How to prevent accidents in collieries : a practical treatise upon the best means of preventing accidents in coal mines, also, advice regarding proceedings after explosion / by Matthias Dunn.

HOW TO PREVENT ACCIDENTS IN COLLIERIES.

A PRACTICAL TREATISE

UPON THE BEST MEANS OF PREVENTING

ACCIDENTS IN COAL MINES,

ALSO,

ADVICE REGARDING PROCEEDINGS AFTER EXPLOSION.

BY MATTHIAS DUNN,

GOVERNMENT INSPECTOR OF MINES IN THE NORTH OF ENGLAND, AND AUTHOR OF THE "WINNING AND WORKING OF COLLIERIES."

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HOW TO PREVENT

ACCIDENTS IN COLLIERIES.

In the year 1852, I published a tract under the above title, which was extensively distributed throughout the North of England, and was intended as a familiar address to warn both colliers and proprietors against the evil effects of careless arrangements, and also to inform managers and the public of the general principles of safety where the same are carried out to perfection.

Since that period, and after the establishment of the Mine Inspection Act, in 1850, and the Newcastle Mining Institute in 1862, much practical experience has been acquired, and mining science has been most extensively circulated by means of the published periodical records of the Mine Inspectors.

Notwithstanding all this, we are constantly witnessing the most appalling results from unforeseen circumstances, as well as from ignorant and negligent management. It has, therefore, occurred to me to revise and enlarge the said tract as follows.

The extraordinary repetition of serious accidents in the coal districts, together with the speculative opinions of writers in the public journals, have induced me seriously to reflect whether something cannot be done to extend practical knowledge, both to the managers and workmen, as to the arrangements proper for an extensive and fiery colliery, as well as ordinary collieries having more or less risk ; for it is often the subject of observation, and frequently an ascertained fact, that the managers or colliers have been guilty of some fatal

oversight, and that, if proper precaution had been used, either the accident might have been prevented, or the extent of the damage diminished.

The examination of practical and scientific persons before Parliamentary Committees of the House of Lords and Commons, although printed at large, as also the Official Annual Reports of the Inspectors, are not accessible to the working colliers, who have no other specific caution for their conduct except their own crude knowledge, and the printed regulations of certain collieries with regard to the management of the safety lamp, so that great ignorance prevails as to the general arrangements of the mine, its machinery, and its ventilation. Therefore, in case of explosion or other violent accident, each person is left to his own immediate resources, instead of being previously acquainted with circumstances which might very possibly enable him to save his own life, as well as more effectually to save the lives of others.

Many lives are lost for want of proper means being at hand to restore ventilation, and obtain speedy access to the interior workings of the mine—the delay of which is fatal to many a poor sufferer. It is desirable that managing persons should be acquainted with the most advisable means of restoring animation to those who may be found sinking under the influence of deleterious gases, and in the absence of a necessary quantum of fresh air.

It is also desirable that means should be available for conveying wounded men from the scene of the accident to their homes, which are frequently distant.

The result of explosions shews that many lives are also lost by persons who, wanting presence of mind, do not rest in those parts of the workings which, although deprived of circulation by the temporary derangement of the air courses, yet may contain sufficent quantities of atmospheric air to sustain life for many hours; whereas to attempt to rush through the after-damp may produce certain death. Such was the

case at the Houghton explosion, in 1850, where, by the blowing away of one of the crossings at the distance of 300 yards from the pit bottom, no less than thirty men and boys were cut off from all communication with the shaft by the after-damp, where they remained unhurt for the period of six hours, until the ventilation was restored, whereas, had they attempted to escape, they would have undoubtedly perished. In the explosion at Aberdare, in 1855, also, whilst no less than sixty persons were found killed by the after-damp within 100 yards of the shaft, some of the horses, considerably beyond them, were found alive and unhurt in the workings.*

It cannot be concealed that in many cases persons are entrusted with the management of mines who are really ignorant both of the theory and practice; whilst others, again, have the credit of being the responsible underground managers, whilst all their movements are directed and controlled by a superior owner or agent, who never goes below ground, and who is practically unacquainted with the subject.

This state of things very frequently obtains throughout the Southern Coal Districts of England, but scarcely ever in the North, where the collieries are managed by professional men, who are mostly well educated, and who have served regular apprenticeships to the profession of a viewer, for, without such a course of instruction, it is impossible for a person to qualify himself for the management of an extensive colliery producing inflammable gas, and requiring the improved science of ventilation. Very many such men may now be had, provided the owners will pay adequate salaries.

* It is well to bear in mind that after-damp is lighter than the common air, and will prevail next the roof; whilst choke-damp is heavier, and most abundant towards the bottom or floor. At the Aberdare explosion, two men were saved by strongly pressing a wet cloth to their mouths in passing through the after-damp; whilst seven of their companions, who did not adopt that precaution, were killed.

A great error in this branch of the subject is committed in assigning to the underground manager duties belonging to the upper ground department, such as the management of books, the payment of money, &c.; not only diverting his attention and responsibility, but holding out a temptation to dishonesty. The office, therefore, of the viewer of an important colliery, ought to be confined to his underground visitations, the making of the surveys, keeping up the plans, and scrutinizing the costs of working and arranging all for the paying of the money.

In order, therefore, to induce reflection, and to anticipate danger of every description, I have determined to collect together an assortment of the various causes of death, and to devise such antidotes as may fall within the province of both managers and workmen, in order that these sorrowful results may not only be avoided, but that, when they do unhappily occur, their evil consequences may be diminished; the whole to be comprised in so cheap and simple a form, that the arrangements of each colliery may be tested by the rules here laid down, and the desired knowledge circulated throughout the whole mining population.

There is reason to believe that many boiler explosions emanate from an excessive size of the boiler, and where set with a wheel flue; also, where only a single fire is applied to a boiler 30 feet in length, and 5 or 5½ feet in diameter—the intense firing necessary to heat so large a body of water tending to diminish the strength of the plate immediately above the fire.

The first Reports of the Government Inspectors, after the passing of the Mine Inspection Act in 1850, shewed the following proportions of deaths from the various causes therein enumerated from the 21st of November, 1850, to the 30th of June, 1851, as follow:—

	Miscellaneous.	Shafts	Falls of Roofs.	Explosions.	Total.
Jos. Dickenson—Staffordshire, Shropshire, Worcestershire, Cheshire, Lancashire, Denbighshire, Flintshire, and Anglesea	37	70	122	53	282
Chas. Morton—Yorkshire, Derbyshire, Nottinghamshire, Leicestershire, and Warwickshire	16	15	12	15	58
M. Dunn—Durham, Northumberland, and Cumberland	30	13	21	8	72
M. Dunn—Scotland, for a month less...	9	19	22	62	112
Totals	92	117	177	138	524

524 in 7 months = 900 per annum. Their being no Official Report of the South Wales district during the same period, I assume it at 250, making in all 1,150 deaths per annum, the mortality of which, from recent events, appears to be on the increase.

Without adverting to the numerous annual returns since the aforesaid, I give the results for 1861 as follows:

	Explosions.	Falls in Mines	In Shafts	Miscellaneous.	Gross Total.
Northumberland, Cumberland, and North Durham	10	40	9	40	99
South Durham	1	30	10	35	76
North and East Lancashire	20	31	18	13	82
West Lancashire and North Wales	31	32	19	22	104
Yorkshire	...	...	...	...	...
Derbyshire, Nottinghamshire, Leicestershire, and Warwickshire	3	21	15	30	69
North Staffordshire, Cheshire, and Shropshire	3	14	20	5	42
South Staffordshire and Worcestershire	13	78	27	16	134
Monmouthshire, Gloucestershire, Somersetshire, and Devonshire.....	4	44	7	14	69
South Wales	16	63	11	20	110
Eastern District of Scotland	4	22	5	21	52
Western Do.	4	21	7	5	37
Total lives lost in 1861	109	396	148	221	874
Do. do. in 1860	363	388	182	176	1109

The foregoing statistics give us the means of forming a judgment of the many risks which are constantly overhanging persons employed in coal mines, and enable us to weigh the degree of success which would probably attach to a circulation of practical suggestions for their prevention.

1. *Miscellaneous Accidents*—Amongst the miscellaneous deaths, many have occurred to boys from being crushed by tubs and rolleys; kicked by horses; some are killed by carbonic acid gas, or by underground furnace smoke; drawn over the pulley; accidents about the engine and waggonways, especially the sudden disconnection of the crank and rope shafts, breaking in of water, and other causes too varied to particularise, and which can only be guarded against by the redoubled caution of the employers and employed, by instituting good and simple machinery, and by placing it under the charge of steady and intelligent managers.

2. *Accidents in Shafts.*—The accidents in shafts arise from persons falling down either from intermediate seams or from the surface, for in many districts numerous old shafts are left unprotected, whilst the custom is retained of employing the skip or basket, instead of the modern improvement of slides and cages; breakage of ropes and chains—the use of the latter cannot be too strongly deprecated, and are now abolished, because their nature and strength is continually varying; the cages getting out of the conductors; persons becoming entangled in the chain at the bottom; also by stones and coals falling down, and out of shafts left undefended or from bricks or timber falling out.

To the credit of the North of England, chains have long been utterly discarded for the drawing of coals; nor should they be tolerated anywhere, either for safety or economy, where life is concerned. Where slides are employed, they ought to be regularly examined by some responsible person, as well as the ropes and the state of the shafts.

Four inventions are now more or less in use, one by Mr. Fourdrinier, and the others by Messrs. White and Grant, Messrs Owen and Co., and Mr. Aytoun, for the purpose of arresting the tub in case of breakage of the rope. The latter two are much preferred on account of their simplicity; but the ropes ought not to be so worn as to depend upon so indefinite an apparatus where such tremendous loads are being carried, and where it is difficult to maintain the apparatus complete; indeed these inventions are nearly extinct in the North of England, notwithstanding which scarcely ever an accident happens from the breakage of ropes. A strict rule should be enforced that not exceeding a certain number of persons should be allowed to risk themselves at one time, for the men are exceedingly careless upon this head. Where coals are sent away from an upper seam, a trusty person ought to be placed, and not allow the ordinary putters discretionary power. In consequence of the slides being almost universal in the North of England, accidents in the shafts are remarkably few in comparison to the numbers of the people and the rapidity of the motion.

3. *Falls of Roofs.*—By the returns, it will be seen that the falls of roofs are, upon the aggregate, much more fatal than explosions, especially in Scotland and the Staffordshire districts, in the latter of which the 30 feet seam and the butty collier systems prevail, the latter of which is replete with evils.

It is impossible to divest coal mining of danger from falls of roofs, especially where the pillars are being taken away, and the whole strata broken; but this danger is considerably increased where the seam is high and butty colliers or contractors are employed, or where the common colliers are made to bring down from the pit head and set their own timber, or where the timber provided by the owner is either too scanty or is furnished of too small a diameter. The casualty of death under any of these circumstances

cannot be too closely scrutinised; therefore, the colliers, whose lives are at risk, ought not to hesitate to complain of any neglect, for where they are made accountable, and do not complain, it is quite common to hear the fatality laid to their charge from being regardless of their own safety.

The objection to contractors lies in their having no permanent interest in the mine, and thus necessarily seeking, by every little saving, to diminish the cost of production; whilst the chief owners conclude that they are not personally accountable. Therefore, it is obligatory upon the colliers to look out for their own safety by complaining in case of neglect.

4 *Explosions of Gas.*—Although explosions are not so extensively fatal as falls of roofs, yet they come upon the public mind with more appalling effect, because the calamity is sudden, is generally unlooked for, is attended with numerous deaths, and the grief extensively circulated amongst friends and relatives, many of whom are left unprovided for; inasmuch as they not only include a number of persons by the same stroke, but for the damage done to the mine, and the time required for the restoration of the ventilation, so that great delay often takes place, attended with prolonged anxiety and excitement, independent of the loss of life from the after-damp arising from the explosion.

Much delusion often prevails regarding the actual state of that part of the mine where the explosion originates, which may be altogether at variance with its general condition, therefore it will be well to particularise some of the chief circumstances in such a case.

1st. The colliery may be generally deficient in ventilating power in regard to the aggregate column.

2nd. The general ventilation may be unobjectionable; but it may be either too much diffused, or ill arranged, and inadequately guided

3rd. However well-arranged, in a general point of view, each working place may require the aid of brat-

tices and doors to carry of the gas discharging from the coal, and this, again, demands adequate attendance.

4th. These doors and brattices may be ill-constructed, or may be formed of small coal, or canvas, or neglected to be carried forward sufficiently near the face.

5th. Some unusual discharge of gas from a blower or bad coal may overpower the air, which is ordinarily sufficient.

6th. Falls or stoppages may take place in the workings or the waste, so as to derange or adulterate the air, and so take the naked lights by surprise.

7th. Often the use of safety lamps is left to the managament and discretion of the colliers. Where they are agreed to be necessary, they are often suffered to become imperfect, and to go unlocked, as also to be opened for the purpose of blasting the coal, which not unfrequently leads to mischief, whilst the colliers sometimes covertly draw the flame through the gauze to light their pipes

8th. The mischief of after-damp is greatly increased if the excavations wherein the bearing stoppings are placed be wide—if the stoppings are built of wood, or made of small coal. Therefore, in all well-regulated collieries, the permanent stoppings are built of brick or stone, plastered with lime, and supported by several yards of stowing.

9th. The course of the main air currents, too, should be preserved, by means of double doors, placed at proper intervals from each other upon the main roads, so that one door shall always remain shut whilst the other is open, but the number of doors in modern times is greatly diminished by the subdivision of the air and the adoption of crossings; indeed, well-regulated pits have scarcely any doors in the principal passages.

10th. It is requisite and advisable, in extensive collieries, to split or subdivide the principal air cur-

rent, so as to avoid carrying the gas which is made in one district into the working places of another; but if this subdividing be carried to an excess, then certain parts of the mine may be left without an adequate quantity of atmospheric air to neutralise the gas. This splitting system cannot be accomplished without crossings, which ought to be formed of brick, with substantial plank coverings well stayed down from the roof, and the discharge over those crossings regulated by slide stoppings, to prevent the shorter air course from robbing and injuring those which are more distant.

11th. The main air courses should be guarded by frame doors kept by boys; but the interior of the workings is often provided with swing doors, with a view of saving the door-keeper, and, if well fitted up, they are calculated to stand against neglect; but they are capable of great improvement, such as the fitting them up in two parts with artificial means of restoring them to position; for the striking of the tub is apt to cause breakage in the ordinary door, and so subject the places to become foul. Sail cloth tarred is often substituted for fly or swing doors, which answers for ordinary cases.

12th. The main principle which puts all into motion and maintains all in stability, is an adequate and suitable proportion of upcast and downcast shafts, with powerful furnaces kept constantly at work, and, where necessary, fed with pure air, with an ample establishment of overmen, deputies, and wastemen, whose daily and hourly attention is devoted to watch the ever varying circumstances of the mine, and upon whose judgment and experience much of the safety of a fiery colliery depends; for it is their judgment, in conjunction with the viewer, which ought to direct where to use candles, and where safety lamps, &c. In recent times fan blasts and various devices have been substituted for the furnace, but many fatal consequences have resulted from their inefficiency and occasiona cessation.

13th. So many fatal accidents have occurred in consequence of the mismanagement of the safety lamps, that, in provident collieries, printed notices are posted up at the entrance of the lamp districts, for the purpose of warning persons against taking naked lights beyond, and also warning them with regard to the employment or withdrawal of the safety lamps in cases of unlooked-for danger. I here transcribe the chief points contained in the printed notices circulated amongst the workmen of collieries in the North of England which are subject to the influence of fire-damp.

General printed Cautions respectiny the proper Use of the Safety Lamps, &c., attended with Penalties :—

1. The overman to fix upon proper stations for notice boards, beyond which no naked lights, lanthorns, or tobacco pipes are to be taken, as also to stop working places becoming dangerous.

2. No lamp to be taken away without it being properly examined and locked by the overman or other officer duly appointed, who shall also control their use during the day, and also, in certain cases, insist upon a tin shield being used.

3. Should any accident happen to the lamp whilst in use, the light to be immediately extinguished by drawing down the wick with the pricker, and the lamp taken to the station for examination.

4. Every person to take home his own gauge and clean it, to be fitted to the bottom, and examined by the lamp keeper.

5. In case of the presence of gas being detected, the lamp wick to be pulled down, and to retreat gradually to the station, giving information to the overman or deputy, as it is forbidden to work where fire-damp is observable.

6. Every hewer and other person is prohibited from interfering with the lamp whilst beyond the naked light station, except for the necessary trimming of the lamp with the pricker, and shall not suspend the lamp upon the row of props adjacent to the goaf or the old works, keeping down the shield and hanging it secure from the stowing of the gear.

7. In case of losing his light, he must take it to the station, to be there examined, and lighted by some responsible person.

8. Lamps not permitted to be carried by the putters or horse drivers, but stationary lights to be adopted.

9. Persons using lamps found in possession of pipes or tobacco, liable to be fined or taken before a magistrate ; and no matches permitted to be taken down the pit.

10. Persons witnessing improper treatment of the safety lamp obliged to give information of the same.

11. Overmen and deputies to examine every working place before the men commence work.

12. Every working place to be sufficiently timbered by the deputies; and the brattice in no case to be further back from the face than six feet.

13. Safety lamps to be exclusively used in the drawing of timber, and stow boards, as also the travelling of the wastes; the condition of which to be daily reported and recorded.

14. The banksmen and onsetters to regulate the number of persons to be trusted at once upon the rope, according to the orders of the viewer.

15. Brakesmen to regulate a slow movement when men and boys are riding the shaft.

16. Ropes, chains, slides, &c., to be daily examined by responsible persons.

17. A barometer to be kept at the bottom of the shaft, to indicate the changes of the atmosphere; and a regular register kept.

18. That no blasting be allowed where safety lamps are judged necessary.

19. That persons observing anything wrong with respect of doors, brattices, or otherwise, shall give immediate information to the overman or deputies of the pit.

20. That the furnace be in no case left without attendance.

21. That a record be kept of the quantum of air passing into each district of the workings, to be ascertained as follows :—

1. Measure off 20 or 30 yards in length of a passage pretty uniform in size, which put into feet.

2. Multiply the average height, width, and length together, which will give the cubic feet in that distance.

3. Let off a flash of gunpowder, and ascertain, by a stop watch, how many seconds the said smoke requires to pass the said distance.

4. Say, as the said seconds are to the said cubical content, so are 60 seconds to the number of cubic feet per minute passing.

Example :—Width 6 feet × height 5 feet = 30; length 90, = 2,700 inches, say 40 seconds.

As 40 sec. : 2,700 : : 60 = 4,050 cubic feet per minute.

When the first safety lamps (the invention of the late Sir Humphrey Davy) were introduced at Hebburn Colliery in 1816, they were frequently worked red hot. In these days, they are not allowed to work if the air is so impure as to exhibit flame inside the lamp.

14th. The condition of the air in the mine is much affected by the state of the atmosphere; for, when it lightens, as shewn by the fall of the barometer, the

pressure, which before pent up the gas within the cavities of the strata, being diminished, a proportionate increase of the discharge takes place, which not unfrequently takes the unwary by surprise in the sudden adulteration of the air. To guard against such contingencies, it is now customary to provide a barometer near the bottom of the shaft, the deviations of which are regularly noted and registered by the overmen and deputies It may be stated in round numbers that, for every degree which the barometer falls, the pressure upon each square foot will be diminished 74 lbs.

15th. An ample stock of deal brattices and brattice cloths should be kept on hand, in collieries liable to explosion, for the purpose of quickly restoring ventilation, and also provision for quickly applying a waterfall at the downcast shaft as a temporary substitute for the furnace after explosion, which it is often unsafe to keep lit, also, the power of applying a steam jet at the upcast shaft.

16th. That some simple and ready apparatus be kept in the office or in the pit, whereby to operate readily upon persons found in a state of suspended animation, instead of bringing them to the surface before being properly revived, such as ordinary bellows.

17th. Also that salves or oils suitable for applying to burnt persons be kept upon the premises, instead of waiting till the arrival of the surgeon.

18th. In case of approaching drowned workings, there is no safety without a front bore hole, and right and left slope holes in the leading drifts, never less than five or six yards of coal being left good, and between each slope hole, about four or five yards. As necessary appendages to the boring a set of wooden plugs to be at hand.

19th. It is next to imperative that the fresh air shall be taken into the workings without going through any waste.

20th. Connected with the furnace ought to be a dumb drift, in order that the return air (if foul) should be taken to the upcast shaft without passing over the fire.

Having thus described the principal machinery by which the workings of an extensive and fiery colliery are governed, I will, at the risk of repetition, sum up with some suggestions as to the duties of managers and workmen in anticipation of dangers which are constantly occurring, and for the more effectual resuscitation of the collier, and the recovery of the dead and the wounded. :—

General Arrangements of the Pit.

1st. The downcast and upcast shafts must be ample, and the latter furnished with an efficient furnace or other ventilating power, kept on day and night.

2nd. The currents to be so arranged, that no air from the goaves, or other part of the mine making gas, shall come upon the naked lights of the workmen.

3rd. In the arranging and splitting of such air currents, care must be taken not to diminish the currents to such a degree as to render them unequal to the carrying away of the gas made in the working places, which is too frequently the case.

4th. The principal stoppings guiding each main current of air to be built of brick or stone in narrow places, plastered with lime, and supported by a few yards of stowing, to guard against the effects of an explosion.

5th. Each main current (where doors are necessary) to be guarded by two at least, kept by separate trappers.

6th. The more perfect the arrangement of the air, the fewer doors are required, for where doors are necessary, irregularity in the air is consequent.

7th. Where brattices are necessary in the working places, they should be contracted at the intake, and pointed towards the entering current.

8th. For single places, swing doors perhaps are the safest, when fitted up upon a proper principle, and well looked after, for they are subject to damage from the stroke of the tub.

9th. All the working places should be examined before the workmen are suffered to enter them; and they are to be directed by some responsible person whether to work with a safety lamp or candle.

10th. In case of a safety lamp being necessary, the blasting with gunpowder should not be permitted. It is a delusion to fancy that because the shot is fired with touch paper it lessens the danger. If gas be there, the explosion of the shot will inflame it, regardless of the manner of firing.

11th. Printed regulations as to the use of the lamps, and the better to guard against accidents, should be distributed freely amongst the workmen, embracing both their conduct in the pit, and also the number of persons who are to venture at one time upon the rope; also, printed notices should be placed at the doors separating the naked lights from the safety lamps, with trusty doorkeepers at them.

12th. The safety lamps should be provided by the owner, kept under the charge and examination of a properly qualified person, and not left to the care of the common collier. The lamps should also be kept locked and examined before being put to use.

13th. The examination of ropes, chains, slides, boilers, &c., should be put under the charge of scientific and responsible persons, and duly examined.

14th. The air courses in the waste ought to be maintained in adequate size, according to the proportion of air passing in each department, the main return never to be less than 30 to 40 feet area; but, where the collieries are very extensive, and the accumulation of 12 or 15 split airs is collected, there is need of double this area. No pit, however harmless, should have less than 10,000 or 12,000 cubic feet per minute.

15th. It is needless to observe that suitable timber, in abundant quantity, ought to be provided, and experienced, understanding men appointed to set it, for the preservation of the workmen, who ought not to be left to their own judgment and discretion.

16th. Many lives are lost by the bursting of boilers. It is therefore a good precaution to have them fitted up with duplicate safety valves, and duplicate feed apparatus ; and, perhaps, a steam whistle would be a great safeguard to give notice of the decline of the water, and to check the other apparatus.

17th. Where coals are sent away from an upper seam, or men and boys are changed at that seam, a person should be appointed to guard them, and to prevent individual putters from running into danger. Many accidents have happened in Scotland for want of the shafts being roomed out and heightened at the bottom, and for want of proper signals to the manager of the engine, between the top and bottom of pit.

18th. That subordination and submission to orders ought to be maintained amongst the workmen, especially in respect to the safety of themselves and their comrades, it being the principle that the workmen are not the proper judges regarding their own safety. Many lives have been lost by the insubordination of the hewers neglecting to prop as directed by the overman, although the props were lying at their feet.

19th. In case of explosion, if a person has sufficient notice, it is good to throw himself upon his face till the blast passes over him ; and as soon as he is satisfied that it is over, (for it is frequently repeated at the interval of a minute or two) let him calm his fears as much as possible, and make his way out towards the fresh air. It is found of practical advantage in such straits, to cover the mouth with a damp cloth. Many persons are lost from undue agitation. If he is not seriously burnt by the blast, although in a part of the workings which are deprived of ventilation, yet the

air may be quite respirable, and in sufficient quantity to sustain life for many hours.

According to the late Dr. Glover, 666 cubic feet of air will sustain a healthy man for 24 hours; therefore, taking an ordinary working place to be 12 feet wide, 4 feet high, and 4 feet long, the air in that place will sustain a person nearly 7 hours; and in collieries where the chief air stoppings are well secured, it seldom happens that so long a period elapses before the air is so far restored as to allow the miners to be reached.

Upon the occurrence of an explosion, the whole ventilation of the colliery should *pro. tem.* be turned into that quarter, reinstating the stoppings with wooden brattices, stuffed with hay, and doors temporarily erected, or brattice cloth.

And it is of the utmost moment for some authorised persons not only to arrange regular relays of people with proper leaders, but also to restrain unwary persons from rushing before the air to their own destruction, recollecting that the first and main object is to direct a temporary current of fresh air towards the locality of the sufferers.

I must, therefore, be excused for repeating, that it is *imperative that the chief air currents be secured by brick or stone stoppings, defended by* 6 *or* 8 *yards of stowing, and that the place appointed for the stopping be not exceeding* 6 *or* 8 *feet in width.* Where the stoppings are formed by a top deal stowed against with rubbish, the blast is liable to sweep them out, and access to the miners is fatally delayed. It is mostly unsafe to continue the furnace whilst the pit is in a deranged state; therefore, a water-fall at the downcast shaft is very effectual for increasing the air current, and in some cases a steam jet in the upcast shaft is useful.

I here reprint some rules, which were published by the South Shields Committee, from French authorities, for the treatment of persons affected with the *after-*

damp, which consists of 8 parts of nitrogen, 2 of aqueous vapour, and one of carbonic acid gas. Where the nitrogen abounds in large proportions, the safety lamp will continue to burn even when the miner is struck down :—

1. Remove the person into pure air.
2. Undress him, and throw on the body effusions of cold water.
3. Endeavour to make him swallow cold water slightly acidulated with vinegar.
4. Clysters should be given, two-thirds of cold water, and one-third of vinegar, &c.
5. Irritate the pituitary membrane with the feather end of a quill, or stimulate with a bottle of volatile alkali put under the nose.
6. Introduce air into the lungs by blowing with the nozzle of a bellows into one of the nostrils, and compressing the other with the fingers, at the same time endeavour to give motion to the chest, &c. Therefore it is well to anticipate explosion by having ready prepared a supply of water mixed with a little brandy ; and also a couple of common house bellows, to be applied as soon as ever the person is removed in moderate fresh air, instead of fatiguing him before he is sufficiently recovered.

MINES INSPECTION ACT.

Acting on the excitement occasioned by repeated heavy explosions and inundations, whereby the public sympathies were roused, successive parliamentary committees were organized, whereat many scientific and practical persons were examined, and at length an act of parliament was passed in November, 1850, appointing four Government Inspectors, viz. : Matthias Dunn, Herbert Mackworth, Charles Morton, and Kenyon Blackwell, as an experiment which might be followed up by amendments according to experience.

The portion allotted to me under this arrangement were the counties of Durham, Northumberland, Cumberland, and the whole of Scotland. It is not necessary to particularize the others. The reports to be made to the Home Office every six months.

In the year 1855 six other inspectors were appointed, which appointments have, from time to time, been changed by death and otherwise, and ultimately settled at a total of twelve for England, Scotland, and Wales.

At the period of 1855 the act of parliament, 18 and 19 Vict, was promulgated, containing, amongst other matters, seven general rules, to be adopted for the safety of the miners; which general rules were afterwards, by 23 and 24 Victoria, increased to fifteen, arising out of various discussions and correspondences between the Secretary of State and the Inspectors, which included iron-stone mines.

The following are the amended General Rules :—

1. An adequate amount of ventilation shall be constantly produced in all coal mines or collieries, and ironstone mines, to dilute and render harmless noxious gases to such an extent that the working places of the pits, levels, and workings of every such colliery and mine, and the travelling roads to and from such working-places shall, under ordinary circumstances, be in a fit state for working and passing therein.

2. All entrances to any place not in actual course of working and extension, and suspected to contain dangerous gas of any kind, shall be properly fenced off so as to prevent access thereto.

3. Whenever safety lamps are required to be used, they shall be first examined and securely locked by a person or persons duly authorized for this purpose.

4. Every shaft or pit which is out of use, or used only as an air-pit, shall be securely fenced.

5. Every working and pumping pit or shaft shall be properly fenced when operations shall have ceased or been suspended.

6. Every working and pumping pit or shaft, where the natural strata, under ordinary circumstances, are not safe, shall be securely cased or lined, or otherwise made secure.

7. Every working pit or shaft shall be provided with some proper means of communicating distinct and definite signals from the bottom of the shaft to the surface, and from the surface to the bottom of the shaft.

8. All underground self-acting and engine planes on which persons travel are to be provided with some proper means of signalling between the stopping-places and the ends of the planes, and with sufficient places of refuge at the sides of such planes at intervals of not more than twenty yards.

9. A sufficient cover overhead shall be used when lowering or raising persons in every working pit or shaft where required by the inspectors.

10. No single-linked chain shall be used for lowering or raising persons in any working pit or shaft, except the short coupling chain attached to the cage or load.

11. Flanges or horns of sufficient length or diameter shall be attached to the drum of every machine used for lowering or raising persons.

12. A proper indicator, to show the position of the load in the pit or shaft, and also an adequate break, shall be attached to every machine, worked by steam or water power, used for lowering or raising persons.

13. Every steam boiler shall be provided with a proper steam guage, water guage, and safety valve.

14. The fly wheel of every engine shall be securely fenced.

15. Sufficient bore-holes shall be kept in advance, and, if necessary, on both sides to prevent inundations in every working approaching a place likely to contain a dangerous accumulation of water.

In addition to the above General Rules, the following regulations are provided for :—

That no boy under 12 years of age be employed in mines, with the exception of boys between 10 and 12 who have certificates as to education and school attendance, and that a penalty of not more than £10, nor less than £5, be inflicted for every false certificate.

That Steam Engines in certain cases are not to be under the charge of persons under 18 years of age.

That the Secretary of State have power to appoint Inspectors of Mines, but that no Land Agent, or Manager of Mines, be allowed to act as Inspector

That the Inspector have power to inspect the different parts of the Mine, at all reasonable hours.

That owners of mines produce maps or plans of Mines to Inspectors; and, if owners do not produce Maps, &c., the Inspector may then require them to be made.

That notice of accidents in mines be given, within 24 hours after occurring, to the Secretary of State, under a penalty of £20.

That every coroner holding an inquest upon the body, give notice to the Inspector of the district in which such accident happened, so that he may attend and watch the proceedings.

That notice be given to the Inspector when any mine is abandoned, or when a new working has commenced.

That owners or agents of collieries who may neglect to provide General or Special Rules, or violate any of the Special Rules, shall be subject to a fine not exceeding £5, or imprisoned, with or without hard labour, for a period not exceeding three calendar months.

That every person obstructing the Inspector in the execution of his duty be liable to a penalty not exceeding £10.

That any person defacing notices, &c., be liable to a fine of 40s.; certified copies of Special Rules to be evidence.

That it be the duty of every Inspector to make a report of his proceedings during the preceding year, on or before the first day of March in every year, and transmit the same to one of Her Majesty's principal Secretaries of State.

That wages be paid to persons employed in Mines, or his representatives in money, and that, when payment of persons employed in Mines is by weight, &c., an account to be kept.

Having enumerated at length the arrangements which are both salutary and economical on the part of the owner and manager, I will follow them up with some recommendations to the colliers, whose duty it is to look beforehand and anticipate danger. When accidents happen, it is quite common to hear that this, that, and the other were known to be wrong — the brattice was not kept up, or badly made—that the air was insufficient, and the stoppings badly constructed—the furnace was ill kept—lamps should have been used instead of candles—their places were not sufficiently propped—two doors should have been set instead of one—such an overman was not a fit man, &c.

I am, therefore, going to suggest that every pit's crew shall elect a committee of three or five intelligent and reasonable men, who shall entreat of the manager to make them acquainted with the general arrangements of the colliery, such as the air courses, the splits, the furnaces, and such other of the general principles of management, as may enable them not only to make suggestions for their own safety, but to be competent to act more efficiently upon the emergency of an explosion, in reinstating the colliery and in relieving the sufferers; for, if a collier understands no more of the general arrangements of an extensive mine than belongs to his individual place, much valuable time is lost in obtaining access to the place of the misfortune, which might redound to the saving of life.

The committee, above suggested, might often, also, with advantage, communicate with the Inspector of the district, and lay before him any deficiency which may exist in the provisions for safety. He would, in such case, be bound to aid them with his advice and interference, and with whom such communications are held confidential; whilst it is a moral impossibility for his personally visiting those places which are continually varying their position. Under such circumstances, occasional reference to him might be most salutary.

I am not unaware of the allegation, that men are often visited with vindictiveness who venture to speak about any imaginary danger; and, although that may be true in some isolated cases, yet, I flatter myself, that very few proprietors of collieries will so far demean themselves as to treat with severity any communications made in a respectful and becoming manner, upon a subject wherein their own interests and character are so immensely involved.

And I think it would be a dangerous responsibility for any agent to treat with disregard the truthful application of reasonable and respectful workmen upon a subject of life and death to them, and of serious consequence to the emlpoyer; because, if he were so fool-hardy, and death ensued, most assuredly he would be visited with signal punishment, whilst his employer would be no longer warranted in holding him in connection.

And, lastly, should such application prove unsatisfactory to the men, they ought to avail themselves of the advantages which parliament has provided for them under the amended Act of 1855. At the same time, I earnestly urge that a good feeling should be maintained with the employer, by addressing him in a reasonable spirit; and, instead of calling upon the Inspector to interfere officially, it may often happen, that he may be of service in reconciling any difference

which may arise, instead of going to extremities, to the production of strikes and ill will.

I will now advert to a Society which has been recently established in London, under the title of the "Accidental Death Society," which the proprietary are anxious to have extensively established amongst the collieries, upon the following principle, viz. :—

Accidental Death Insurance Company, 7, Bank Buildings, Lothbury, London, for granting insurances against accidents of every description.

Rates for persons employed in collieries, &c.

For 1d. a week, or 4s. 4d. a year, £10 in case of death by accident of any kind ; £5 for the loss of a limb or of an eye ; £5 for a broken leg or arm.

For 2d. a week, or 8s. 8d. a year, £25 in case of death by accident of any kind ; £12. 10s. for the loss of a limb or of an eye ; £12. 10s. for a broken leg or arm. And so on in proportion for any larger amount of insurance.

As it is impossible that this Society can deal with the colliers individually, and, as the owners are averse to taking any dictatorial part in its establishment, I have suggested that it may be worked with great simplicity and effect if once made the rule of the colliery, similar to what is practised in many great works in respect to education, viz., that every worker shall contribute one penny a week, which payment shall be kept off his wages by the agent of the colliery, and the respective sums paid in case of accident; if taken up by the owners, they would be enabled to make better terms than colliers could do individually.

But to induce the proprietors of collieries to cause such arrangements to be enacted, some such petition as the following should be signed by a majority of the workmen, and submitted to their employer, who, I have reason to believe, would, in that case, cause the arrangement to be carried out, and which could not fail to be a great boon, for it would not interfere in the slightest degree with any other club or society, or with the poor rates, or smart money, customarily paid by the proprietor.

Petition to the Owners of Colliery.

We, the undersigned, forming the majority of the workmen of this colliery, are desirous of availing ourselves of the advantages offered by the "Accidental Death Insurance Company," whereby the payment of one penny per week will ensure us the sum of £5 in the case of a broken limb, and to our surviving relatives, the sum of £10 in case of death by any accident whatever, as explained by their published cards.

But, finding that we cannot accomplish this desired object individually, we respectfully request that you will enforce a regulation in the colliery to the above effect.

To witness the dreadful effects to poor families in these cases of distress, it cannot be doubted that a provision of this nature would be highly commendable, and, especially where it can be carried out with a wealthy company, and be managed in a simple and inexpensive manner, and at a small sacrifice of money.

I will now present a notice of the causes and results of a series of explosions and other fatalities which have occurred, and have been officially examined into, since the passing of the Act for "The Prevention of Accidents in Collieries" in November, 1850; because persons will be able to recognize circumstances analogous to some of the cases with which they have been intimately connected, and may be brought to conclude that, with ordinary caution, and the practical application of the knowledge already existing, many of these lives might have been saved.

1. *Borrowstowness Colliery,* December 14, 1850.—Two persons killed by choke-damp. The water had been drawn from an old waste, which was succeeded by carbonic acid gas, when these persons were incautious enough to penetrate into the workings without any specific circulation of atmospheric air, and they were found dead at the shaft from the effects of carbonic acid gas.

2. *Garscube Colliery, Scotland,* Dec. 21, 1850.—Five persons killed by the smoke of an underground engine. The smoke from the engine, after passing through the waste, was expected to ascend an upcast

shaft; but, as that shaft was possessed of no other ventilating power, and contained a great deal of falling water, the air reversed, and this smoke passed through a narrow drift into the workings, in which five persons were suffocated close to the shaft.

3. *Nitshill Explosion in Scotland*, March 15, 1851.—61 killed. This colliery had an abundant downcast and upcast shaft, with a tube fitted for a furnace; but so well satisfied was the manager with the ventilation, that the furnace had been discontinued for some months. Many of the principal stoppings were of brick, and many of slit deal, to carry the air round the extremity of the workings; but there were no "sheth" stoppings in the waste. The accident was attributed to the damage of one of these stoppings, whilst the want of internal stoppings allowed the air to pass straight to the upcast shaft; and, as the men were permitted to begin work without the examination of an overman, the gas discharged from the waste fired upon their naked lights.

4. *Washington Explosion*, August 19th, 1851.—28 men and boys killed. Here the upcast shaft was only seven feet in diameter. The total air was about 28,000 cubic feet divided into five parts, and the quota allotted to the workings which exploded would be about 6,000 or 7,000 cubic feet, the security of which depended on single doors; whilst the bratticing of the places was not scrupulously carried out. The ventilation had been for several weeks in a very unsatisfactory state, as exhibited by the appearance of gas upon the candle; so much so, indeed, that several persons had left their work, but the managers were not impressed with any fear of consequences. Still, the bulk of the men continued to work till the explosion took place; and it never occurred to any one to communicate with the Inspector, whose report at the inquest shewed that there was great want of ordinary caution and sufficiency of ventilation to supply so many splits.

5. *Killingworth Explosion*, Oct. 31, 1851.—9 persons killed The scene of the explosion was a very limited exploration in the whole coal, which was 6½ feet thick, and lying at a very considerable angle, and 190 fathoms from the surface. The whole ventilation of the colliery consisted of about 30,000 cubic feet per minute, the upcast shaft being 12 feet in diameter, operated upon by two furnaces. The air was four times split, and the portion devoted to the district in question was about 6,000 feet. In consequence of some trifling fires, the workings were all carried on with safety lamps, the naked lights being ordered to be left at an adjacent door. The leading headways were 20 yards apart, and holed at intervals of 40 yards, which occasioned 60 yards of bratticed air to each holing. It appeared in evidence, that one of the men had, contrary to orders, taken into the said workings both gunpowder and candles, and the presumption is, that such disregard of orders had occasioned the accident. During the investigation, it came out that the ventilation was much deteriorated by the extreme wetness of the upcast shaft, which neutralized the effect of the furnaces ; for since then a proper repair has been made, and the amount of ventilation has been nearly doubled.

6. *Busby Colliery, Ayrshire*, December, 1851.—Three persons killed by fall of stone. Some unusually large pillars were being worked away ; the roof was excellent, so that it would not fall till a large excavation was effected. No managing man had been in the pit for some days; and the usual custom prevailed of the colliers bringing down and setting their own timber, part of which timber was much too small for this purpose. The timber being set in a straggling, irregular manner, an immense mass of roof came down, without warning, and killed three, other three very narrowly escaping.

7. *Hebburn*, May, 1852, whereby 23 persons were killed. The aggregate ventilation of this colliery,

whose downcast and upcast shafts were each 12 feet diameter, was upwards of 70,000 cubic feet per minute, the air was six times split; but the quantum allotted to the workings in which the explosion occurred was not much more than 4,000. There was need of all the places being bratticed, with doors at the board ends, the seam being 5½ feet in height; whilst the men worked with the safety lamps, but were permitted to open them for the purpose of blasting the coal The principal stoppings were all well constructed and stowed; and the air was so naturally governed by regulating stoppings, that not a single door was employed in the rolleyways, some of which were 2,000 yards in length. A single board 37 yards long, becoming foul from the neglect of a door (two of which were kept by one boy) is supposed to have produced the disaster; the greater part of the men were killed by the after-damp, occasioned by the blowing away of a pair of doors, at the distance of 220 yards from the place of explosion, which carried the ventilating current forward, rather than by the quantity of fire.

8. *Guindraeth, South Wales.*—27 lives were lost by holing abruptly into some old drowned workings; and it does not appear that any systematic boreholes had been carried on to discover the exact position of the said waste, which precaution is necessary in all such cases.

9. *Middle Duffryn Explosion, Aberdare*, 1855.—68 lives lost. This pit was ventilated by a furnace and an occasional steam jet, to the amount, it is said, of about 28,000 cubic feet, which was three times split; and the workings were carried on with naked lights. They had an engine pit and coal pit, the latter of which was bratticed, and formed the upcast and downcast, the engine pit being shut off The explosion was attributed to some gas having come suddenly off from a fall, and that it had fired at the furnace. Mr. Blackwell, after a previous explosion, had recommended lamps, to do away with the shaft brattices,

and to cause a dumb furnace to be provided, not one of which suggestions had been attended to. The stoppings used near the lower part were 18 inches thick of dry wall, and the upper part of mortar, backed with 8 or 10 yards of rubbish. The men were made to go up and down the engine shaft by means of ladders; for it does not appear that they had slides. Not more than 30 acres were mined over, which were mostly standing in pillars. The arrangements of the ventilation demanded no less than 35 doors, the necessary leakage of which would require a much more ample current than 28,000 feet.

10. *Coppul Explosion*—36 persons killed. In this case, both downcast and upcast pits were 12 feet diameter; but, in ordinary, no ventilating power was employed, the small furnace at the bottom of the shaft being seldom used, and, in lieu of it, a small common lamp was suspended in the shaft. In several parts of the air course the area was only 10 or 12 feet. The stoppings were all built of coarse coal and rubbish, and the air was all retained in one column. The colliers and drawers were bound to provide their own safety lamps; and, it appears that rather than lose their work, they would risk working with the candles, notwithstanding the alarm of gas. The mine was understood to be well ventilated; but it does not appear what quantity of air was passing.

11. *Lundhill Explosion*, 1857, whereby 189 persons were killed. A paper on this subject was brought before the Mining Institute, by the President, in May, 1858, and comprised—

I. The system of working.

II. The system of ventilation.

III. The distribution of the air with the numerous doors, regulators, and other artificial means used in such distribution.

The Lundhill Colliery was working the Barnsley bed of coal, 6 or 8 feet in thickness, the customary mode of working being by *board gates* and *benks*;

benks being the excavated part, which is all well where the seam makes no gas, but, otherwise, the gas lodges in the upper part of the benks, and forms magazines of gas, therefore dangerous to work with naked lights. In this case the lights used were candles, so that falls and interruptions of the air were constantly to be feared, as driving out the gas upon the candles. In my opinion this was the proximate cause of the explosion. The colliery had two shafts, with powerful furnace, supposed to produce from 50,000 to 60 000 cub. feet of air per minute, split into two divisions. The distribution of air throughout the working places was injudicious, fifty-three doors being required to keep the air current in its proper course; eight board-gates in the pit, with single doors, which ought to have been double. The whole of this part of the system therefore was objectionable. The use of lamps and naked lights was left much to the discretion of the workmen, as well as with tops on or tops off, in the working places and benks. This is the third severe explosion in this same district under similar circumstances, and would have been avoided by the use of safety lamps. The fire had been general throughout the benks which had been mostly filled with inflammable air. No gas, it appears, had exhibited itself in any alarming way to the workmen.

Other collieries in the neighbourhood were working on the same system, so that the question of improvement becomes a very serious one. If the Government Inspector of Mines knew that such a system was in operation, it might become a question as to what would be his duty.

The President said that no candle had been used since the accident; but no such notice had been given previous to the explosion. The furnace, was now supplied entirely with fresh air, lest a firing should take place there, which some suspected had taken place previously. The return air now went through a dumb drift into the upcast shaft.

The splitting of the air in many parts of Yorkshire is little understood. Regulators were found advantageous to supplant doors

According to the above exposition, such a state of things should not have been permitted to exist, and the wonder is, that workmen can be kept in ignorance of the extreme danger they are daily running.

12. *Burradon Explosion,* March 2, 1860, whereby 74 lives were lost. The leading features of this catastrophe were as follow:—The workings were carried on in the low main seam, at a depth from the surface of 145 fath. with a ventilating furnace in the yard coal 30 fath. above. The establishment consisted of two shafts, each 10 feet in diam. ; the downcast for the drawing of coals, and the other as a pumping shaft as well as upcast, in which the pumping apparatus greatly diminished the space. The total ventilation was about 24,000 cubic feet per minute; and the pillars, in certain districts, just begun to be worked. In consequence of which the managers had instituted considerable changes in the ventilation, such as doubling the number of splits in the air, and, as a matter of course, lessening each detailed air current, whilst the facts elicited during the investigation shewed that the air-courses, generally speaking, were greatly deficient in space, and much neglected.

The impending catastrophe was shewn forth in the evidence of several of the colliers, who described the weakness and unsteadiness of the air current, and the manner in which it was loaded by the increasing gases, so much so, that many of them left the colliery. At length the fatal day arrived, viz., on the 2nd March, 1860, when the explosion burst forth. The population of the neighbourhood were roused to exertion, and all ran to endeavour to extricate the unfortunate beings who were down the pit. In the meantime the proceedings at the coroner's inquest were made doubly important by the employment of several lawyers, viz., Mr. Philipson, Mr. Serjeant Bal-

lantyne, Mr. Blackwell, Mr. Lockey Harle, Mr. Longstaff, &c., as well as various viewers and others, called in by one or other of the parties.

According to the evidence of some of the men belonging to the colliery, the deficient state of the ventilation was obvious for some time previous, and ought to have created greater anxiety than had taken place, and so averted the dreadful consequences.

Walter Nicholson, collier :—

Have you reported the pit to be foul? Yes; I have? How often? Three or four different times, when I found it foul, after the 23rd January—Reported it to Mr. Berkely

William Dryden left the pit for fear of explosion. He spoke to the alarming state of the air exhibited by the candle, and upon showing it to his neighbour Carr, he said "Oh! how way hame," and I said "I'm going." I came away and told persons about the pit there would be an explosion. If it does not happen now, it will happen, and not be long. I said I would beg my bread before I would go down that pit again, in the state she is in. They afterwards said they had discovered the cause of the state of the air, and I offered to go back again, but was told that in consequence of what I had said, I was not to start again :—that was on the 6th of February.

He described the appearance of the candle, in consequence of the gas. It was a blue lowe, mixed with a little grey on the top of the candle, and about an inch and a half long. There was no door, because there was no air—scarce any.

After twelve days of tedious examination, during which various and conflicting opinions were expressed, the jury, after a lapse of two hours, came to the following verdict :—

The Jury say, "that the said Mr. Wilckie, on the 2nd of March, was killed by an explosion of gas in Burradon Colliery, and have come to the conclusion that the accident has been caused either by the fall in the North Return, or, from Thirlwell's door being left open; also, that there has been part neglect or oversight of some of the officials connected with the colliery, and the workmen in not complaining to the proper quarter of the state of the ventilation. The Jury beg at the same time to recommend that additional government inspectors, or sub-inspectors, be appointed to examine mines, to enable more frequent official visits to be paid to the workings, and with increased power to control the arrangements of those which may be in an unsafe or critical position."

The conclusion of my Annual Report adverts to the Burradon explosion in the following terms :—

"If the evidence of the workmen as to the state of the pit was correct, it is impossible to doubt that such state was well known to the officials, therefore, it was equally their duty and interest to call for some supervision ; the danger being alike to all, and the obligation to officials greater. I beg to express my regret at finding it my duty to reflect on many of the defects in the management of the colliery.

"An important object is to be attained, with regard to the future. The character which this district has justly obtained for advanced knowledge of mining, the magnitude of the calamity, and the free and unlimited scope that has been devoted to the enquiry, have led the public to expect that some extensive knowledge would be acquired as to the cause and prevention of such accidents.

"Great and astounding contradictions arose as to the amount of the ventilation and the direct cause of the explosion, but no sooner did they begin to scrutinize the waste and reorganize the pit, than it was discovered that the air courses were entirely deficient, requiring the employment of great numbers of men constantly to enlarge them, &c."

13. *Risca, South Wales,* Dec. 7th, 1860—Explosion, by which 130 men and boys, and 28 horses were killed. The workings in the black vein seam, 6 to 8½ feet in thickness, had previously been examined and reported to be safe, when 200 colliers proceeded to their work, soon after which the explosion took place. The effects of the explosion were fatal in almost every part of the extensive workings of the pit, which is 150 yards deep ; and the black vein seam is remarkable for its produce of inflammable gas. The extent of the workings were said to be three miles, and within 15 years 40 lives have been lost in this colliery. The recklessness of the colliers was spoken of as the cause, also the precautionary conduct of the managers was much called in question, as well as the main principle of the mode of working and ventilating—for there the grand question was raised during the investigation. Mr. Harrison, the viewer and manager, was from the North of England, and was esteemed a good practical man, but it came out in evidence that he was overruled in his management by the superior agent.

The pit was ventilated by Mr. Strueve's machinery, and was said to command nearly 40,000 cubic feet of air

per minute, but some of the witnesses spoke to great leakages from the main current.

Mr. Brough the Government Inspector, in his evidence, gave the following statistics :—

Ventilation caused by mechanical exhaustion. Six sets of main-doors in the various levels; cross headings have mostly double doors, and on almost every stall a frame-door, also with a canvass sheet between every double door. The airometer pit is oval, 16 feet by 10 feet, and 70 yards deep. The winding shaft is of the same dimensions, and 148 yards deep; distance between shafts, 480 yards. Diameter of ventilating cylinders, 18 feet each, and stroke 12 feet, speed 8 strokes per minute, which, if perfect, would give 48,858 cubic feet per minute, but on account of various deductions would not be more than 40,000.

Mr. Brough was of opinion that more splits would have been desirable. Had recommended a new sinking, with a reiteration to the same effect at the end of his examination. After lamenting the absence of Mr. Dobson, the consulting viewer, the jury then came to the following verdict :—

"That the deceased died from the effects of an explosion of fire damp at the Black Vein Pit, which gas was given off suddenly, but there is no evidence to shew how that gas ignited. The jury recommend that the present rules be revised, that the working places he more frequently inspected, and that the workings be so arranged that future explosions may be confined to distinct localities, and that a new shaft be sunk for the permanent improvement of the ventilation of the colliery."

14. *The Hetton Colliery Explosion,* Dec. 20, 1860, whereby 22 persons lost their lives. This may be characterized as one of those strange and unlooked for events which are so frequently recorded in the history of colliery explosions, inasmuch as it occurred in a colliery possessing the most ample ventilation in the coal trade, there being 180,000 cubic feet of air, per minute, in the East and West Minor Pits immediately before the explosion, and in a portion of the mine close to the downcast shaft, and entirely away from any accumulation of gas in the interior of the workings. The general circumstances of the case were

as follow :—Very near to the shaft was situated an underground engine, with boiler 28 feet by 6 feet diam. The smoke from the boiler had to pass along an underground flue or chimney, till it was delivered into a portion of the upcast shaft. This boiler chamber and fire were fed with fresh air direct from the shaft, and an iron damper in the flue served to regulate the draft. Previous to the explosion, the fire had been damped, and the damper nearly closed, but the subsequent investigation shewed that this arrangement had had the effect of producing a gradual development of gas of the most explosive nature, characterized by the chemical witnesses as carbonic oxide. It would appear that this gas had gradually accumulated, so as to fill the said flue with 7,000 cubic feet of gas, which gas had, by some unexplained event, become ignited, and exploded in the most appalling manner : for, what with the shock, and the effects of the after-damp which followed, no less than 22 men and boys, and 36 horses and ponies were killed. The destruction to the shaft, stables, &c., cannot be described ; but, suffice it to say, that many months elapsed before coal work could be resumed, and the cost and damage amounted to many thousand pounds. At the inquest the jury returned the following verdict :—

We find that John Grieve, and twenty-one other persons, on the 20th Day of December now last past, came to their death in the East and West Minor Pits, Hetton Colliery, in the Parish, Ward, and County aforesaid, by an explosion of inflammable gas, accumulated in the flue leading from the boiler fire of Davison's engine to the upcast shaft, which gas was not generated in the workings of the said pits."

15. *Clay Cross Inundation*, July, 1861—23 lives lost. This calamity arose from the circumstance of an insufficient barrier being left between the old workings and those made from a subsequent winning. The old workings appeared to have been extended 42 yards beyond the line specified by the old plan, and the great queston raised was, that such should have

been the case, whilst the plans and management were in the hands of the same parties; further, that no systematic boring had been carried on, although the Act of 1860 expressly provides in 15th sec. "that sufficient bore holes be kept in advance, and if necessary, on both sides, in every working approaching a place likely to contain a dangerous accumulation of water." Facts proved the plans to be erroneous, and they should not have been depended upon—and in such case the new workings should have been carried forward with three bore holes. The verdict of the Jury was accidental death, but accompanied with the recommendation that, in all cases where a distance to a barrier is proposed to be made, notice should be given to the Inspector, so as to provide for the safety of the mine, and that owners should drain old workings on the property they are working.

16. *Summerlee Colliery, Scotland,* August, 1861.—A number of persons were suffocated by the coal getting on fire from the ventilating furnace below ground, and the communicating medium being a single bratticed shaft with wooded sides, which, together with the shaft frame and pullies, were burnt down. Forty-five persons were in the pit at the time, and were only rescued after days of labour to form a communication with some of the old works. Several persons died from exhaustion, and the occurrence raised a great clamour against wooded single shafts.*

17. *Hartley Colliery,* Jan. 16, 1862.—Loss of 204 lives, in consequence of the breaking of the engine pump beam that overhung the single shaft, which, in the fall of it and other materials, so damaged the timber in the shaft, as to utterly prevent the escape of the men who had reached the yard coal seam, by means of a ladder in the air staple between the yard coal and the low main, which had been provided by the foresight of the inspector of mines, to guard against

* Many of the Shafts in Scotland are oblong in form with a wooden brattice down the centre, whilst the sides are formed also of wood planking.

the drowning of the lower seam by any sudden influx of water from the surrounding wastes. The workmen in the interior of the mine being shut up in the yard coal seam, were every one killed by choke-damp, produced either by the dying embers of the ventilating furnace, or the noxious vapours from the mine, now deprived of active ventilation. Five of these unfortunate men lost their lives at the period of the fracture of the beam, as they were coming up the shaft, it being the time for changing the shifts ; the others in the manner above-mentioned, occasioning an extensive sensation against single shafts, and their dangers in cases of explosion or inundation.

The annals of mining, which embrace many varied causes of accidents, such as explosions, inundations, &c., have seldom, if ever, recorded a more signal illustration of the dangers attendant on mining operations, than the Hartley catastrophe. Yet, with all its appalling results, it has not been without its lesson, for since that time the question as to the necessity of double shafts has frequently been discussed, and it is admitted, both by practical and scientific men, that they are imperatively necessary where a proper regard is entertained for good ventilation and for the safety of the workmen, although many great and destructive explosions have occurred in collieries having duplicate shafts. The result of an inquiry into this lamentable occurrence has induced the Secretary of State to require the Inspectors to furnish returns of the number of single shafts in each district, with their capabilities of being duplicated, which may propably lead to a conditional order, after allowing a reasonable time for the carrying of such into effect.

18. *Gethin Colliery, South Wales,* March, 1862—In this case 47 persons perished, part from fire, but the greatest part from choke-damp or after-damp. During the inquest, which lasted many days, a great variety of conflicting evidence was given as to the previous state of the pit, managed as it was by a viewer from

the North of England. The enquiry was carried on in the presence of Messrs. Lionel Brough, and Thos. Evans, Government Inspectors, and also Mr. Kenyon Blackwell, who was sent by the Government to attend the enquiry and examine the pit, and whose evidence, (which had great weight with the Court and Jury) was to the following effect—"Good and well arranged ventilation, not liable to be destroyed by the shock of an explosion, which should be confined to a limited district, ought to be sought for by every mining engineer in the pits under his charge, *but such arrangements did not exist in this pit.*" The verdict of the Jury was as follows :—

"1.—The ventilation of Gethin pit was deficient in quantity, badly arranged, and liable to frequent interruption.

"2.—That the viewer disregarded the first General Rule, and also permitted the Special Rules 16, 18, 24, 26, 31. 34, 37, and 63 to be generally disregarded by the officers, and we find a verdict of manslaughter against John Moody."

Bilston, June 2nd, 1862.—This lamentable catastrophe, by which the lives of four men and three boys were sacrificed, occurred in the following manner :—As it was known that there was an accumulation of water in the thick coal seam, a level was being driven from the pit shaft, known as No. 7 of the Gubbin ironstone measure, with the view of draining it off, and it was into this level that the irruption of water took place. Above the level which was being driven, gate roads in the thick coal were known to extend, with a thickness of only about 4 feet intervening, and the roof was of a somewhat friable nature, but it was thought that the level had not been driven within 13 or 14 feet of the water. In reliance on this belief, a blast to bring down about 5 inches of the roof, no doubt at the very time the water was lying close above, was applied. The chartermaster was in the level a short time before the accident, and observed no indications of water there, but no sooner had he reached the surface than a rush of water and the cries

of men were heard. The skip was at once lowered but the scaffold was gone, the shaft filling immediately with carbonic acid gas, which was not cleared out until the lower measures were emptied of water. It was stated that no boring rod had recently been employed. The following verdict was returned by the jury :—

"That the death of the seven deceased persons was caused by a rush of water into the pit in which they were working, occasioned by the neglect of John Harvey, senior ; but the jury do not consider the evidence sufficient to criminate him."

GOVERNMENT INSPECTION.

The subject of government inspection of collieries, until an Act was obtained, used to be thought the panacea of the numerous evils which attend colliery operations, but very few persons agreed as to the useful extent of such inspection, nor how it would operate.

First, it was laid down as a principle that Parliament must not be too stringent, and must make a reasonable allowance (as compared with the Continent, where the mines all belong to Government), on account of the mines all belonging to private companies or individuals, but that the law should be so framed as to protect the workmen against the negligence or rashness of the owners or manager, and to check and control the system rather than attempt to meddle with minute details. Hence they have constantly refused to countenance sub-inspectors, especially those taken from amongst the uneducated colliers.

The practical question, therefore, seems to hinge upon the number requisite to keep a controlling eye over the colliery operations of England, Wales, and Scotland, under considerable Parliamentary powers hereinbefore referred to.

In perusing the lists of casualties published in the reports of the inspectors, it will be seen that the deaths by explosions are by no means so numerous as many other of the classifications over which the office of inspector can have little or no control, such as falls of the roof. It is true that the principle and quantum of ventilation, with the mode of conducting it through the interior, can be overlooked; and it is in this department that the most appalling accidents occur. The minor details are greatly out of the province of the inspector, but the office and its duties serve to record the progress of science and practical improvements, and hence is entitled to honourable notice.

As a remarkable instance of the utility of Government Inspection, I may mention the following case which occurred in connection with the Hartley catastrophe. In July, 1861, the workmen requested me to examine the colliery, and ascertain the dangers apprehended from some drowned workings then being bored against. After a minute examination of the point in question, I addressed a report to the owners and to the workmen, which contained the following passage :— "As a safeguard against the danger of a heavy discharge of water, I think it imperative that an efficient and convenient ladder (long since arranged for) should be completed without delay, at the Yard Coal Staple, as a means of escape for the miners."

My suggestion was accordingly complied with.

The above circumstance is fully corroborated by Mr. Blackwell in his report of February, 1862, to the Home Secretary, in the following terms :—

"The Inspector of Mines for the district, recognizing the danger to be apprehended at the Hartley Pit from a possible sudden influx of water, and for the improvement of the ventilation of the pit had, during the period while these drifts were in progress, induced the proprietors to sink a staple from the yard to the low main seam at a point where the latter was fourteen fathoms higher than the mouth of the stone drift by which the workings in that seam were connected with the shaft; this staple was, therefore, to some extent, out of the reach of water.

"The Inspector had also procured the placing of a ladder in this staple, by which, after the accident, all those who were then in the low main workings reached the yard seam."

As a most important element in the consideration of the Inspection Act, and the well working of the system, I may mention that, at a meeting of the Inspectors, in the year 1858, having previously had communication on the subject with the Secretary of State, I submitted the following suggestions to the meeting, founded upon the published evidence of important explosions, in which it was shown that for many months previous to the catastrophe the mines had been working under the most dangerous state of mismanagement, the particulars of which were entirely unknown to the Inspectors until the sitting of the inquest. And assuming that, if such were the case in collieries which had been for years under inspection, similar cases must be obvious when a new Inspector is appointed to a district where he has previously had little professional knowledge, how is he to acquire such general acquaintance with the circumstances of the collieries as to draw his attention to the most dangerous and the most pressing cases? It cannot but require great time and labour, be he ever so active and solicitous to do his duty.

Impressed, therefore, with these facts, I submitted to the Inspectors the suggestion that each Inspector should be empowered to issue a circular to such collieries as he had reason to suspect required scrutiny, demanding returns as to the chief points of danger or management, such as follow :—

BELOW GROUND.

1. Principles of ventilation, natural or artificial.
2. By lamp or furnace, dimensions of do.
3. If other means, state particulars.
4. Area of downcast shaft.
5. Do. upcast.
6. Depth of each working seam.
7. Total quantity of air per minute.
8. How many times split.

9. How many doors in the pit—nature of.
10. Safety lamps or naked lights.
11. Are lamps daily inspected and locked.
12. Furthest extent of workings.
13. Principle of working.
14. Drawing shafts, how fitted up.
15. Ropes or chains.
16. What sort of brattice.
17. Do. stoppings.
18. Are plans kept.
19. Name of responsible viewer, also resident.
20. Rules, are they printed and distributed.
21. Number of persons allowed on the rope at once.

ABOVE GROUND.

1. Engines, first or second motion.
2. Has each engineman a fireman.
3. Is the shaft put up with guides.
4. Tubs, skips, or baskets.
5. Weight drawn at a pull.
6. Boilers, what safeguard as to steam.
7. Do. water supply.
8. Are resting catches employed.
9. Are there signals between top and bottom.
10. Who takes charge of machinery.

A good deal of discussion arose upon the subject, but no specific resolution was come to, my suggestions having met with no reponse. However I introduced the subject into that year's annual report, and I may add that subsequent experience has fortified me in the opinion that, had such suggestions been acted upon, some of the late calamities would have been averted.

CORONERS' INQUESTS.

A very important branch of the working of the Inspection Act hangs upon the conducting of the case by the coroner and jury. In the first place, the coroner assumes the privilege of ruling in his court despotically, as to the nature of the evidence, and especially as to the right of the government inspector putting questions to witnesses independent of the coroner, although the nature of the enquiry may essentially require the

technical knowledge of the inspector to suggest questions that the coroner is unwilling to put, especially in cases where professional lawyers are employed. Again, by the present state of the law, the verdict of the jury is confined to accidental death or manslaughter, whereas it often happens that, although great blame is attached to persons having charge, yet it is not that species of misconduct which would rationally call for a verdict of manslaughter, consequently the defendant escapes with the verdict of accidental death —not to mention the very frequent occurrence of persons being placed upon the jury who are directly or indirectly interwoven with the influences of the colliery proprietor or his agent. I often hear it remarked by Coroners, how advantageous the deodand provision was, being a pecuniary check, ready ot adoption, and enabling a jury to use a salutary control over persons having the lives of others in charge, and especially if the fines inflicted were to be made payable to the survivors of the deceased.

In case of flagrant neglect, which would bring the parties under the operation of Lord Campbell's Act for the Recovery of Compensation, the law demands that the claimants shall first administer to the effects of the deceased, the cost of which utterly debars the surviving family from availing themselves of the advantages ot the Act, and the last alternative in such case is not unfrequently the parish.

During the coroner's inquest which succeeded the explosion at Hetton Colliery, in December, 1820, the scientific and chemical evidence given by Mr. Isaac Lowthian Bell, and Dr. Thos. Richardson, was so highly important that I here insert an abstract of it :—

"The gas was formed in the flue ofthe underground engine, which flue, containing about 7,000 cubic feet of space, became filled with *carbonic oxide gas*, which could be produced by 150lbs. of fresh coal ; also 40lbs. of coke would be sufficient, which might occur from damping the coals.

"Supposing the said 7,000 feet to be exploded, it would become 56,000 feet, which would immediately be converted into after-damp.

The temperature of these exploded gases being about 1,500 degrees of Fahrenheit—or a bright red heat—the above would be equal to 75 quarter casks of 25lb. each of gunpowder. A ton of coal, calculated to produce 10,000 feet of light carburetted hydrogen gas, and about 650 feet from 150lbs. of coal, and add about 9½ times of atmospheric air, which makes 6,835 of explosive mixture.

"The explosion of even 3,000 feet of gas would be quite sufficient to account for the results which were visible."

In the 20th clause of the Act relative to the Adjournment of Inquests, it is provided that in cases of single death, and, where the coroner has given the Inspector not less than 48 hours' notice of the inquest, "it shall not be imperative on the coroner to adjourn such inquest as aforesaid, in case the majority of the jury think it unnecessary so to adjourn, and the Inspector shall be at liberty to examine any witness at any such inquest, subject to the order of the coroner."

Now, this is a practical foregoing of the office of inspector, especially in the County of Durham, and others where the jury are not paid anything for their attendance, therefore, they very readily give in against any adjournment of the case.

I hope that the aforesaid exposition of the proper management of collieries, and the duties of the managers, may so far instruct the working classes, that they may reasonably enforce a due regard to their safety; and to the welfare of the work in which they, as well as the proprietors, are so much interested, and that, by bringing the parties into amicable communication, it may serve to enlighten the colliers, and to extend that good feeling which is so desirable upon all hands, and to diminish those fatal and apalling catastrophes which are constantly harassing the feelings of the community, and bringing wretchedness to the families of the deceased.

With respect to the amount of ventilation requisite for a colliery, no certain rule can be laid down, so much depends upon the extent of the workings, the thickness of the seam, the quantity of waste, the production af inflammable gas, &c., &c. But even where

inflammable gas is not produced, the wastes, generally speaking, produce carbonic acid gas, which adulterates the air, and renders the workings unhealthy; therefore it is inexcusable to have the ventilation of a colliery so weak as to be incapable of driving away the production of noxious gases which frequently require the lights to be extinguished, and the workings inaccessible for days together. I should, therefore, say that the minimum quantity of fresh air, for the most harmless of pits, ought to be from 8,000 to 10,000 cubic feet per miuute.

I will conclude with a repetition of my opinion, that the practical prevention of accidents in coal mines producing inflammable gas, consists of an ample ventilation produced by a well constructed furnace, until some more powertul means are devised: that the said air current be conducted with skill through the workings, and not so split as to diminish each separate current lower than 6,000 or 8,000 cubic feet per minute, care being also taken that the adulterated currents are kept apart from the naked lights and the furnace: that as little dependence as possible be placed upon safety lamps, but, where necessary, to be provided by the owner, and placed under the care and government of responsible persons, instead of being left to the discretion of the common colliers: that single bratticed shafts be avoided, and the area to be commanded by each establishment be not extended beyond the fair capability of the ventilating power: and, lastly, that the colliers interest themselves in looking beforehand in anticipating danger, and that they punctually obey the rules and regulations laid down by the managers, for without that no amount of Government Inspection will be perfectly effective; besides they will constantly incur the charge of endangering both their own lives and those of their fellow-workmen.

MATTHIAS DUNN, Mine Inspector.

SUMMARY

OF

SERIOUS ACCIDENTS SINCE THE YEAR 1658.

DATE.	COLLIERY.	CAUSE.	LIVES LOST.
1658 May	...Gallow Flat, near Elswick	Inundated	Unknown
About 1710	...Bensham *	Exploded.	70 to 80
1743 Jan.	18...North Biddick	Do.	17
1757 June	10...Ravensworth	Do.	16
1766 March	18...Walker	Do.	10
—— April	16...South Biddick.....	Do.	Several
1767 March	27...Fatfield	Do.	39
1773 Dec.	6...A Colliery near the Wear.....	Do.	Several
1778 Dec.	8...Dolly Pit, Chaytor's Haugh.....	Do.	24
1793 Dec.	27...Hope Pit, Sheriff Hill	Do.	14
1794 June	9...Rickleton Pit, near Pictree.....	Do.	30
—— June	11...Harraton	Do.	28
1794 Dec.	21...Hope Pit, Sherriff Hill.....	Do.	Several
1795 April	24...Paradise or West Pit, Benwell	Do.	11
1799 Oct.	11...Lumley	Do.	39
1803 Sept.	25...Wallsend	Do.	13
1805 Oct.	21...Hebburn	Do.	35
—— Nov.	29...Oxclose.....	Do.	38
1806 March	28...Killingworth	Do.	10
1809 Sept.	14...Killingworth	Do.	12
1812 May	25...Felling	Do.	92
—— Oct.	10...Herrington Mill Pit, Pensher.....	Do.	24
1813 Sept.	28...Hall Pit, Fatfield	Do.	32
—— Dec.	24...Felling	Do.	22
1814 Aug.	12...Hebburn	Do.	11
1815 May	3...Heaton Main	Inundated	75
—— June	2...Success Pit, Newbottle	Exploded.	57
—— June	27...Sheriff Hill	Do.	11
—— July	31 . Newbottle	Bursting of the boiler of a high pressure locomotive engine...	18
1817 June	30.. Row Pit, Harraton	Exploded	38
—— Dec.	18...Plain Pit, Rainton.....	Do.	27
1819 July	19.. Sheriff Hill	Do.	35
—— Oct.	9...George Pit, Lambton	Do.	13
1821 Oct.	23...Wallsend (Russell's)..	Do.	52
1823 Nov.	3...Plain Pit, Rainton..	Do.	59
1824 Nov.	19...Dolly Pit, Newbottle	Do.	11
—— Oct.	25...George Pit, Lumley	Do.	14
1825 July	3...Judith Pit, Fatfield	Do.	11
1826 Jan.	17...Jarrow	Do.	34
—— May	30...Townley.....	Do.	38
1828 Nov.	20...I Pit, Washington	Do.	14
1830 August	3...Jarrow	Do.	42
1832 June	15...Newbottle	Boiler exploded	12
1833 May	9...Springwell	Exploded	47
1835 June	18...Wallsend	Do.	102
1836 Jan.	28...Hetton Colliery	Do.	20
1839 June	28...Hilda Wallsend, South Shields.....	Do.	50
1844 Sept.	28...Haswell.....	Do.	95
1845 August	21...Jarrow Colliery	Do.	39
1850 Nov.	11...Houghton.....	Do.	26
1851 March	15...Nitshill, Scotland	Do.	61
—— August	19...Washington	Do.	28
—— Oct.	31...Killingworth	Do.	9
1852 May	—...Hebburn	Do.	23
1855	...Middle Duffryn	Do.	68
1857	...Lundhill	Do.	189
1860 March	2...Burradon	Do.	74
—— Dec.	7...Risca, South Wales	Do.	130
—— Dec.	20...Hetton	Do.	22
1861 July	—...Clay Cross.....	Inundation	23
1862 Jan.	16...Hartley	By breaking of Engine Pump Beam	204
—— March	—...Gethin	Exploded.	47
—— June	2...Bilston	Inundation	7

* This was the first attempt made to work the low seam in the neighbourhood of Newcastle.