting; and the nature of circumstances demand, that a publication, having in view a permanent amelioration to the state of certain branches of the community, should argue every point, and simplify all necessary evidence to the understandings of mankind in general.

There are many very valuable communications and comments upon the subject of coal mines, scattered about in a variety of eminent literary publications; and in them every necessary corroboration will be found as to the similarity of sentiments and generality of opinions in regard to mining and explosions.

Could any individual, who sympathises in the dangerous incertitude attached to the life of the poor miners, seat himself at the mouth of a pit and contemplate the horrors of their life, he would feel an increased anxiety in their fate; and did the remembrance of an explosion at that particular time strike upon his memory, he would shudder in the anticipation of death to those who were enclosed in the dark and dismal cavern he beheld. But did he go still further, and descend this aperture of earth, it would require all the fortitude of nature to refrain from fear, and to examine every thing with calmness and precision. The immense depth, the innumerable windings, and the dark solitary wastes of a coal mine, are truly astonishing, and create a sensation of horror in the imagination. It is impossible under the impression every circumstance gives, and the frequent loss of lives enforces, not to feel great anxiety that legislative interference will at length obviate some portion of the misery occasioned by the taciturnity of persons employed, and the tardiness of proprietors in adopting means of security.

Mr. Farey senior, speaking of mines, thus expresses himself: "The vast importance, both to the owners and the public, of the extensive and curious works which are carried on under ground in these kingdoms for procuring that truly essential article fossil coal, seems to have failed of attracting such a general attention to them, and to the principle on which they are and may be best and most securely conducted, as their importance has demanded; until of late the sympathy and feelings of a portion of the public has been raised by the lamented losses of lives that have occurred. Although on one hand the rights of private property, and the respect due to characters of the first respectability, who are owners and lessors of coal works, to the professional talents and to the private characters of the agents, overlookers, and men employed, call for and require the utmost delicacy in speaking or writing for the public eye, on their individual concerns or proceedings; yet on the other hand, in a matter of so much importance as the preventing of the distressing catastrophes which have of late years wrung the hearts of the inhabitants of Northumberland and Durham, it may appear little short of criminal apathy in those who may happen to see much of the management of collieries in this or other districts, not to endeavour, by as plain and intelligible description as possible, to make the true circumstances of the unfortunate case fully known to the public; and in temperate and proper terms to describe the defects of system or management that they may perceive themselves, in order that the influence and weight of opinion of persons conversant with the subject, and of the intelligible part of the public, may be brought in aid of recommendations that may be made of an improved system or management of these important concerns; and without which aids, the representation or volunteer support of persons unknown to most of the parties could be expected to have little attention from them."*

I perfectly agree with this gentleman in his ideas; and although much delicacy is certainly due where private characters or private property are concerned, still, circumstanced as things are now, the secure state of society, and the removal of evils extensively destructive, are, or ought to be, the tantamount considerations. This cannot be done without a legislative act,† which appears absolutely

* See paper by W. Farey, sen. Phil. Mag. June, 1815, page 437.

† The experience of coal miners on the Continent proved several centuries past that the public welfare *required* and *demanded* a correct knowledge of the progress and manner in which individuals conducted their collieries. Therefore, as similar circumstances in these kingdoms *are not less urgent*, it is expedient that the subject of these essays should rouse the public attention, particularly as increased ills *in a rapid progression* are attendant on delay. *Observations by W. Chapman, Esq., Civil Engineer, on the Necessity of Adopting Legislative Measures to diminish*

necessary for the regulation of a source of supply which following ages must depend upon.

Such was the supposed extent of improvement in ventilation antecedent to the accidents in 1815, that it was deemed almost impossible to attain any greater perfection; so that unless some new and effectual remedy was discovered to prevent the explosion of carburetted hydrogen gas, it would be impossible to repose with any sort of certainty upon the duration of security.

*Accidents, and prolong the Duration of Coal in the United Kingdom.*

## CHAPTER XII.

*Society for Preventing Accidents in Coal Mines, under the Patronage of His Grace the Duke of Northumberland.—Vice Patrons—President—Members—and Proceedings.*

THE greater number of accidents and explosions however previous to 1813, small as they were comparatively with the last year's list, united with the repeated accounts which appeared in Dr. Thomson's Annals of Philosophy, and other publications, caused the first formation of a society for preventing as much as possible any new calamities. And in October, 1813, the miner began to exult in the prospect of some certain and efficient measures being adopted for the security of his life, and happiness of his family.

At present however nothing material has been done, further than the institution of the society, which certainly may be considered the grand desideratum to our future improvements. In its Patron we find an illustrious and benevolent character, distinguished for his public and private virtues; and in the Vice-patrons we find a list of noble personages, who have given an additional lustre to their names, by thus becoming the friends and protectors of suffering humanity.

The permanent Committee and Subscribers are of the most respectable class of persons, and include the names of many very able and intelligent men.

This Society was instituted October 1, 1813, and contains the following distinguished names:

## PATRON.

His Grace the Duke of Norhumberland.

## VICE PATRONS.

The Marquis of Bute,
Earl Percy,
The Earl of Carlisle,
Viscount Barnard, M. P.
Dr. J. Cornwallis, Bishop of Litchfield and Coventry, and Dean of Durham,
Sir T. H. Liddell, Bart.
Sir J. E. Swinburne, Bart.
Sir R. J. Eden, Bart.
Sir M. W. Ridley, Bart, M. P.

The Members of the Chapter of Durham,
T. R. Beaumont, Esq. M. P.
J. G. Lambton, Esq. M. P.
Cuthbert Ellison, Esq. M. P.
George Allan, Esq. M. P.
M. J. Davison, Esq.
Adam Askew, Esq.

## PRESIDENT.

Sir Ralph Milbanke, Bart., (now Sir R. Noel, Bart.)

## SECRETARY AND TREASURER.

Mr. W. Burn.

## PERMANENT COMMITTEE.

The above Members,
The Rev. R. Gray, D. D.
The Rev. G. Stephenson, M. A.
The Rev. T. Baker, M. A.
The Rev. J. Hodgson,
The Rev. W. Turner,
Thomas Hopper, Esq.
Rowland Webster, Esq.
Thomas Wilkinson, Esq.
Addison Fenwick, Esq.

Robert Surtees, Esq.
Stephen Pemberton, M. B.
W. Reid Clanny, M. D. and M. R. I. A.
John Armstrong, M. D.
Henry Fearon, M. D.
J. R. Fenwick, Esq.
J. J. Wilkinson, Esq.
G. Robinson, Esq.
Richard Pemberton, Esq.
John Douthwaite Nesham, Esq.
B. M. W. Chapman,
Mr. Stobart,
Mr. John Buddie,
Mr. Thomas Fenwick,
Mr. Matthew Dunn,
Mr. Edward Steel,
Mr. Thomas Croudace,
Mr. Hoyle,
Mr. George Hill.

## HONORARY MEMBERS.

Thomas Thomson, M. D. F. R. S. L. & E.
William Allen, F. R S.

This Society is supported by voluntary subscriptions, from whence it was proposed to raise a fund, adequate to afford premiums for the discovery of new methods of lighting and ventilating mines: unfortunately however, notwithstanding the exertions that have been made, the finances of the society remain at a low ebb, owing in a great measure to a want of activity in some of the practical members on the spot, by whom little or nothing has been done; and it will require some permanent renovation to produce those beneficial effects which were at first so anxiously anticipated.

Much praise is due to the attention of the President, and the exertions of Dr. Gray, Dr. Pemberton, and Dr. Clanny, and it is to be regretted that circumstances should have so occurred as to damp the active stimuli from whence the society originated. We may now however hope, from the zeal with which the subject is taken up by some of the most distinguished societies of the age, that much will be done. And I cannot pass by the mention of this institution, without paying a small but sincere tribute of acknowledgement to the humane and unceasing exertions of J. J. Wilkinson, Esq. one of the members, and a barrister, resident in the Temple. His mind has been constantly employed in promoting the object of the society, whereby he has rendered essential service to the country and mankind.

To Dr. Thomson the society is indebted for the publication of many valuable papers upon the subject of accidents in coal mines; and it is yet to be hoped that much good will result, and many improvements be introduced through the exertions and means of this humane institution; at all events the members must feel an extreme degree of anxiety not to be superseded by other bodies in their plans for ameliorating the state of the poor miners.

*First Report of the Society; with Observations on Mr. Buddle's Letter to Sir R. Milbanke, Bart.*

The first report of the society was a letter from Mr. John Buddle, to the President, Sir Ralph Milbanke, Bart., (now Sir R. Noel,) stating the different methods of ventilation used in coal mines, and describing the nature of the accidents by which most injury was sustained.

It will be unnecessary to follow Mr. Buddle through the whole of this report, particularly as I have, in a former chapter, availed myself of his ideas in describing the present method of ventilation: suffice that, in every scheme recapitulated by Mr. Buddle, there are such a number of contingencies required for rendering each plan safe, that I am sorry to observe it does not elucidate any greater or more permanent means of safety than were before known. We are all very well aware that, *if* a candle is extinguished previously to the mixture of the inflammable air up to the firing point, an explosion will be prevented; that, *if* a furnace at the bottom of an upcast shaft is put out, *before* an accumulation of inflammable gas is forced through its cylinder, no accident can happen; and that *if* miners *could*, and *would*, always depend upon the indications of their candles, many accidents might be prevented. This is all plain sailing: but we might as well say that, *if* a bomb-shell did not burst, it would be perfectly harmless. The fact is, that long experience has proved the mines of this district to be in such a state, that no dependence whatever can be placed upon these contingencies; and I appeal to Mr. Buddle himself why, if so much security is provided by the system of management in use, have we the dreadful explosions and continual accidents which are so perpetually occurring?

But, as it has very properly been observed by

Mr. Menzies, in his paper on the ventilation of mines, * "there are strong deeply-rooted prejudices here of more than fifty years' undisturbed growth, in favour of the existing system of ventilation, which the influence of any individual, be his genius what it may, can never remove." Notwithstanding the opinions of Mr. Buddle, however, I am much disposed to anticipate great improvements in ventilation, as the subject is now before the public in a more conspicuous manner than ever it was before.

Mr. Buddle, in speaking of the different indications afforded by the flame of a candle when hydrogen gas is present, and of the various circumstances by which these indications are effected, observes, that "long experience and attentive observation are consequently necessary to obtain a thorough practical knowledge of the art." This may be, although I found no difficulty, when down a mine myself, in detecting the different indications of gas under different circumstances; and I have little hesitation in saying that there are very few uncultivated miners, of the least common understanding, who do not understand it as well or

* Thomson's Annals, p. 284, 1816.

better than any practical agent who lives on the surface; and yet we have not security—we have not those beneficial results which might be expected from almost every person concerned, knowing his danger. Consequently we have proof that the evil will not correct itself; on the contrary, unless some permanent regulations are introduced, and extensive improvements adopted, there will be no end to the destruction of these works.

What however most particularly struck my attention in Mr. Buddle's letter was an observation that, "on the strength of my own experience in collieries thus circumstanced, I fully hazard my opinion, that any further application of mechanical agency towards preventing explosions in coal mines would be ineffectual; and therefore conclude, that the hopes of this society ever seeing its most desirable object accomplished, must rest upon the event of some method being discovered of producing such a chemical change upon carburetted hydrogen gas, as to render it innoxious as fast as it is discharged, *or as it approaches the neighbourhood of lights.*"

This opinion, from a person who has gained himself so much popularity in practical viewing as Mr. Buddle, naturally threw a damp upon the exertions of the society, and led many persons to *fear* that the security, which at that particular time seemed to be the exclusive object of their attention, was yet impossible to be attained. Luckily, however, it was a question in which humanity was deeply concerned, and benevolence would not suffer the stimulus of its own dictate to be overcome by a hopeless aspect, or by gloomy opinions.

Many writers, seeing the illiberality and partiality of the above sentiment, commented severely and extensively upon it; and so far reopened the portals of hope, that this desponding opinion was very shortly looked upon as improper, either to repress or discontinue the exertions of the society.

## CHAPTER XIII.

*Necessity of Encouraging Improvement.—The Progress of New Systems.—Bad Effects of delaying the Adoption of Plans beneficial to Mankind.—Opinion of Dr. Thomson.*

IN a very short space of time the society was presented with the nearest possible approximation to rendering the inflammable air innoxious in the presence of lights, in Dr. Clanny's insulated lamp; * and, although the numberless causes before enumerated have prevented the benefits of this invention from being reaped by the persons most interested in its adoption, it is still to be hoped that, improved by additional securities, and enhanced as it is by the approbation of eminent philosophers, and by absolute experiments in situations of the greatest danger, this excellent lamp (or others if equally secure) will be generally introduced in the coal mines of Great Britain.

Government would do well to the security

* See page 112.

of the subject, not only to take into consideration such means as are best adapted to forward the adoption of inventions tending to secure the mines, but to form such an establishment as would be enabled to watch over the regulations, and dispense premiums to those persons whose inventions produced the greatest benefits, or to each, according to the good resulting from their plans.

It is the natural operation of all human affairs to oppose new systems by some obstacles or other, and call forth not only the utmost merit of its origin, but the utmost exertion of its advocates to gain the least establishment in the minds of society; but once fairly established, it becomes the central point of examination; and the ability of that branch of mankind which is interested either in its establishment or demolition, mutually converges to illustrate the benefits of a new invention, or to scrutinize and palliate its real merits. Thus it is that we trace the liberality of intelligent ideas; for it seldom happens, where any new or improved system gains the slightest reputation, but that it ultimately soars above the strength of opposition, and gradually attains a firm and beneficial establishment. Nothing can better illustrate the merits of any invention or plan for the welfare and happiness of society, than its surmounting the steeps of prejudice and private interest.

This generally requires a considerable lapse of time, as there are many old established customs to overcome, exclusive of the change of habits, which to a certain extent must necessarily be effected. This can only be done by perseverance, and by illuminating the system, and the evidence which supports it, in as plain and intelligible a manner as possible, without confounding by intricacy, or losing the spirit by simplicity.

Generated as prejudice is by habit, the alteration of the latter naturally lessens the force of the other; and by conveying the simple language of demonstration and fact to the minds of men, according to their capacity of judgment, impresses upon their understanding the superior bias of conviction.

It certainly appears extraordinary that persons should not only neglect to avail themselves of invention on the first discovery of its utility, but that they should systematically oppose its introduction. This may be attributed in a great measure to the interference of some private interest, or some local alteration which would be effected, and which long familiarity with old and different ways render difficult: indeed the theory of this fact will explain itself on reference to our own feelings; as it seldom happens that a person willingly renounces any custom to which he has been habituated from youth, without first admitting by degrees the forcible convictions of superior information.

In no country have invention and improvement (notwithstanding all obstacles) proceeded with more permanent rapidity and success than in England: nor has the improvement been confined to the mere discovery of artificial necessaries and equivalents, but widely blended itself in the regulation of the vegetable, animal, and mineral kingdoms; so as to palliate the rugged and more unmanageable features, and produce regular and harmonious assimilations, uniting created realities and artificial inventions in the general good, and subservient to the general use and happiness of society. Nor in any instance has more ingenious philosophy been exercised than in discovering new mediums of light, which constitutes one of the most acceptable branches of modern science. When we contemplate therefore the abundant supplies afforded to those who inhabit the surface of the earth, it will readily occur to commiserate with the industrious pitman, who, perpetually excluded from the rays of the sun, would hail with gratitude the means which afforded him a cheerful and secure light, by which he might proceed in his daily labour, without continual dread of destruction.

It is a melancholy reflection that, during the time Dr. Clanny's lamp has been neglected, eight or more mines have been blown up by explosions, which most probably might have been prevented; and some hundred souls deprived of existence, exclusive of the indescribable extent of want and wretchedness carried to the homes and families of the poor unfortunate sufferers.

Did we not look around for a moment to the natural though extraordinary causes which invariably retard the progress of improvement, nothing could prevent the benevolence of feeling from accusing every person concerned in the regulation of these mines of inexcusable inhumanity. But it is to be hoped that, if the stimulus to save their fellow creatures is not sufficient to provide the means of safety, government will not longer witness, unmoved, such dreadful innovation on the subjects' happiness and security.

Dr. Thomson, referring to a visit he made to the counties of Durham and Northumberland, says, "I have already, on a former occasion, stated my opinion on the mode of working the collieries practised here, and indeed all over the kingdom; and have seen nothing in my late visit to induce me to alter that opinion. Delicacy would have prevented me from venturing to state that opinion; but the numerous lives sacrificed to the present system, and the increase of the danger as the miners get deeper, render silence on the subject improper if not criminal." *

Time has not however been misapplied by the ingenious inventor of the insulated lamp, but served to render his apparatus in every respect an object more than ever deserving the attention of society, and the powerful sanction of the legislature. It is true there are now many other inventions, none of which appear to have any particular claim to security except those of Sir H. Davy and Mr. Stephenson, and indeed of these I have my doubts to a considerable extent; but we are indebted to the exertions of Dr. Clanny for this ultimate burst of scientific plans: and, setting the point of originality out of the question, I have no hesitation in

* See his Annals of Philosophy for 1814, p. 412.

asserting that every individual must concur in this opinion, as it is owing to his indefatigable exertions that the subject is at length brought publicly forward. Allowing the recent inventions all the merit they possess, there is still a deficiency in them of that permanent security and brilliance of light, afforded by Dr. Clanny's lamp; and although they may be applicable in the common working of a mine, his alone will be most secure in dangerous cases, and in exploring old wastes.

When the distresses which occur around an individual are of sufficient importance to call forth a devotion of time and ability in discovering the means of remedy, it certainly must concern the government, as representatives of a humane people, to see the remedy adopted, and to see that a waste of life is not made with impunity, when no longer shielded under the plea of unavoidable necessity.

## CHAPTER XIV.

*Rights of Interference in Private Property. —Correspondence of Drs. Dewar and Trotter.—Danger resulting from having only one Shaft.—Regulation of Expenditure.—Old Wastes and Inundations.—Mr. Farey's Scheme for Insulating Mines.*

SIR W. BLACKSTONE says, in regard to the interference of government with private property, that "in *vain may it be urged* that the good of the *individual* ought to yield to that of the community:" again; "in this, as in similar cases, the legislature alone can and frequently does interpose."

I presume that this is meant to apply more strictly when the individual, by retaining what is good to himself, does not thereby trespass either upon the good of individuals, or of the community; but surely if ever a government is justified in interposing its authority between the interests—we may say security—of the public and individuals, it must be in instances where the good of individuals is daily trespassing upon the moral polity of the country, and the social happiness of the community.

Several pamphlets have at different times appeared upon the very important subject of coal mines, most of them suggesting the propriety of parliamentary interference, and containing more or less a great variety of arguments upon the various theories of the gases. But it does not appear that any of them entered fully upon the historical relations of mining, or sufficiently expatiated on the extent of explosions, or the danger to be feared from overwhelming inundations.

Referring to Dr. Dewar's Answer to Dr. Trotter, published in 1805, "On Destroying the Fire and Choak Damp in Coal Mines;" * when he speaks of explosions being only occasional accidents, not more frequent than in other hazardous employments, it is presumed that he or any other writer, who then entertained a similar opinion, would not now review the extent of these accidents without offering some better stimulus for the discovery of preventives, than the theory of their being necessary occurrences.

And, carrying the reference still further,

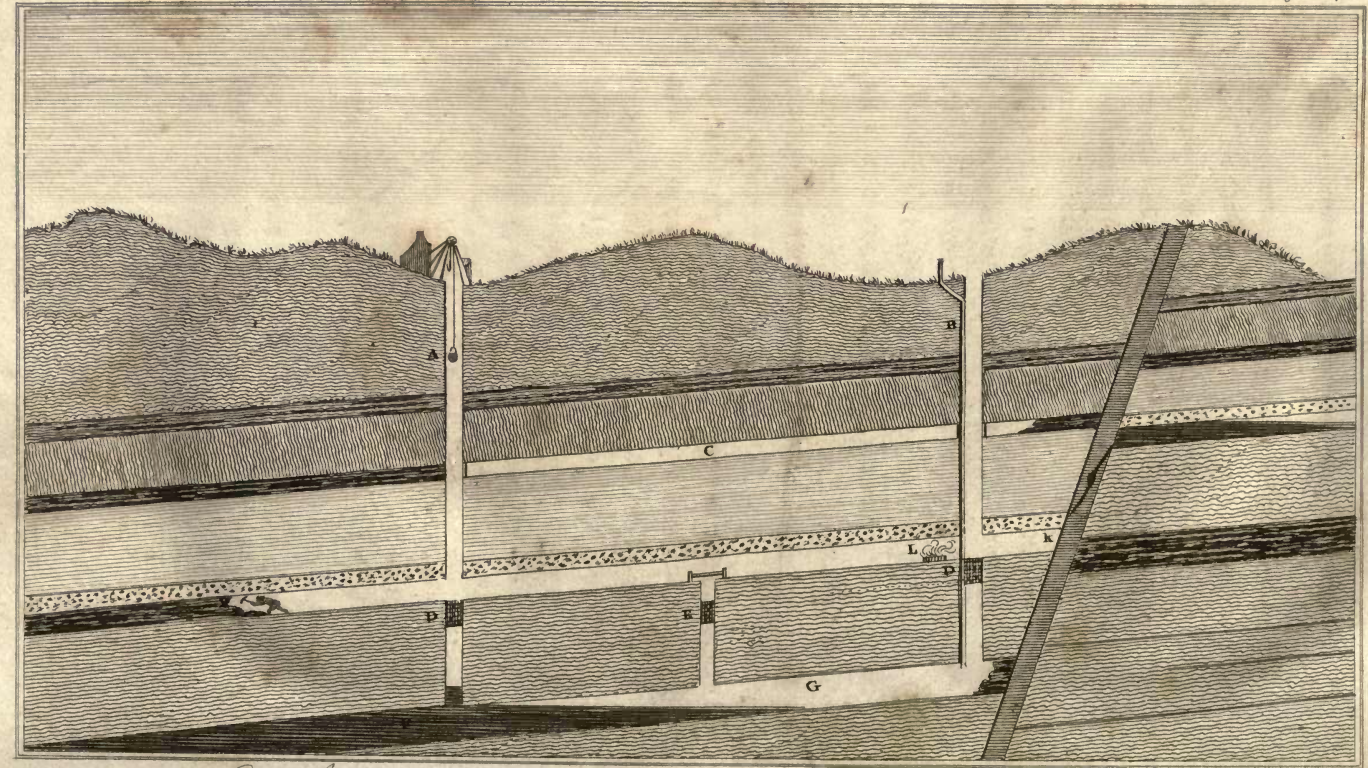
* See his Answer, p. 9.

that Gentleman, in speaking of ventilation by means of a furnace on the edge of one shaft, whereby to attract a current of air through the workings proportionate to the heat of the fire, very properly infers a supply of cool air through the mine by means of *another* shaft. But how shall we find an apology for those owners who, in the parsimonious arrangements of their works, never sink a second shaft, but depend upon a collateral division of one into separate partitions, by boards or brattices placed vertically down them, and which have in many instances proved fatally abortive: unfortunately we are not without a very recent case in the Sheriff Hill Colliery.*

It would strike to the root of all argument if plans were to be advocated which must fail in their execution through the enormity of expense. But when this is not the case, on the contrary when the remedy is easy and simply applicable, no consideration can justify the owners in not either adopting them themselves, or otherwise, as it is a subject of national importance, assisting to establish some permanent and answerable means of management and official examination.

* See page 103.

The great number of old wastes which are now in a state of complete inflammability, or inundation, presents a serious objection to the present system, and will, it is feared, in many places prevent the access to seams lying at a greater depth, and ultimately deprive the kingdom of many valuable resources of mineral wealth: And judging from the dreadful inundation of the Heaton colliery in 1815, and the similarity of situation in which other mines are placed, we may expect to hear of more collieries rendered useless by water, and more lives lost for want of proper information relative to the boundaries of a mine. When an old worked-out mine adjoins another in work, many circumstances may cause the water or gas contained in the wastes to find their way into the colliery which is winning, such as the decomposition of an alluvial or shaly fissure, but nothing more particularly than the want of knowledge in regard to the boundaries. Sometimes when two mines, the one worked out and the other at work, lie on each side of a dyke or slip, and the old mine lies upcast of the other, the waters will drain down to the dyke; but, finding that impervious, they are turned in their course or forced upwards in springs. But should this dyke be not more




Coal Strata thrown down by a Dyke, descriptive of old Wastes

Middlemist, So.

than a few feet thick, a stroke of the hewer will sometimes cause a rent through it, which immediately gives passage to the whole accumulations of gas and water. By reference to Plate V. the particular situation of old wastes below, seams in work, and excavated parts above them, will be shown. *A* the downcast, *B* the upcast shaft; *C* part of a seam worked out and stopped up at shafts; *D D* shafts stopped up by scaffolding, &c. at second seam, the third seam being worked out; *E* a staple, stopped up the same as shafts; *F* an old waste nearly filled with water, which as it accumulates compresses the inflammable air to the upper region of the mine, as at *G*, and causes it to force its way up the shafts, staples, &c.; *H* a cast iron pipe to carry off gas from the waste, &c.; *I* a seam above the dyke with water, and which represents the danger of the mine below at *K*, should a rent, fissure, or other means, suffer the water to penetrate the dyke and descend; *L* a furnace at the bottom of upcast shaft to accelerate the current of atmospheric air.

To obviate in some measure the danger resulting from adjacent wastes, and an ignorance of boundaries, Mr. Ryan proposes that a man should be employed in all suspected places to bore ten yards before the pitmen with a boring rod, and that by his contract he should have so much per yard, with a forfeit of five guineas payable to the workmen, in case he neglected to bore the full length: this would ensure the proprietors from neglect, and discover danger in time to prevent its effects.

Mr. Farey, sen. in a late number of the Monthly Magazine,* has suggested the idea of dividing some of the larger mines by means of strong walls, leaving an aperture properly constructed for the drainage of water, and having an additional number of pits sunk at the dip and rise of those subdivided divisions in order to facilitate the process of ventilation, and more readily carry off the inflammable matter. I certainly think this scheme is worthy of much attention; and, where the collieries of the Tyne and Wear district have attained such an unmanageable extent as is in many of them the case, it might be applied with certain and beneficial effects.

What makes all this of much more importance is that, exclusive of the coals still left in

* See his paper in the Monthly Magazine, Feb. 1816, page 32.

old workings, it has lately been discovered that in many parts they abound with alumine, which certainly makes their value much more considerable. This is produced in a great measure by the decomposition of pyrites contained in the superincumbent shale or schistus, and which, combining with sulphuric acid, forms an alumine concretion.

## CHAPTER XV.

*Evil Tendency of old Customs.—Mr. Buddle's Calculation of Accidents.—Mysteries of Mining.—Observations by Dr. Thomson, on the Necessity of Legislative Interference.*

HAVING delineated the most important circumstances affecting the collieries, and described the dangers and misery attendant upon the present system of management, I shall anticipate with considerable anxiety the active exertions and feelings which will produce an amelioration in the situation of many thousands of poor persons;* and it is to be hoped that the miner will hereafter be led to participate in the beneficial effects of philosophical and scientific improvements, without custom

* "To smooth the smartings of calamity, to bind up the wounds of those whom fortune has crushed under her wheel, is real and exalted virtue. But there is a philanthrophy of a yet higher order, *which is busied in removing the causes and occasions of want, poverty, and distress.*" *Sedgwicke on Blackstone*, p. 235.

and prejudice being suffered to consign more martyrs to the tomb.

There is sufficient evidence in existence to prove the extreme danger, in regard to collieries, of suffering the continuation of old customs, which have invariably been attended with calamities, beyond the mechanical existence of any plan which, in altering the force of habit, lessens the liability of danger. Could the hundreds of unfortunate beings, who have been sacrificed to an untimely death in coal mines, raise their voices from the grave, they would be employed in supplicating mankind to provide better security for their successors, and describing the principal agent of destruction as the contact of fire and foul air.

Mr. Buddle, indeed, in his Letter on the State of Ventilation, &c. to Sir R. Milbanke, tells us that the "*ordinary and unavoidable casualties in collieries occasion more calamity than explosions of inflammable air.*" Here then we have an admission of some, and certainly of melancholy magnitude. Let any person calculate the destruction caused in one year by explosion, and still according to this statement, only find one third of the actual losses. Is not this enough to call for investigation? is it not time to make some inquiry into the system? or is it so in any other district?

An unaccountable mystery has too long concealed the process of mining from public scrutiny, and prevented those circumstances being known which would induce a more positive interference; but the sacrifice of human life has been too flagrant of late, the inhumanity of the systems too notorious to remain any longer unrevealed, and it now remains for society, and more particularly for the legislature, to judge whether, in a nation like England, such melancholy consequences are to pass unnoticed and uncorrected. Can any thing be more strikingly serious than the immense slaughter which these last few years have witnessed, or can any argument better corroborate the assertions contained in this work than that of Dr. Thomson, in his Annals for November, 1815, where, after commenting upon the plans of William Thomas, Esq., and William Chapman, Esq., for the better regulation of mines, he thus expresses himself:

"Mr. Chapman has shown that such a plan, though absolutely necessary for the good of the country, can never be executed without the interference of the legislature: indeed this is sufficiently obvious. The proprietors of the collieries, from mistaken views of self-interest, are anxious to conceal every fact which they observe from the public. Hence it is quite obvious that they never will, of their own accord, form such a society as is described in the pamphlet before us; and that if such a society be formed they will communicate no information to it unless compelled by Act of Parliament. As to the coal viewers, they appear to be averse from all publicity and all changes in the present mode of working the collieries: * this I conclude from a fact which I could not have believed *à priori*. Though *several hundred colliers lose their lives* every year by explosions of carburetted hydrogen gas, and though they have been expressing a great anxiety to discover a mode of destroying this gas, not one of them has ever thought of trying the lamp of Dr. William Reid Clanny,

* There is no doubt but many of the viewers, from mistaken views, act very differently from what ought to be expected in a case of such importance to humanity. But I would not wish this observation to extend too far, as considerable liberality has of late been evinced by many of them; and for my own part I wish to particularize Mr. Buddle, Mr. Dunn, and Mr. Wood, though I cannot reconcile Mr. Buddle's treatment of either Dr. Clanny or Mr. Ryan.

of Sunderland, though a model of it has been within their inspection for several years, and though there *cannot be a doubt* but that it would effectually prevent such accidents. They may perhaps allege that it is more expensive than the present mode of lighting the mines. I should like to know at what they estimate the lives of three or four hundred men, or what additional expense to the country it is to support the widows and children of so many workmen that have perished in their service, because they did not choose to increase the expense of lighting their mines?"

Again: "In all parts of Europe where mining has been carried to a great degree of perfection, it has been done under the inspection and control of Government. That coal mines should be in this predicament, and that exact plans should be preserved of all the excavations and of all the coals left, is too obvious to require any illustration."

This, with several other concurrent circumstances, so completely agitated the subject, and brought it before the public in such a manner, that meetings were called at Sunderland and Newcastle, for the purpose of making inquiry into the means of improvement; and my attention was taken from this work for a time in the pursuit of experiments: and it now affords me much gratification that the intermediate time has been almost exclusively occupied in furthering a question so materially connected with humanity.

On the 7th of December, 1815, a paper from Dr. Clanny, containing an account of our experiments with his lamp was read before the Royal Society, and published in Thomson's Annals for May, 1816. After referring to his former paper, and briefly describing the numerous accidents which had occurred in collieries since that period, Dr. Clanny proceeds to state: "About four years ago I constructed a small lamp of strong glass, the bottom of which was shut, with the exception of a small opening to admit the tube from the bellows, for throwing in the necessary quantity of air to support the combustion of the candle within the lamp.

"I found that it safely insulated the candle; but I was soon told that it would never answer for the purpose intended; that frequently large pieces fell from the roof which would destroy the lamp; and as the candle would thereby come in contact with the mass of inflammable air of the mine, an explosion would occur as a matter of course. I also found that valves would not suit; for the expansive force of the explosions within the lamp threw open the valves and allowed a communication to take place between the candle and the surrounding atmosphere; besides, the water when used as a valve not only keeps the apparatus cool, but ensures perfect safety. I was told that frequently large masses of coal are struck off from the sides of the mine whilst the pitmen are hewing out the coal, as I have witnessed myself; and should a piece of coal strike the lamp upon the side, it would of course break it, and expose the inflammable gas to an instantaneous explosion."*

Dr. Clanny then goes on to describe the uses and application of his invention, which it will not be necessary to repeat here, as they are mentioned in a former part,† and concludes thus: "I made many fruitless efforts

* I have heard similar remarks to these from practical men; but they are founded upon such extreme cases as entitle them to be noticed more as the objections of prejudice than actual ones: it is true, these circumstances often occur, but seldom in such a manner as to affect Dr. Clanny's lamp. With Sir H. Davy's however, or Dr. Murray's, I could not say the same, as their construction is unavoidably too light to withstand a common splinter of stone or coal.

† See p. 107—114.

to descend a mine charged with inflammable air. At one time the person who invited me to his house, at a considerable distance from Sunderland, went from home when I arrived. Two years afterwards, when I arrived at a person's house (likewise at a considerable distance), who had promised to descend a colliery with me, I found that he had just examined all the parts of the mine, *as he said*, and that there was no inflammable air to be found in any part of it. This I afterwards found was not the case.

"Indeed the ungenerous opposition I have met with is almost incredible; but the train of miseries detailed in this and my former paper leaves no room for delicacy, and the state of the case demands that some remedy should be applied.

"In the mean time all the men of science who came into this neighbourhood examined the lamp, and gave it their entire approval.

"Vexed at such treatment I wished to forget the subject, and let things run their course, when, immediately after an explosion in one of the mines, a letter appeared in the Morning Chronicle, signed J. H. H. Holmes, which, after much close reasoning upon the subject, put the question, whether any of my lamps had been used in those coal mines which had recently exploded?

"After a time, and as no person appeared to take up the subject, I thought it my duty to state, amongst other things, that no person had ever used my lamp in a coal mine.

"From this public correspondence a private one arose; and not long afterwards this gentleman did me the honour to visit me, and immediately commenced an investigation of the coal mines, in order to give some general information upon this very interesting subject.

"It will be unnecessary, after the preceding statements, to trouble the Royal Society with any further particulars except the two following certificates, which were drawn up and signed according to their respective dates, on the spot where the trials were made, which, it is expected, place the value and security of the lamp beyond a doubt. The trial within the mine was conducted at the place where twenty-four persons were not long since killed by an explosion.

"FIRST CERTIFICATE.

"*Harrington Mill Pit, Oct.* 16, 1815.

"An experiment took place this day on Dr.

Clanny's lamp for preventing explosions in coal mines. It was effected at the mouth of the upcast shaft of the Harrington Mill Pit, by means of inflammable air obtained from a cast iron tube communicating with the Hutton seam, and witnessed by the undersigned.

"In order to ascertain the quality of the gas given out at this tube, a bladder was filled from it, and on trial its contents proved to be carburetted hydrogen gas of the purest nature.

"One end of a leaden pipe was affixed to the iron tube; the other end placed within a room which was quite closed up, except at the door where the pipe entered. In a very short time the carburetted hydrogen gas became mixed with the atmospheric air of the room up to the firing point, when the lamp, with a lighted candle within it, was carried into the centre of the room; and after conveying two or three draughts of air through the bellows an explosion took place, which extinguished the candle without communicating to the surrounding inflammable atmosphere. This experiment was practised a second time, and the same results followed.

"On witnessing the experiment, the undermentioned William Patterson and Joseph Gleghorn declared that they would go into any part of a mine without any fear, if lighted by this lamp.

(Signed) "J. H. H. HOLMES.
"WM. PATTERSON.
"JOS. GLEGHORN.
"ANTH. HOPPER.
"GEORGE PATTERSON.

"SECOND CERTIFICATE.

"*Monday, Nov.* 20, 1815.

"Dr. Clanny and Mr. Holmes left Sunderland this day, for the purpose of experimenting upon Dr. C.'s lamp, in some of the most inflammable parts of a coal mine; for notwithstanding that it was satisfactorily experimented upon on Oct. 16, within a room filled with inflammable air at the firing point, it was thought expedient to carry it into those parts of a mine where its benefit must ultimately be produced.

"They descended the Harrington Mill Pit, which is one hundred and one fathoms in depth from the surface; and having proceeded upon the examination of the mine, found the most inflammable part at the bottom of a staple, which was closed about twenty feet down by scaffolding, and made to communicate with the Hutton seam, which, being now worked out, is full of inflammable air. [And from this the tube runs by which we were enabled to make the experiments of Oct. 16, 1815.—W. R. C.]

"Much caution was required in keeping the candles from approaching too near the staple, as their appearance, when held near the mouth, clearly indicated that, had they been introduced too far, an explosion must necessarily have followed.

"Dr. Clanny and John Birkbeck, a man employed in the mine, stood at the top. Mr. William Patterson, a very able and intelligent man, descended half down the staple, and Mr. Holmes stood upon the scaffolding. The lamp with the lighted candle was handed by Dr. Clanny to Mr. Patterson, who descended with it to Mr. Holmes; and after the bellows of the lamp were urged a few seconds, a slight flash occurred within the body of the lamp, and the candle was immediately afterwards extinguished. No particular caution was observed with the lamp, as a confidence in its security resulted from the experiments of Oct. 16; and if a further proof of this was necessary, it was afforded by the presence of

Mr. Patterson and Birkbeck,* both of whom declared 'that if the candle had communicated with the circumambient air on the spot where the experiment took place, the mine would have been blown to pieces.'

(Signed) "J. H. H. Holmes.
"Wm. Patterson.
"Jno. Birkbeck."

Dr. Clanny's lamp is not, however, now the only invention of this sort held up as a security against explosion, as within the last few months a great variety of lamps on different constructions have become candidates for popularity, though every one must admit that he was the first who discovered the means of dis-

* Patterson and Birkbeck having witnessed the effects of several destructive explosions, and knowing the danger of those mines which had not been worked or had lights in them for two years, were at first naturally reluctant to venture to the staple with the lamp. When Patterson however reflected upon the security of our former trials he hesitated no longer; and it was pleasing to observe his and Birkbeck's satisfaction at the result of this experiment. Patterson afterwards took me to a different part of the mine, and, holding the light nearly on the floor, showed me, through a trap door, an old waste of one hundred acres, filled with foul air.

arming the enemy, and of affording a secure and brilliant light in the midst of danger. It is useless, however, to agitate the question of originality any longer: a word to the wise is sufficient; and it now only remains to describe the remaining lamps.

# CHAPTER XVI.

*Experiments at the Literary and Philosophical Society of Newcastle, on the Lamps of Mr. Brandling, Dr. Murray, and Mr. Stephenson.*

MR. BRANDLING was the next person who constructed a lamp to prevent explosions from light; and I had the satisfaction of being present at a private meeting of the Literary and Philosophical Society * of Newcastle, when this invention was first presented and experimented upon. But as it was dependant either for use or security upon determinate strata of air, which certainly never occur with any regularity within a mine; and as the carbonic acid occupies the lower region of the workings, it cannot be expected that any apparatus supplying itself with air by means of

* The meetings of this excellent society take place the first Tuesday in every month; but on the Tuesday preceding, the president, secretaries, and some of the members, assemble in the evening, and after taking tea proceed to the perusal of such papers, or the trial of such experiments, as may be proposed for the next public meeting.

a tube hanging from the lantern to the ground can ever be answerable.

This lamp was constructed of tin, being about twelve inches by eight square, and was supplied with a bellows chamber at the top for the purpose of accelerating the draught of air (see Plate VI. Figure 4). *a* the bellows; *b* the perforations for the air to pass out of the lamp, over which lies a small piece of wood hinged on with leather as a valve; *c* the glass; *d* the oil lamp; *e* a belt by which the lamp is carried; *f* the elastic tube. The lamp, when lighted, is screwed in underneath at *g*. Exclusive of this invention being inadequate on account of the carbonic acid which occupies the floor, there did not appear any security from an explosion within communicating with the surrounding air. Experiments were tried by sending some gas provided for the purpose up the tube, which exploded violently, forcing the sides and making the tin extremely hot; had it been surrounded by inflammable air there is little doubt but a communication would have taken place through the perforations in the bellows.

*Dr. Murray's Lamp.*

On the same evening a very long and interesting paper was read from Dr. John Murray, of Edinburgh, on the different gases of a coal mine, and on a lantern or lamp which he had invented for the purpose of preventing their explosion. However well Dr. Murray may be acquainted with the gases in their simple or compound state, he certainly did not by this paper appear to understand the manner in which they were arranged in a colliery, or at least the various manners in which they occur.

Plate VI. Figure 5, represents this lamp, which, like that of Mr. Brandling, was to supply itself with air through an elastic tube. *a* the glass body fixed into a tin or copper stud at *b*. The elastic tube is fixed to the lamp, which when lighted is screwed into the body at *c*; *d* a kind of handle to carry the apparatus. The objections to this lamp are evidently combined in those against Mr. Brandling's, with this addition, that a slight explosion would break the glass, and that a blower striking from the roof or floor of a mine might force the gas through the tube or down the chimney of the lamp, when the effects are obvious. The different phenomena of the gases in a colliery are so extraordinary, and so different to the common calculation of chemists, who arrange them in their imagination as though they were regulated by the same laws as definite quantities of gas would be in a chemical laboratory, that it is not surprising to find these mistakes made; nor is it at all prejudicial to the abilities of the most eminent practical chemist, to point out the errors which arise from an ignorance of local circumstances only to be known by absolute examination.

### *Mr. Stephenson's Lamp.*

Mr. Stephenson is an engineer employed at the Killingworth Main colliery, so that whatever from local or practical information is required for the construction of a safe lamp he was possessed of, and undoubtedly claims great merit, if the invention produced was from his own genius. As I was present at a general meeting of the Society at Newcastle when this lamp was presented, and made some experiments myself upon it, I am enabled correctly to describe the apparatus, and to speak differently upon the subject from what has been done in Tilloch's Magazine.

Plate VII. Fig. 4, represents this lamp. *a* the lamp made of copper; *b* the glass chimney fitted air-tight in the lamp, and which (when I examined it) was enclosed in a case of tin with holes of about a quarter of an inch in diameter, cut out for the escape of the light; *c* the cover or tin case so perforated; *d d d d* air holes. The principle of this lamp is its being supplied with air through small perforations at the bottom, which, when in pure atmospheric air, enables the light to burn something similar to the radiance of a rush light; but when it is in carburetted hydrogen the light is so weak that, in the struggle to expand itself, which is the first step to explosion, it dies out.

In regard to this lantern having been tried in a mine six weeks previous to its appearance at the meeting, I must express some doubts, as it certainly did not wear the appearance of so old a practitioner; and as Mr. Stephenson appeared totally ignorant of the manner in which the air and gases operated upon the light. Nothing was heard or said of it previous to the private meeting before spoken of, which was exclusively for the purpose of taking into consideration the methods of lighting collieries. A few days following, a paragraph appeared in the Durham paper announcing that Stephenson's lamp had been used six weeks in the Killingworth Main pit: this, however, is not of much consequence, further than what relates to the testimony of its application. The least prevalence of carburetted hydrogen, or carbonic acid, extinguishes the light; and it is so extremely feeble that I doubt very much whether the many concussions to which it would be exposed would not perpetually leave the workmen in darkness.

It has been stated * that no explosion took place when carburetted hydrogen gas was sent into the lamp. This is very true; but the gas was only sent in in inflammable quantities, and not in exploding proportions: this caused the light to expand and then go out, and though I suggested the experiment of inverting a small gasometer over the chimney of the lantern I did not see it satisfactorily fulfilled; for the gas being sent in so as only to cause an inflammation did not produce those effects which probably would have resulted had the air been properly mixed up to the firing point. I certainly did not see the candle put into the

* See Tilloch's Phil. Mag. 1816, p. 459.

gasometer, neither do I think if this had been the case that it would have exploded, as every one knows that carburetted hydrogen gas extinguishes light if unmixed with common air. These are points which ought to be considered; for, without detracting from the merits of the inventor, it is necessary that plans of this sort should have some stronger corroboration than mere superficial and speculative statements.

I am disposed however to give every latitude to the improvements which may be suggested by use and experience; and I am happy to understand that, subsequently to its first appearance, Mr. Stephenson's lamp has been much improved, and rendered a very desirable and secure apparatus.

We come now to a series of inventions by Sir Humphry Davy; and though I feel much pleasure in recording the experiments and plans of so eminent a philosopher, I cannot help feeling some regret that they did not originally emanate under more auspicious circumstances, and free from an appearance of unmanly assimilations to previous productions.

## CHAPTER XVII.

*Experiments of Sir H. Davy on the Inflammable Air of Mines.—His Lamp.—Observations thereon, and on a Paper in the Edinburgh Review.*

SIR HUMPHRY DAVY being on a visit to the North of England was invited by the Rev. Dr. Gray, of Bishop-Wearmouth, an active member of the society before-mentioned, to visit the collieries, and endeavour to discover some preventive against the accidents which occurred in them. He did not, however, descend the mines, but made several experiments from the information communicated to him by gentlemen practically employed.

These experiments were not satisfactory; but Sir Humphry Davy was determined to attain some certain and conclusive point. For this purpose he had considerable quantities of gas forwarded to London, in order on his return to proceed in his experiments; and though many of the results contained in his paper to the Royal Society have been long known amongst our chemists, still there are further gaseous qualities elucidated which make his inquiries extremely interesting.

He found that one part of fire-damp, mixed with one of air, burnt on the application of a lighted taper, but did not explode; the same results were produced by two and three of air to one of gas; when four of air and one of gas were exposed to a lighted candle, the mixture being in the quantity of six or seven cubical inches, in a narrow-necked bottle, a flame descended through the mixture, but there was no noise; one part of gas inflamed with six of air in a similar bottle produced a slight whistling sound; one part of gas with eight of air, a louder sound; one part of gas with ten, eleven, twelve, thirteen, and fourteen, still inflamed, but the violence of combustion diminished.* In one part of gas with fifteen of air, the candle burnt without explosion with a greatly increased flame; and produced the effect of enlarging the flame, but in a gradually dimi-

* Before these experiments Sir H. Davy did not extend the explosive proportions beyond three or four of air with one of gas. See his Elements of Chem. Phil. Dr. Clanny found that any mixture became explosive, from one-sixth to one-twelfth. See his Paper on a Steady Light in Coal Mines.

nishing ratio, as far as thirty parts of air to one of gas.

Dr. Thomson and Dr. Henry had previously experimented upon the fire-damp of mines; but it does not appear from Sir Humphry Davy's paper, that its combustible principles had been analysed comparatively with other gases. The above proportion was however, no doubt, well known to them, and we have a brief statement of similar facts in Dr. Clanny's paper to the Royal Society. Sir H. Davy, in his analysis of some gas from the Hepburn colliery, states it to contain one-fifteenth of atmospheric air, and the most impure to contain one-twelfth, which he supposes to be derived from the circumambient air of the mine; and one of the fire-damp required two of oxygen for combustion by the electric spark, forming one measure of carbonic acid.

It is material that the researches of Sir H. Davy corroborate the opinions of former chemists in regard to this gas, and that it is similar to the inflammable gas of marshes, which was demonstrated by Mr. Dalton, and found to consist of four proportions of hydrogen, in weight 4, and one proportion of charcoal in weight 11·3.

An electric spark would not explode five of air and one of fire-damp, but had the effect upon six of air and one of fire-damp; but very strong sparks from the discharge of a Leyden jar possess the power of exploding the gas in the same manner as a lighted taper: burnt charcoal to any degree of heat did not explode mixtures of air and fire-damp. Iron heated red hot, and to a common degree of white heat, did not explode it, but when in brilliant combustion produced the effect.

Numerous other experiments were performed by this able philosopher, of more importance to the chemist than to the miner, except in the results which may be anticipated from scientific men becoming acquainted with new facts relevant to this matter. Metallic tubes of one-fifth of an inch in diameter, and one inch and a half long, were found safe canals for conveying the fire-damp; but the most extraordinary and important discovery was the security of gauze wire, which proves impervious to flame, and, though surrounded by inflammable air, prevents any inflammation within from communicating to it.

Azote and carbonic acid were found to diminish the explosive power of the fire-damp, and one of carbonic acid to seven of an explosive mixture prevented an explosion. These facts led to a great number of experimental lamps; but I am doubtful whether any lamp made simply from an analysis of the gases in chemical proportions will be found answerable when applied to a mine, as the proportions to contend with there must depend upon circumstances which seldom are known, and never can be depended upon.

Sir H. Davy is however inclined to believe, from the results of his experiments, that air-tight lanterns supplied with air from tubes or canals of small diameter,* or from apertures covered with wire gauze and placed below the flame, with a chimney covered in the same manner, will prevent explosion; and that in all lanterns the explosive power of the fire-damp, being consumed by an inflammation within the lamp, prevents any communication through the chimney. His first lamp was secured by metallic tubes, which for security require to be one-seventh of an inch in diameter, and two inches and a half long.

The second lamp was nearly similar, only

* This fact was discovered about two years ago by Dr. Clanny, who tried it satisfactorily by sending in a mixture of fire-damp and air through a pair of double blast bellows, having a perforation at the end of their tube of about one-eighth of an inch in diameter.

that the air was sent in through what he terms *safety canals*, or close concentric metallic cylinders fitting within one another, and leaving an aperture between each of an inch and seven-tenths long, and from one twenty-fifth to one fortieth of an inch in width. The chimney may be protected in the same way; but if Sir H. Davy is satisfied that the fire-damp or combustible principles is destroyed within the lantern, and does not ascend much above the lower end of the chimney, why is this necessary? Upon this principle various lamps are applicable with a little alteration.

The third lamp is a close lamp or lantern having the air apertures covered with brass wire gauze, of one two-hundredth of an inch in thickness, having apertures of one one hundred and twentieth of an inch.* This prevents explosion, and, should the fire-damp inflame in the lantern, will not suffer any communication with the surrounding air: unless this very *fine* covering is well protected by some stronger material I should doubt its security very much

* These are the proportions mentioned in Sir H. Davy's paper to the Royal Society; but in an abstract published in the Edinburgh Review, the apertures are stated at one twentieth of an inch, and the thickness of the wire at one sixtieth. When Doctors disagree, who shall decide?

in a coal mine, wherein all implements and requisites are exposed to the roughest and most destructive treatment; of this however, Sir H. Davy ought to be well convinced. It is a subject upon which I shall say something more in a future page; at present we will suppose it all correct.

No difference was noticed in these experiments from the effects of the metallic tubes, gauze, &c. becoming heated; but it is presumed, according to some experiments Dr. Clanny made from Grotthus, who discovered that inflammable mixtures when expanded to six times their volume were deprived of explosive power, there is some sensible difference.

It will be unnecessary to recapitulate the great diversity of experiments made by Sir H. Davy, further than I have already done, as many of them may probably be found merely theoretical, in regard to fire-damp, when practically adopted in a colliery. Sir H. Davy suggests the use of a fire made of charcoal in those parts of a mine where the air is explosive, as it burns without flame. But surely he could not be ignorant that in this situation the great absence of vital air would make it difficult for the respiration of miners, and as charcoal is the most greedy of all other things in consuming oxygen, exclusive of the increase of carbonic acid which it would create, it would only be transferring the danger from one source to another equally destructive. The effect of the gas upon the senses and feeling is certainly not a new discovery, as I found all miners with whom I conversed sufficiently acquainted with every information of this sort.

That no precaution is required in constructing lanterns of strong materials to withstand the effect of explosions in the chamber of the lamp, I am much inclined to dispute. A lantern capable of receiving one quart of inflammable air must be made very strong to bear the expansion, particularly if the venting apertures are confined to a small space. When Mr. Brandling's lamp was experimented upon at the Literary and Philosophical Society at Newcastle, the effect was so great as to force the sides very considerably; and even was this not the case, it is giving rather too dangerous a latitude, as the nature of the uses to which lanterns must be applied in a colliery require the greatest strength.

When at Sunderland, in the latter end of March, I was informed of Sir H. Davy being then at Newcastle, and that his lamps were not found sufficiently secure in their present state for application in a colliery.

Fig. 1.

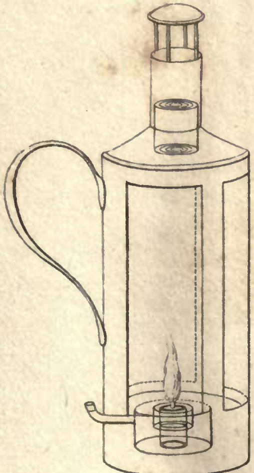


Fig. 2.

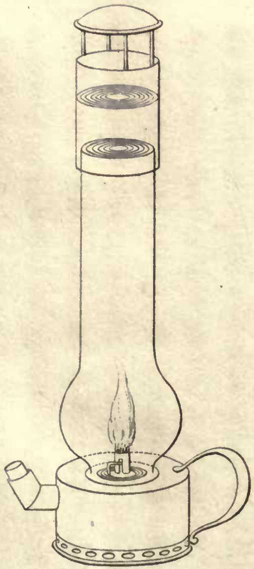


Fig. 3.

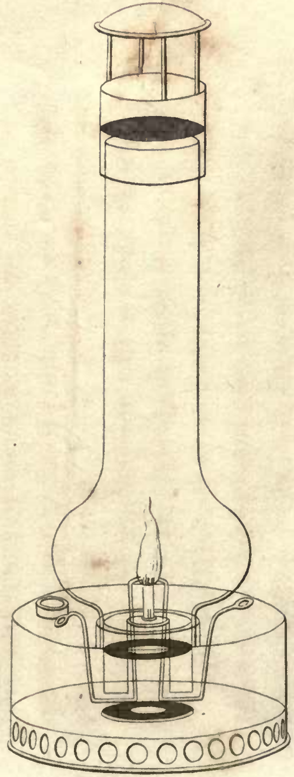


Fig. 4. p. 188.

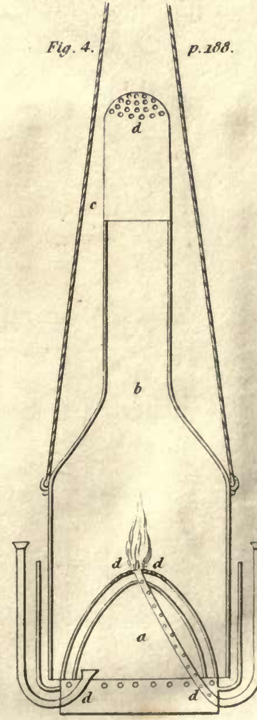



Fig. 1. 2. & 3. Sir H. Davy's Lamps.

Mr. Stephenson's.

## EXPLANATION OF PLATE VII.

Fig. 1 represents Sir H. Davy's lamp, with the air feeder and chimney, furnished with the concentric metallic canals, and is made to contain nearly one quart of air: the sides are of horn or glass made air-tight; and at the top is a hollow cylinder covered with a cap to prevent dust from getting into the lantern.

Fig. 2 represents a lamp upon the same principle as fig. 1, with concentric metallic air feeders at the bottom, and a glass chimney with similar canals in the top, and covered with a tin plate. An Argand lamp may be used in this way; and if the apparatus is furnished with metallic gauze sieves in the chimney, the security is more certain.

Fig. 3, a metallic gauze lamp, with screens of wire gauze, and so constructed that the wick may be trimmed without inconvenience.

Sir H. Davy had some glass tubes constructed with metallic gauze feeders, in which a common candle may be burnt; but there is no doubt of many practical alterations in his as well as other lamps: and as some of them require the test of application, it would be superfluous to describe the numerous different methods in which these principles, as well as those of other lamps, might be used. I shall be happy to hear of the ultimate experiments furnishing security, as I have no doubt more difficulty will be found in contending with gas in a mine, than in experimenting upon it in the laboratory; as I have had this sufficiently testified by Dr. Clanny's experiments, who, though he obtained the gas immediately from a colliery only five miles from Sunderland, found much difference in its nature after letting it remain a day or two. The fire-damp from the Hepburn Colliery is full of inflammable particles: when burnt it gives a brilliant lambent flame, and emits a stream of bright red scorifications or sparks, which, according to Black, are small combustible substances which explode on inflammation; and not unfrequently, when ignited by the spark of a steel-mill, communicate explosion to the surrounding air. *I* did not find these scorifications so numerous in gases from other mines; but few give out gas wholly free from them.

It must be remembered that Dr. Clanny's original lamp was heavy, strong, and durable, and yet objections were made to it as insecure, from the danger of being broken by splinters of coal falling down, &c. as described in his paper to the Royal Society.* How Sir Humphry

* See page 176.

Davy's lamps will surmount these difficulties I am yet at a loss to ascertain; for the wire gauze is necessarily of so fine a texture, that the least concussion or splinter of coal would penetrate and liberate the flame. It may certainly answer very well for experiment when held with the greatest care, and merely suspended by the hand in a region of gas: but even this will not last long; and in practical application the perpetual hard usage to which it would be subjected requires to be considered in speaking of its merits.

The very circumstance of its being insulated with gauze renders the light feeble, and prevents the application of any sufficient external security; and though the gas burns within, and sometimes expands the flame completely over the inner surface, there are evils arising from it which I fear will be found difficult to remedy.

In fifteen minutes after it is lighted, the heat becomes so intolerable that there is no touching it, a circumstance which must soon render the fine wire unfit for use. In half an hour the small apertures in the wire-gauze become nearly choked up with soot, condensation, &c.; and in one hour the whole becomes totally choked up, except about half an inch at the bottom; and in two hours the light can scarcely be perceived. The air forced through the workings of a mine in ventilation produces a continual dustiness, which, exclusive of the above effects, would soon choke up the apertures, and forming a thin coat of coaly matter on the outer surface would be liable to communicate explosion from the effect of little luminous sparks or flames, created by the inflammation within setting fire to it.

I am aware of the danger I encounter by making any comments upon observations in the Edinburgh Review; but I have perused with satisfaction, in more instances than one, the declared independent principles of that work, and therefore feel no hesitation in remarking what I consider erroneous, and making my observations upon part of the paper relative to Sir Humphry Davy's experiments,* with that freedom which becomes my own judgment, and the information I possess upon the subject.

I candidly confess that I would much rather have excluded any sort of controversy from this work; but when I see a person so eminent, so popular, and so distinguished by abilities as Sir Humphry Davy, claiming originality in inventions, and founding his fame upon

* See Edinburgh Review, No. LI, page 233.

merits which exclusively belong to a sincere and valuable friend, I can no longer abstain from expressing my sentiments.

Notwithstanding my letter in the Tyne Mercury, Dec. 5, 1815, relative to Sir Humphry Davy's visit to the coal district, and the manner of his first obtaining a knowledge of safety lamps, I could see his *discoveries* blazoned about in almost every London and Provincial paper, without thinking of introducing any sort of refutation into the pages of this work, under the conviction that society would ultimately give honour to whom it is due; until I found the language used in expressing them coupling itself with hints of reward, and speaking of him as entitled to a civic crown, for "disarming one of the most powerful agents of destruction." I contend that this merit is due to Dr. Clanny, whatever may be the merit of Sir H. Davy in altering his principle; and although the lamps of Sir H. Davy and Dr. Clanny may appear now as different in their construction as black from white, still it is easy to trace the association of circumstances which produced this difference, without amending the security.

It does not require any wonderful degree of penetration to discover *that it is the quantity of gas admitted to a light which increases the* *power of expansion and explosion, and that as the air sent into the candle of a safety lamp is frequently explosive, it is necessary for security to prevent it from breaking the lamp, or communicating with the surrounding air.* These preventives Dr. Clanny discovered, and some time afterwards Sir H. Davy examined his apparatus.

After this it certainly was not difficult to discover that the air *might* be sent *through oil instead of water*, and that a *piston* might be used instead of *bellows*. This however was so evidently but a simple alteration of Dr. Clanny's invention, that it never was brought publicly forward; or *if* brought forward *was rejected*—that it was tried I have sufficient evidence to testify.

Dr. Clanny had experimented with a tube, having a small perforation to convey the air from a pair of double blast bellows. After this it was not difficult to find out that small air apertures would answer the same purpose: from hence the safety concentric canals, &c. follow in regular succession of ideas; and ultimately the gauze wire apertures are the extremity of refinement, upon a principle clearly originating with Dr. Clanny. And until I am told that any person invented a safety lamp *before* Dr. Clanny, or that subsequent inventions are not produced from a regular association of ideas arising from his plans and experiments, I must still remain in the same opinion.

And here I must repeat what I mentioned in my letter inserted in the Tyne Mercury, that, although M. M. Gay-Lussac, and Thenard refined upon Sir H. Davy's decomposition of the fixed alkalies, he retained all the merit (and which was certainly his due) of being the first discoverer. Controversy may stimulate the exertion of abilities for obtaining the precedence in a secure invention: it is essential however that the public should be rightly informed upon a subject so long neglected, and whereon so much is dependant.

But lest these observations should be construed to extend too far, I must express my opinion that, so long as a man devises any improvements or modifications to the inventions of another, which have a tendency to benefit society, he is entitled to its countenance and protection, as he is thereby rendering the public a service; but this does not authorize him to graft his merit upon a claim to the original idea: on the contrary, by attempting this he derogates from the true liberality of science, and must expect to be opposed.

## CHAPTER XVIII.

*Dr. Clanny's New Lamp, with curious Account of Experiments with his Original Apparatus.*

THE security of Dr. Clanny's original lamp was testified beyond all doubt, by the experiments which were made by him and myself at and in the Harrington Mill Pit: and such was the force of conviction which this trial carried, that some neighbouring viewers began to feel an anxiety for its application. Dr. Clanny having given one of his lamps to Mr. Patterson, the engineer who accompanied us in the mine, with an appropriate inscription, several subsequent and most satisfactory trials were made, some of them in situations where it was thought totally impossible for any light to be introduced: one of these I shall mention. The machinery of the downcast shaft to a mine adjoining the Harrington Mill Pit being under repair, the miners were obliged to remain on the surface away from their work, until the repairs were completed. It was necessary however that the horse-keeper should at times be sent down in order to feed the horses, which could not be done conveniently while alterations were making in the downcast pit.

And to descend the upcast pit and proceed underground to his horses, he would be compelled to pass through a region or tornado of inflammable air, which was looked upon as totally impracticable with lights. This collection of inflammable air arose from particular circumstances. The Hutton Seam of coals, which runs about twenty-four fathoms under the Maudlin Seam, and about one hundred and twenty-five fathoms from the surface, is worked out; the shafts which used to communicate with it are stopped up at the Maudlin Seam, and the air forced down a few staples which remain open, while the waters are permitted to drain into it, which with the gas rapidly and progressively increase. The water having in many parts pent the gas up into a narrow compass, and both of them continuing to accumulate, the gas is forced to rush out through many fissures; and even through the clay scaffoldings which stop up the shafts. It was found necessary in one part to bore a hole of three inches diameter from the Maudlin to the Hutton Seam, in order to give the gas vent; and it was this particular part which it was necessary the horse-keeper should pass. When the wind is north, north-north-east, or north-west, the gas is going down; but when south-east, or east by north, the gas is given up, and rushes through this aperture in the most violent manner, similar to its coming up the cast-iron tubes. Mr. Patterson, convinced that no danger could arise, descended the upcast shaft with the horse-keeper, and passed through this reservoir of gas with Dr. Clanny's lamp; and by this means the man was enabled regularly to attend to his cattle.

The objections to this lamp arise from its requiring a person to work it; and as there is no possibility of altering the principle securely to act otherwise, Dr. Clanny has invented a new lamp, supplying itself with air, and yielding a cheerful and brilliant light.

## *New Lamp.*

The first new lamp of Dr. Clanny's is a modification of the original upon a much more portable scale, and in every respect calculated to answer the purposes of working mines in dangerous places, and of exploring old wastes; providing its introduction into general use is not left to the determination of persons who, from prejudicial motives, will oppose it without consulting either the safety or convenience of the miner.

The second lamp is a curious invention for conveying the air through a volume of steam before it comes in contact with the candle. By this means the explosive power is found to be diminished, and the fire-damp will burn at the wick without exploding, so long as there is a proportion of atmospheric air sufficient for combustion. It was first discovered by Grotthus,* that inflammable mixtures, expanded to six times their volume by heat, would not explode on the application of flame; and that an explosive mixture of two of hydrogen and one of oxygen, heated to sixteen times its volume, would not explode by the electric spark. Dr. Clanny's attention was first drawn to this circumstance from his water-lamp having been carried into an explosive mixture in a mine, without exploding at the wick. At first he was at a loss to discover by what meams this was accomplished, but ultimately found that the man had descended the furnace or upcast shaft, the heat of which had in his descent so completely warmed the water in the cisterns,

* Henry's Chemistry.

that steam was produced and formed a security which was not calculated upon.

## *Description of Lamps.*

Plate VI. fig. 2, represents the lamp upon Dr. Clanny's original principle in a more portable and improved shape; the strata of water being dispensed with, and the air urged in by bellows through the oil which supplies the lamp. The means of carrying this apparatus is to suspend it by a belt on the left side, and fix the bellows like those of a bag-pipe player under the right arm.

*a*, a tube fixed to the lamp, and which conveys the air; *b*, lamp for oils; *c*, air apertures under the burner in the oil; *d*, conducting tube, to which an elastic tube, having the bellows at one end, is fixed; *e*, a pin passed through the tube to prevent the lamp from falling out; *f*, bellows; *g*, the glass.

Fig. 3, in same plate, represents the lamp invented by Dr. Clanny for passing the air necessary for the combustion of the candle through a cistern of steam; *a*, tube by which air is admitted; *b*, tube fitted air-tight in the smaller tube *a*, and which supports the water and steam cistern; *c*, cistern in which the water is kept boiling by the flame of the lamp.

*d*, *d*, tubes, through which the air, after passing up the tube *b*, descends to supply the combustion of the lamp, and then passes up the sides of the cistern out of the chimney; *e*, bottom fitted air-tight; *f*, the glass.

These lamps have been tried in a mine; and on their being presented to the Society of Arts, in May, certificates were sent with them of highly satisfactory experiments. They were, as usual with all inventions sent to this society, referred to a proper committee for investigation, and the silver medal was ultimately awarded to Dr. Clanny, as a testimony of approbation for the modification of his original lamp presented to the Royal Society in 1813.

The steam lamp (as it was then), on being experimented upon, exploded, in consequence of the gas being forced through the tubes much more rapidly than it would have been drawn in, had the lamp been immersed in an inflammable mixture. I thought proper however to put it to the test, and as it failed, to let it stand for further improvement: the air tubes at that time were much shorter and quite open at the bottom; but Dr. Clanny has subsequently made satisfactory improvements by lengthening the tubes, and striking small perforations through the bottom of them.

## CHAPTER XIX.

*On the Necessary Regulation of Collieries.—Explosion of the Wellington Pit.—Observations of Mr. Thomas and Thomas Chapman, Esq. thereon.—Plan for establishing an Office by Act of Parliament, and for appointing Commissioners, and a Master Superintendent, for regulating and inspecting Mines.—Abridgment and Alteration of Mr. Chapman's Rules.*

THE lighting and ventilation of mines, however important to the interests of the country and to humanity, do not combine the whole improvements which are necessary in the mining system. It has now got to such an extent, and the excavations under ground, particularly in the district of the Tyne and Wear, are so immense, that it is essential to the future prosperity of England, to have a regular and systematic principle in the working of collieries; for, exclusive of the dependance a nation has upon her mineral resources, the revenue produced by them ought to make government very watchful over the mining of Great Britain.

Nothing is wanting to prove the impossibility of having any security from the present system; and I have to regret that, even while I am writing this treatise, fresh accidents occur to swell the lists of calamity. The subject had already become too seriously injurious to the happiness of society to be any longer trifled with; but now that we see instances almost every month of our fellow-creatures being destroyed by subterraneous explosion, it is no longer to be endured, and necessity demands that something be done.

On Saturday the 28th of April, 1816, the Wellington pit, near Newcastle, exploded from the ignition of the carburetted hydrogen gas, and raged with terrific fury through the excavations to a distance of two hundred yards in one continued flame. Luckily however this mine had *two shafts,* and the powerful rarefaction of air which was caused by the explosion drew a strong atmospheric current down the Blucher pit; and by this means all except thirteen men escaped: these were dreadfully bruised or scorched, whereas, had it not been the case, every soul must have perished.

Mr. Thomas, in his "Hints for establishing an Office at Newcastle (originally brought forward in 1797, and revived in 1805) for collecting and rendering information relative to the state of the collieries in its neighbourhood; and the progress that has been made as to ascertaining the nature and constitution of the Strata, *below those Seams* to which the working of this Country has been confined," suggests that the proprietors of collieries in the neighbourhood subscribe to such an establishment, and direct their agents to deliver into the office plans of the boundaries, with any other information relating to their respective mines. After this Mr. Thomas suggests eight other rules necessary for the regulation of such office, and which appear very applicable.

Thomas Chapman, Esq. Civil Engineer, suggested some further measures upon this head, and urged the increasing necessity of parliamentary interference. I perfectly coincide in the general rules laid down by these gentlemen, but think they ought to be established under an act of parliament expressly for that purpose, and empowering a superintendent to see all the regulations carried into effect. This ought in the first instance to form the object of the existing society for bettering the state of the mines; and it is to the members I submit the following additions and alterations of former plans. I am well convinced that any institution dependent upon voluntary subscriptions and information would be useless and ineffectual. I therefore suggest that a petition be framed, praying his Majesty's Government to grant an Act of Parliament upon the following grounds.

That an office be established at Newcastle, Shields, or Sunderland, (whichever may be found most convenient,) having a clerk or agent at the remaining two places; to be regulated by five or more commissioners appointed for that purpose, and under the immediate direction of a master superintendent or inspector.

That this establishment should be provided for by a rate upon the coals, mutually affecting the proprietor and lessor. This rate would be comparatively trifling, and ultimately of no pecuniary consideration to either party, as its difference would not be felt by the consumer. Calculating therefore, on the least possible scale, upon the annual exportation of one million of Newcastle chaldrons from the ports on the Tyne and Wear, which by reference to the account of exportations we may fairly presume, and including the land sale collieries, it may be estimated that one million five hundred thousand chaldrons of coals are annually led away from the mines of this district.

A duty of one penny per chaldron upon this quantity, to be paid by the owners or lessees of the mine, and by the act imposed in due moieties or proportions upon each, or wholly upon the proprietor if working his own mine, would produce annually 6,250*l.*

Out of this might be apportioned the salary of the superintendent or inspector and commissioners. Another part to establish a permanent fund for the liquidation of any extraordinary expenses or premiums to persons devising improvements for preserving the security of a mine, provided the necessity and propriety of the means to be adopted be first communicated to the superintendent, and verified by certificates from a sufficient number of persons practically acquainted with the subject; who should lay them before the commissioners; but that nothing relating to the repairs of the machinery, or common and usual working of the mine, should be included in this claim.

That examinations should be made of existing wastes; and if, upon proper investigation, a sufficiency of coal, alumine, or other product, could be depended upon to defray the expenses of draining or otherwise securing such wastes, that they should be let by contract to a person undertaking to perform the same, and to leave the excavated parts in a state of security; and that any profit gained by such contract should relapse into the fund for the general uses of mining.

That another portion of the above proceeds should be substituted for the present benevolent fund; and that, exclusive of the commissioners appointed by government, all proprietors and viewers, on signifying their wishes before a certain day, in any year, should become joint trustees of *this* fund, five of whom should act as a joint committee with the commissioners and superintendent; and that any surplus arising herefrom should subjoin and be transferred to the fund or accumulating annual proceed of the monies applicable to the extraordinary uses of mining.

That the permanent fund should be suffered to accumulate for a certain number of years, after which, dividends should be made out payable to the proprietors and lessees, according to the duty annually paid by them.

An establishment upon principles of this kind could not certainly be deemed oppressive in its tendency: on the contrary, it would be upon a most equitable plan; and, additionally regulated by other arrangements which would develope themselves in the forming of such an act, it would certainly prove beneficial to the country, and a source of security to miners. The expense would ultimately be felt, or probably not felt at all, by the consumer; and I hold it as a principle of common equity, that government should preserve, in the strictest manner, what must always be a source of great assistance to the revenue, what the present population have only a life interest in, and what ought to be transferred in as ample a manner as possible to their successors.

*Principle of the Plans suggested by Mr. Chapman, abridged and altered.*

That on the conclusion or relinquishment of the working of any seam of coals in any colliery, known by any individual designation, the owner or owners, workers or occupiers of the said colliery shall, within nine months after such relinquishment, lodge, or cause to be lodged, in the office of the master superintendent, a duly authenticated and correct plan of the said wrought-out or relinquished seam of coals, drawn on a scale of not less than four chains to an inch, and containing the full extent of the workings of the said coals, distinguishing such parts as are totally wrought out from those where the pillars are left standing; and also with the following particulars delineated upon it, accompanied by proper explanations and marks of reference, viz.

The direction of all dykes or fissures intersecting the seam.

The position and denomination of all the pits.

The precise boundaries of the colliery, so that the unwrought parts and extent of barrier may be known; every drift into such unwrought parts to be correctly delineated as to its direction and extent.

That the direct line of dip or depression be correctly laid down, with all alterations in the course of the seam.

A delineation of all the roads, brooks, and principal objects, permanently situated on the surface, with the compass line and date.

This map, with its delineation and references, shall, after being duly signed and authenticated by the principal coal-viewer or manager of the workings of the colliery and the overman, and secured in a tin case with a label signifying the colliery or seam to which it refers, be lodged, within the period mentioned in the master superintendent's office, under penalties for failure in so doing. This map should likewise be accompanied with a paper of reference, containing the length or depression of strata in various parts of any dyke intersecting the same, the depth and diameter of each pit from the surface, the height and quality of seams, the description and formation of the roof and thill, the faults or troubles, and the relative situation of coal seams in regard to others.

All drifts communicating through the barrier from one seam to another colliery should be noticed; their situation, and whether any stops or frame-dams have been put into such drifts.

All other local or partial circumstances which may preserve authentic information of the pits, staples, scaffoldings &c. in case it may ever become necessary to re-work the seam.

That viewers, &c. who should deliver in plans, as above, of mines which were worked out antecedent to such Act of Parliament, should be entitled to a certain premium, as a stimulus to obtain retrospective information.

That all persons be entitled to see the

documents, and have extracts, on application, twelve months after any seam or colliery is wrought out or relinquished, and on paying the fees to the clerk of the peace.

That on the plan being delivered into the master superintendent's office, notice thereof should be given by the attesting parties to the clerk of the peace to whom the original should be delivered within three months from such notice, after having exact copies taken at the superintendent's office, to obviate the loss of such information by fire or otherwise.

That the superintendent should ascertain the number of seams relinquished or wrought out, and should thereupon request the viewer or other managers, if living, to prepare plans accordingly, and if dead, avail himself of old plans if any are in existence.

That in case any or all of the records in either office be destroyed by fire or other means, the same shall be replaced from the undamaged office properly examined and signed by the parties who originally delivered them in, if living, and if dead, upon being verified by the clerk of the peace and master superintendent; the expense to be borne by the parties requiring the same.

That a separate book shall be kept by the which all information relative to such colliery shall be regularly inserted.

That reports be delivered in quarterly from every mine, verified by viewer, overman, and engineer, of the state of the mine under their charge, and of the machinery used in working them with reference to any alteration since last report.

Under an establishment of this kind the mining system would soon become secured by regular and authentic records; and, by a continual watchfulness to the interests and management of collieries, many of the present dangers would be removed, and we should not be agitated by repeated and destructive accidents.

I am aware that the coal owner has at all times but a speculative property, and frequently sinks an immense capital without knowing how far the deposit of coals may answer his expectations; and sometimes, owing to the working of too great a number of pits at one time, and consequent depreciation in the market, is rendered a great loser by his trade. It as frequently happens that an accident in the mine causes a loss of some thousands of pounds, which naturally makes them look with an eye of jealousy upon any plans of superintendent for every colliery at work, in improvement, &c. which may require immediate expense. But I am of opinion that the placing of mines under the protection of Parliament, and bettering the state of ventilation and light, would tend very much to lessen the recurrence of those accidents, and ultimately remove causes of great loss and trouble.

Having therefore proposed a plan for the better regulating and securing of the mines, I will proceed to show the great national and individual interests which are combined in this extensive trade.

## CHAPTER XX.

*Brief Statement of the Newcastle and Sunderland Coal Trade.*

BEFORE I enter into the particulars of this, it may be necessary to make a few observations upon the great quantities of coal wasted for want of proper regulation in the working or hewing them out, and a proper arrangement of the government duties affecting the exportation of small coal. The English collier only curves the top of the block, and down one side, which causes the uncurved side to shatter considerably on being forced out by the wedge. In this respect he is excelled by the Scottish pitman, who proceeds more economically, and, by curving down both sides, gets the coal out more entire, and with much less waste. This is probably however an established custom of working which it would be difficult to change; but it is certain that from one cause or another, there is a great deal too much small coal made at the Northern English collieries. This has been publicly complained of by Mr. Chapman, whose experience and investigations upon the subject render his opinions very valuable to society.

Mr. Chapman estimates that nearly one fourth of the coals won up the shafts are taken away by screening before they are put on board, some parts of which are used for making cinders, and other parts for making mineral tar; but by far the greater quantity remain in large heaps near the mouth of the pit, exclusive of the waste previously made by hewing the coal underground.

Those heaps which lay on the surface undergo a process of decomposition from the effect of wet, &c., and spontaneously take fire, continuing to burn for a great number of years, and illuminating the country at night in almost all directions.

Mr. Chapman very justly remarks, that the coal thus wasted would be of the greatest service for agricultural purposes, by enabling the farmer to burn lime at a more economical rate than he can possibly do while excluded from the benefits of cheap fuel, and at the same time obviate a great and increasing incumbrance to the soil near the collieries. To accomplish this, Mr. Chapman proposes that the small coals, upon which he would have the coasting duty taken off, should be gauged through parallel metal bars of about half an inch asunder; and, to prevent the introduction of larger coals under this exemption, that the carrier should be liable to the payment of double duty in case of any fraud being detected; with several other regulations tending to secure the revenue from fraud and misapplication.

To induce the coal owners to adopt these measures, if sanctioned by Parliament, a certain tax was by Mr. Chapman's plan proposed to be laid upon the masses of coal accumulated near the pits, according to their dimensions; which would in some measure compel the owner to lessen the heaps, and in future screen smaller quantities. And in order to aid the lessee as much as possible, that the small coals should not be subject to the same rent as others when *led away*, according to the custom of rental at these collieries: but to give the vendor, and at the same time the owner or lessor, a profit, that a charge in the proportion of one fourth of the rent upon large coals, should be imposed upon them; whereby the proprietor would derive gain from what at present lies useless. And that the Duke of Richmond's (now a government) duty of one shilling per chaldron, should be reduced in the same proportion upon small coals.

Much small coal is produced after the coals are taken away from the mine, by the friction on teaming them from the staithways into ships or keels, and by unlading in the Thames, exclusive of the further operation of filling and emptying the sacks from the wharfs. Each chaldron of coals, when delivered from a ship into a lighter, is authenticated by a sworn meter, according to a recent Act of Parliament, at the additional charge to the consumer of four-pence per chaldron.

The coal trade from the Tyne and Wear, and from Hartlepool and Blyth, has continued to increase for many years, and at this time an amazing quantity of coal is vended.

It will be unnecessary to trace the subject through its early gradations. Suffice that, on an average of six years ending 1776, there were annually cleared at the custom-house of Newcastle two hundred and sixty thousand chaldrons to London, ninety-two thousand to British ports and the colonies, and twenty-seven thousand chaldrons to foreign ports.

It appears by a treatise on the coal trade published in the year 1789 by Mr. Beaumont, that France and her dependencies were in the habit of receiving upon an average twenty thousand chaldrons of coals annually from the Tyne and Wear, principally for forging and distillery. This demand has however been subsequently decreased by the war; and it is not expected that it can revive to the former extent, as considerable improvements have in the mean time been made in the collieries of that country, and as coal is found more answerable to their purposes than any they could discover before; a circumstance which I fear will counteract Mr. Beaumont's anticipations, that an increasing population would enhance the price of wood and other fuel, and thus augment her demand of coals upon this country.

Several mines in the county of Durham send their coals entirely to the Tyne; and I believe the coals raised from the following pits are generally sent to that river, and exported principally for manufacturing uses, viz. Simpson's Pontop, Windsor's Pontop, Tanfield Moor,* Hedworth, Hepburn, Eighton, and Pelaw.

* These collieries are not shown in the map given in this book, but lie considerably on the south western side of the county.

| | New. Chal. |
|---|---|
| In 1802 the exportations from the Tyne amounted to...... | 538,489 |
| 1803 ........................ | 549,461 |
| 1804 ........................ | 632,518 |
| 1805 ........................ | 602,400 |
| 1806 ........................ | 633,826 |
| 1807 ........................ | 561,713 |
| 1808 ........................ | 629,447 |
| 1809 ........................ | 564,853 |
| 1810 ........................ | 641,834 |
| 1811 ........................ | 652,325 |

Since which time up to the present period the coal trade of Newcastle has continued nearly the same.

The vend of coals from Sunderland has proportionately increased; and as I am favoured with some very authentic accounts as to the exportation, &c., I shall give them at length. A rapid increase must have taken place in the exports of coal from this port, from 1710 to 1747, as the average exportation from 1704 to 1710 did not exceed 65,760 Newcastle chaldrons, whereas in June 1748 the export of coal amounted in to ............ 147,403

| | |
|---|---|
| 1749 ........................ | 135,549 |
| 1750 ........................ | 162,277 |

| | |
|---|---|
| 1751 | 128,891 |
| 1752 | 177,056 |
| 1753 | 167,242 |
| 1754 | 165,770 |
| 1755 | 174,165 |
| 1756 | 175,122 |
| 1757 | 178,939 |
| 1758 | 187,242 |
| 1759 | 186,681 |
| 1760 | 180,479½ |
| 1761 | 169,610 |
| 1762 | 171,542 |
| 1763 | 182,162 |
| 1764 | 205,468 |
| 1765 | 203,777 |
| 1766 | 205,569 |
| 1767 | 195,205 |
| 1768 | 202,726 |
| 1769 | 212,737 |
| 1770 | 213,645 |
| 1771 | 219,760 |
| 1772 | 253,980 |
| 1773 | 264,232 |
| 1774 | 234,563 |
| 1775 | 285,933 |
| 1776 | 266,287 |
| 1777 | 261,237 |
| 1778 | 252,894 |

| | |
|---|---|
| 1779 | 231,868 |
| 1780 | 233,515 |
| 1781 | 213,552 |
| 1782 | 197,958 |
| 1783 | 224,710 |
| 1784 | 248,204 |
| 1785 | 255,511 |
| 1786 | 271,528 |
| 1787 | 265,560 |
| 1788 | 280,598 |
| 1789 | 269,238 |
| 1790 | 298,077 |
| 1791 | 309,968 |
| 1792 | 303,862 |
| 1793 | 279,862 |
| 1794 | 316,807 |
| 1795 | 301,057 |
| 1796 | 269,170 |
| 1797 | 264,874 |
| 1798 | 285,694 |
| 1799 | 260,929 |
| 1800 | 322,252 |
| 1801 | 267,667 |
| 1802 | 259,011 |
| 1803 | 340,628 |
| 1804 | 290,957 |
| 1805 | 299,226 |
| 1806 | 302,372 |

| | | |
|---|---|---|
| 1807 | ........................ | 297,150 |
| 1808 | ........................ | 315,937 |
| 1809 | ........................ | 311,957 |
| | From June to Dec. 1809.. | 172,928 |
| | Dec. 1809 to Dec. 1810.. | 356,801 |
| 1811 | ........................ | 329,128 |
| 1812 | ........................ | 326,865 |
| 1813 | ........................ | 330,793 |
| 1814 | ........................ | 360,917 |
| 1815 | ........................ | 339,117 |

The proportions in which the respective collieries on the Wear contribute to this exportation, will in some measure be shown by the following account, ending Dec. 31, 1815.

| | New. Chal. |
|---|---|
| 1. Lady Frances Vane Tempest's collieries.................... | 47,960 |
| 2. John George Lambton, Esq..... | 46,149 |
| 3. Messrs. Nesham and Partners... | 18,977 |
| 4. Messrs. Grimshaw and Bonner.. | 14,268 |
| 5. M. J. Davison, Esq. ........... | 11,745 |
| 6. Sir Thos. Liddell and Co. ....... | 7,841 |
| 7. Messrs. Carr and Co. ........... | 7,494 |
| 8. J. Humble, Esq. (Leefield)..... | 6,614 |
| 9. Wm. Russel, Esq. and Co....... | 6,157 |
| 10. Sir Ralph Noel, Bart.......... | 4,210 |

| | |
|---|---|
| 11. Messrs. Thomson and Co., (Urpeth)................... | 1,759 |
| 12. Messrs. Thomson and Co., (Fatfield)................... | 328 |
| Half year's exportation | 173,502 |

*List of Collieries which export from the Tyne.*

| | |
|---|---|
| Adairs | Newcastle Main |
| Backworth | Ords Main |
| Benton | Pelaw Main |
| Bewicke | Pontop Simpson's |
| Brandling Main | Pontop Windsor's |
| Burdon | Shipcote |
| Bishop Main | Tanfield Moor |
| Coxlodge | Tanfield East |
| Chapter | Team |
| Eighton | Townley |
| Eighton High Moor | Usworth |
| Fielding | New Walker |
| Hepburn Main | Wallbottle |
| Heaton | Wall's End, Bell and Co's. |
| Holywell | Wall's End, Bewicke |
| West Heaton | Wall's End, Brown |
| Hunt and Co. Main | Wall's End, Newmarch |
| Killingworth | Wall's End, Manor |
| Kings Meadow | Wall's End, Russel |
| Kenton | Wall's End, Riddell |
| Liddle Main | Willington |
| Murton | Wylam |
| Norfolk | Wortley |

*List of Collieries which export from Sunderland.*

| | |
|---|---|
| Birtley Walls End | Hutton Primrose |
| Bourn Moor | New Eden |
| Brayton | Nesham High Main |
| Eden Main | Nesham |
| Eighton, South | Primrose Main |
| Eighton, Lawson and Co. | Russel New Main |
| Hepburn Wear | Wear Brandling |
| Hedsworth | Wear W. End (Hunt and Co.) |
| Lambton | Lumley |
| Hutton Main | Wear Main |

The quantity of coals sworn to before the commissioners at Sunderland as consumed in potteries, lime-kilns, &c. is about 10,000 chaldrons annually.

An estimate of the number of persons receiving employment from this trade was made in 1792, by Dr. Macnab, who calculated that 64,724 persons were employed by the collieries of the Tyne and Wear, of whom 26,250 belonged to the Wear, and 6,704 were pitmen and boys belonging to the works on the Tyne; and the remainder on the Tyne as follows:

| | |
|---|---|
| Fitters and runners ........... | 103 |
| Keelmen, boys, boatmen, &c. ... | 1,547 |
| Trimmers, ballast heavers, &c. .. | 1,000 |

| | |
|---|---|
| Pilots and foymen ............ | 500 |
| Seamen and boys............. | 8,000 |
| Shipwrights, keel-builders, &c.. | 946 |
| Purveyors for ships' keels ...... | 1,100 |
| Coal factors, clerks, &c........ | 2,000 |
| And if one-fourth of these have families and three in a family unemployed ...... | 16,425 |
| Making a total at that time on the Tyne ............ | 38,325 |

In 1810, Mr. Bailey, in his "General View of the Agriculture of the County of Durham," estimated that there were thirty-four watersale collieries in the county, which annually vended 1,333,000 chaldrons of thirty-six bushels, and employed 7,011 men, and that the land-sale collieries in Durham vended 147,080 similar chaldrons, and employed 382 men. Mr. Bailey calculated that the proportion of coals carried to the Tyne from the Durham pits was as eight to five of those carried to the Wear. The keelmen on the Wear at that time amounted to 750; casters, trimmers, and fitters to 507: so that by the above proportion there would be 2000 persons employed by the Durham trade on the Tyne; making the total amount exclusive of pitmen, seamen, &c. 3,257. The Newcastle coal trade is supposed to employ about 6,530 pitmen; and at this time the pitmen on both rivers may be fairly calculated at 10,000.

Mr. Bailey calculates that the number of men employed in the aggregate, as casters, trimmers, keelmen, &c. is in the proportion of 10,650 to 1,480,080 thirty-six bushel chaldrons. This is nearly the annual exportation of both rivers; so that in the working of pits and conveying coals on board there is about 20,650 persons employed in this district, exclusive of men employed in landsale collieries.

The duties upon coal have been extremely variable; and with all the precaution possible I run much danger, owing to the numerous acts, statutes, &c. relating to them, of making some incorrect statement; but this I have of course endeavoured to avoid, as much as circumstances will admit, by making brief references where I deemed longer ones unnecessary.

In 1421, there was a custom payable to the Crown of two-pence per chaldron on all coals sold to persons not franchised at Newcastle: this however was suffered to run considerably in arrear for nearly a century, until Queen

Elizabeth in 1599, demanded that the arrears should be made up. To avoid this the inhabitants petitioned the Queen, and offered to charge themselves and their successors in perpetuity with one shilling per chaldron providing the claim to these arrears was cancelled, to which Her Majesty assented. An attempt was made in 1610, by the hostmen of Newcastle, to shackle Blythe as a branch of that place with this duty, but it was not then accomplished; it appears however to have been done in 1638. In 1661 a similar attempt was made towards Sunderland but without success; and in 1706 a fruitless effort was made to get it altogether repealed. On Sept. 18, 1677, Charles II. made a grant of this duty to his natural son Charles Duke of Richmond and Lenox, his heirs and assigns, and in default of issue to Louise Duchess of Portsmouth and her heirs, subject to an annuity of five hundred pounds to Sir Thomas Clayes, at a reserved rent of 1*l.* 6*s.* 8*d.* In 1800, the Richmond family sold the proceeds of this duty to Government for 19,000*l.* per annum; whereas, calculating upon the present exportation of coals from Newcastle to persons not franchised at 550,000 chaldron, and Blythe at 50,000, the revenue arising from it amounts to 30,000*l.* annually.

An act 5 and 6 William and Mary, c. 10. passed, entitled "an act for the relief of the orphans and other creditors of the City of London," wherein amongst other things it was enacted that four-pence per chaldron metage-money, over and above the duties then existing, should be imposed upon all coal or culm imported into the port of London from and after June, 1694. In 1700 a further sum of six-pence per chaldron was imposed for and during the term of fifty years, being to the 29th of September, 1750.

21 Geo. II. c. 29. enacted that the import or duty of six-pence per chaldron should remain and continue for the further term of thirty-five years. 27 Geo. III. c. 37. continues the said tax for the term of forty-two years from and after the expiration of the aforesaid term of thirty-five years, which carries it to 1827.

Nothing has been a greater drawback upon the coal trade than the City of London, as appears by the several acts, 19 Car. II. c. 3. s. 36. 22 Car. II. c. 11. 1 James II. c. 15. 8 and 9 Will. III. c. 14. 1 Anne, stat. 2. c. 12. 9 Anne, c. 22. 1 Geo. I. stat. 2. c. 23. But by 5 Geo. I. c. 9. s. 1. the duties imposed by these acts and statutes were put under the control of His Majesty's Commissioners of

Customs for the use of the state, and were made perpetual by 6 Geo. I. c. 4. s. 1. Notwithstanding this it appears by the appendix to the report of the Committee on the Coal Trade in 1800, as delivered to the House of Commons, that in the year 1795 the City received (from the orphan's duty of ten-pence per chaldron, No. 57, of Appendix; metage duty of four-pence per chaldron, No. 58; the Crown allowance of one halfpenny per London chaldron, No. 59; and groundage and balliage of sea coal, No. 60, at half a farthing per chaldron) 55,058*l.* 12*s.* 4*d.*; and in 1800, exclusive of many other dues, 61,898*l.* 14*s.* 3½*d.**

The town's dues at Newcastle have been two-pence per chaldron since 1793, to all classes; the coast duty is now six shillings. In London, King's duty nine shillings and four-pence; war taxes three shillings and two-pence; metage four-pence; orphan's duty ten-pence; and market dues one penny, per London chaldron; also one farthing Lord Mayor's dues, and one penny Trinity dues, per Newcastle chaldron.

* See Letter of Nath. Atcheson, Esq. F.A.S. on the Present State of the Carrying Part of the Coal Trade, published in 1802.

The same duties affect the coals from Sunderland, except the town's dues which are greater than those at Newcastle. In 1747 the commissioners of the town were empowered by Act of Parliament to levy one penny halfpenny per chaldron on the coal owners; and one halfpenny per chaldron on the fitters, for all coals exported from thence, in aid of the necessary repairs of the town, and the preservation of the harbour.

In 1785 this duty was increased to threepence per chaldron upon coal owners, and one penny per chaldron on fitters, making a town charge of four-pence per chaldron. And in 1808 it was further increased to four pence halfpenny on owners, and one penny halfpenny on fitters, making the town charge sixpence per chaldron.

The Newcastle chaldron is nearly equal to two London chaldrons, as it contains sixty-eight Winchester bushels; the London chaldron containing only thirty-six bushels of the same measure.* And by the foregoing statement it appears that the exportations from the Tyne and Wear at this time average one million

* In 1655 it was agreed that 136 Newcastle chaldrons should equal 217 London chaldrons, which was confirmed by Parliament in 1667.

Newcastle chaldrons annually, making about 1,900,000 London chaldrons. An exportation of this extent from our coal district will require an immense supply to continue for many generations; and as the increase of population in London or the country will increase the quantity necessary for consumption, it is requisite for the future welfare and happiness of society, as well as for the protection of our commercial interest, to place the mines under the best possible regulation. The duration of the supply is doubtful, and at all events the resources ought to be administered with caution and public economy.

To show the necessity of this, and improve the condition of miners, has been my principal object, and I submit the information I have collected to the examination of a discerning public, and more particularly to those who have the administration of National affairs, and to the Patrons, Vice-Patrons, and Members of the Society for preventing Accidents in Coal Mines, in the hope that my endeavours will be justly appreciated, and that the subject will receive that attention to which it is so eminently entitled.

# GLOSSARY

OF

# TECHNICAL TERMS

USED IN MINING.

---

*AIR-FUNNEL.*—A large wooden box of a circular shape, open on one side, with a vane on the opposite side to turn its mouth to the wind; it is used to accelerate a current of air through the downcast pit.

*Brattices.*—Partitions of wood used in ventilating the boards in which the miners are at work. In some instances where the cruel practice of having only one shaft is adopted, brattices are used to divide it.

*Brakemen.*—Men employed to work the engines or other machinery used in winning the coals.

*Banksmen.*—Men employed on the surface to unhook and empty the laden corves, as they ascend.

*Bearing door.*—A door which forces the air through more of the workings than one sheth of boards.

*Bearing stopping* answers the same purpose.

*Blower.*—A fissure in any region of the mine from which inflammable gas escapes.

*Boards.*—The principal excavations of mines from which the daily supply of coal is obtained running east and west.

*Corve.*—A strong hosier basket in which coals are brought up the shaft.

*Crossing.*—A brick arch, or lofting of plank, where the currents of air decussate, or intersect at acute angles.

*Cranemen.*—Stout lads employed in raising the corves by the power of a crane, from the trams upon a higher carriage.

*Coursing the Air.*—Passing the current of air up one board and down another, or up and down three or four.

*Cross-cuts* are oblique passages made in extensive workings for the purpose of shortening the way to particular parts of the mine.

*Curve.*—To make an incision in the stratum, in order that the miner may clear the coal out in blocks.

*Drifts.*—Narrow oblong excavations made to carry off water, to convey the air from one shaft to another, or to make researches.

*Frame Dams.*—Beams of timber wedged together for the purpose of draining water.

*Firing Point.*—When the inflammable gas is sufficiently mixed with atmospheric air as to explode on the application of a lighted candle.

*Fire-line.*—A staff with a candle at the end, to fire the carburetted hydrogen on the roof of a mine.

*Falls* are breakings down of the roof of a mine, and frequently injure the workmen very much. In many cases they obstruct the ventilating medium.

*Headways.*—A passage single or double, driven in the longitudinal direction of the coal, and running parallel to another. The two drifts between the shafts are called the double or winning headways.

*Hewers.*—Men employed to cut the coal from the stratum.

*Jenkins* are narrow passages cut through the middle of the pillars for the purpose of getting the coal left in the first working.

*Keeper.*—An inspector of the hewers, &c.

*Low.*—Small candles which the miners use, and which are fixed in pieces of clay in order to hold between his fingers, or stick upon the coal.

*Mothergate.*—The principal avenue, used as a road from the shafts to the workings and extremities of the mine.

*Overman.*—A kind of underviewer, who has command of all the mine below. Mr. Buddle observes, "that the office of overman is of the utmost importance to the management of a coal mine." I admit it is so; but what is the use of this office if the person filling it be permitted to leave the duties to some of the hewers or sinkers; need I name an instance where the overman seldom descends a mine?

*Onsetters* are those who hook and unhook the corves at the bottom of a shaft.

*Pillars.*—The coal left between the boards and headways for the support of the roof, and which is generally in the shape of a parallelogram. The quantity left for this purpose depends upon the depth of the mine, and the *thill* or floor, and roof, which if soft, require more to be left; the general average is from one-fourth to one-sixth of the stratum for pillars; the Walls-end coals are so valuable, that Mr. Russel is taking away all the coals, and substituting stone walls.

*Pot-holes* (Staffordshire).—Holes in the roof of a mine, occasioned by the falling in of the strata in which gas accumulates.

*Stoppings* are partitions of brick and lime to procure ventilation through the wastes or old workings of a colliery.

*Sheth, Sheth-door, Sheth-stoppings, &c.*—Different means used for regulating the passage of the air through the boards, headways, &c.

*Screeners.*—Men employed to screen the coals, which descend an iron screen into the waggon, and suffer the small coal or culm to pass through.

*Shafts.*—The pits sunk down to the coal seams.

*Startings.*—Openings between two headways.

*Thill.*—The floor of the mine.

*Trappers.*—Boys employed to open and shut the doors used in ventilation, &c.

*Wastemen.*—Men employed to examine the mine daily, in order to see that it is properly worked, to clear away all obstructions, to repair the water-courses, air-stoppings, &c. in fact to keep the colliery in perfect order.

*Walls.*—The passages between the boards at the end of each pillar.

## ERRATUM.

Page 90, line 13, *for* "through the strata immediately above the coal," *read* "through the coal intended to be worked."

# APPENDIX.

As numerous circumstances concur at the present moment to render the information contained in this work desirable to society, I have come to a conclusion without availing myself of several authentic documents, which are in preparation for me, on the coal duties, and the present importations of coal in London from the Tyne and Wear. As my main object however consists in showing the absolute danger and great mismanagement of the mines, I trust an omission in this collateral point will be excused: but having just received the following statement, I here insert it for the information of my readers.

*Importations of Coal into the Port of London since 1800.*

| | Chaldrons. | Average of 5 years. |
|---|---|---|
| 1801 ............. | 859,738 | |
| 1802 ............. | 902,284 | |
| 1803 ............. | 940,470 | ....924,761 |
| 1804 ............. | 947,001 | |
| 1805 ............. | 974,314 | |

| | Chaldrons. | Average of 5 years. |
|---|---|---|
| 1806 | 987,750 | 1,010,525 |
| 1807 | 933,148 | |
| 1808 | 1,088,050 | |
| 1809 | 923,440 | |
| 1810 | 1,120,237 | |
| 1811 | 1,115,171 | 1,082,926 |
| 1812 | 1,071,361 | |
| 1813 | 970,898 | |
| 1814 | 1,140,168 | |
| 1815 | 1,117,034 | |

Thus, by the above statement, the duties received by Government and the City have upon an average amounted to the following sums, viz.

| Time. | Government dues of 9*s.* 4*d.* per chal. | City dues, arising from orphan's duty and metage money of ½*d* per chal. | Market dues 1*d.* per chal. |
|---|---|---|---|
| | £. *s.* *d.* | £. *s.* *d.* | £. *s.* *d.* |
| 1800 to 1805 inclusive | 431,554 14 8 | 53,944 7 10 | 3,853 3 5 |
| 1805 to 1810 | 471,579 6 10 | 58,947 5 10 | 4,210 10 5 |
| 1810 to 1815 | 505,365 9 4 | 68,170 13 8 | 4,512 3 10 |

DR. CLANNY has just invented a new apparatus, which burns with a bright flame from an oil lamp when in a current of atmospheric air; but should it be in the neighbourhood of gas, a tube is made to convey hydrogen into the lamp so as to burn like a common gas-light, immediately upon which the oil lamp is extinguished.

# INDEX.

## C.

## R.



## S.



## T.

THE END.

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