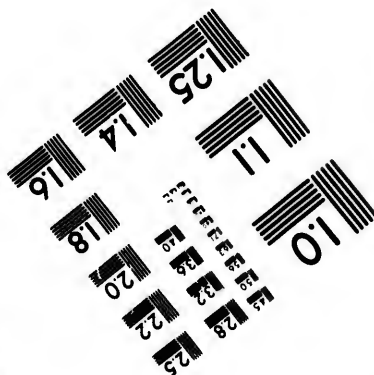
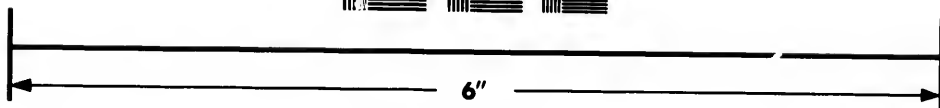
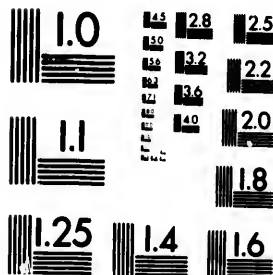


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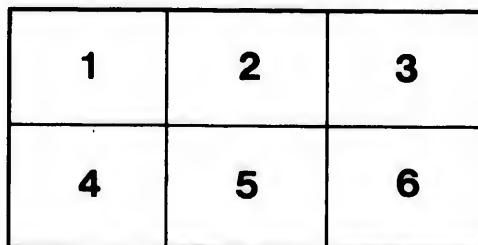
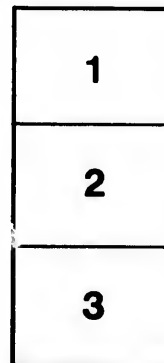
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# EXPLOSIONS IN NOVA SCOTIAN COAL-MINES.

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A PAPER READ BEFORE THE FEDERATED INSTITUTION OF  
MINING ENGINEERS.

BY

EDWIN GILPIN, JUN., A.M., F.G.S., F.R.S.C., ETC.,  
DEPUTY COMMISSIONER AND INSPECTOR OF MINES.

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ANNUAL GENERAL MEETING AT NEWCASTLE-UPON-TYNE,  
SEPTEMBER 5TH, 1894.

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EXCERPT FROM THE TRANSACTIONS OF THE FEDERATED INSTITUTION  
OF MINING ENGINEERS.

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## EXPLOSIONS IN NOVA SCOTIAN COAL-MINES.

BY EDWIN GILPIN, JUN., A.M., F.G.S., F.R.S.C., ETC., DEPUTY  
COMMISSIONER AND INSPECTOR OF MINES.

At present coal-mining is carried on in Nova Scotia in three widely separated districts. The geological horizon however of all is the same, the middle or productive division of the Carboniferous.

The coals from these districts vary somewhat in their general character. The Cape Breton seams are enclosed in strata holding many beds of sandstone with shales, arenaceous and argillaceous, presumably in large part formed from the re-worked beds of the adjoining Millstone Grit. The measures are usually presented at easy angles, and free from faults. In Pictou county the beds are thick, heavily inclined, frequently faulted, and at points associated with a great thickness of shale, carbonaceous, and occasionally somewhat bituminous. In a part of the Pictou district, to be more specially referred to later on, these shales attain a thickness of about 500 feet.

In the Cumberland district the natural sections of the Joggins present long-continued alternating deposition of shale and sandstone, with strata dipping at moderate angles, and not notably faulted. At Springhill, some 18 miles away, the same measures assume high angles, and are disturbed by heavy faults.

Broadly speaking, the Cape Breton coals are the most bituminous, followed by the Cumberland, and then by the Pictou coals. The coals of the two latter districts are rather of the free-burning type, although in some cases coking, but not as in the case of the Cape Breton coals almost invariably coking and adapted for gas-making.

The following average of analyses from a paper by the writer on Canadian coals will serve to show the differences in a general way:—

	Cape Breton.			Pictou.			Cumberland.		
Moisture ... ..	...	...	0.75	...	1.19	...	...	1.46	
Volatile combustible matter	...	37.26	...	...	29.10	...	...	33.69	
Fixed carbon ... ..	...	58.74	...	...	60.63	...	...	59.35	
Ash ... ..	...	3.25	...	...	9.34	...	...	5.50	

The generally higher percentages of ash in the Pictou and Cumberland coals may be connected with the presence of the included beds of shale



already referred to, as compared with the small ash percentages of the Cape Breton coals associated with a larger proportion of sandstone-beds. The lesser thickness of the Cape Breton Coal-measures and the more bituminous nature of the coals may be contrasted with the free-burning characteristics of the western coals included in measures of much greater thickness.

The official records of coal-mining in Cape Breton go back to the year 1785. From that date to this the annual production has been comparatively small, amounting for the year 1893 in round numbers to 1,000,000 tons of coal. During this long period the deepest shaft and workings have equalled a vertical depth of about 700 feet. Gas has seldom been met in quantities large enough to cause trouble. One accident only requires record in this connexion. The mines in this district were for many years damp along the outcrop workings, and can at this date be fairly called dusty in part of one mine only, attaining a vertical depth of about 700 feet.

The regularity of the seams, the overlying water-saturated sandstones, the thin cover, all, combined with changes of water-level effected by shafts, appear to have resulted in an almost complete discharge of gas from the seams as far as they have been worked.

There have been a number of cases of ignition of gas in Cape Breton, only one of which would be classed as an explosion, the remainder being of trifling extent due to small local collections of gas or to remissness in sweeping the workings thoroughly with the air. The explosion in question took place at the Sydney mines, on May 21st, 1878. The work of opening out the submarine operations was being pushed. From the pit-bottom an engine-plane ran to the north-east, and an engine-deep had been put down about 1,000 feet to the south-east to a landing. From this point a pair of levels had been driven southwardly for about 130 feet beyond a cross-cut which ran from the low level up through a few rooms that had been driven parallel to the levels. There was also a head between the levels within a few feet of the faces. It appears that a canvas door stood at the mouth of the upper of the two levels and forced the air-split for these deeps down the deep slant, along the low level, and then up along the working-faces. The places being idle, part of the canvas on the door was removed to another part of the pit, laying the two leve's dumb. After standing for several days, the place was entered by the upper level by the overman and a deputy carrying open lights, and a severe explosion ensued killing five men. The bodies of the over-

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man and deputy were found about 60 feet from the face and not much burned. At this point the coal was not coked, nor were the props disturbed. In the lower level, however, there was evidence of great heat and violence; the explosion could be tracked out along the low level into the deep, where part continued across into the north deep workings and part towards the pit-bottom. When it is remembered that these levels from the south-east deeps were in only 130 feet beyond a cross-cut going to the rise and were connected by a head at their face, it is presumable that the management minimized the risk of gas accumulating. There was probably, judging from the position of the lamps and bodies, gas lying back to a distance of 60 feet from the face in both levels, and probably about 6,750 cubic feet of air containing gas as calculated by the manager, Mr. R. Brown. It would appear that the ignition of gas in the upper level flamed into the gas in the lower level, and, bearing dust and air with it, afforded an opportunity for the violence of the explosion. The workings are referred to by the inspector as dry, and the roadways as deep in dust. The management considered that although dry, the mine would not be considered as dry and dusty in a dangerous sense. This view would seem to be partly borne out by the fact that the coking of the coal and props did not extend for over 450 feet from the face of the low level. The management consider that, during the many years this seam has been worked, dust has played no part in any of the small explosions of gas which have occurred from time to time.

In Pictou county, the chief coal-mining interest centres around the main seam which lies at an angle of about 17 degs. and is bedded in the great mass of shales already referred to. The comparatively open character of the coal, lying in dry surroundings, and broken by numerous faults has made it a gas-drainage channel for a large area. This constant exudation of gas from the outcrop of the seam, some 40 feet in thickness, is reported to have been long known in Indian tradition, and at a distant date the ignition of the gas has caused a local fusion of a large body of shale overlying part of its outcrop. The word Pictou is stated to be the Indian equivalent for explosion, and may be connected with this fire. The gas exuding under the still water of the river crossing its outcrop could be ignited. Under these circumstances it will be seen that the operations in this seam begun in 1827 by miners accustomed to the thin seams of the North of England were attended with unusual difficulties. Little reliable information can now be secured as to the cause of the early explosions and fires in the Albion mines.

Systematic operations were commenced in 1827. On December 29th, 1832, fire was discovered in the pit, and it was found necessary to flood the workings. This fire was established to be of incendiary origin, but the guilty parties were never discovered. In 1834, the mine caught fire from a feeder ignited by a shot; in 1836, a heavy explosion killed several men; in 1838, during the sinking of No. 2 pit, an explosion killed three men. It may be remarked here that all shafts sunk in the great shale-bed overlying the main seam gave off gas.

Finally, in 1839, a feeder of gas lighted by a shot set fire to the coal and in spite of every effort the pit exploded with great violence during the night. So intense was the heat of the flames in the shaft that the hoisting-chains, etc., were melted. This first range of working was then abandoned.

Other shafts were then sunk to the dip. In 1862, night watchmen ignited gas and three men were killed. In 1867, these shafts were lost by a fire from an ignited feeder and filled with water.

In 1869, a new shaft called the Ford pit was sunk further to the dip, striking the coal at about 900 feet. As it was being holed around the shaft-pillar it caught fire and had to be flooded. This pit was re-won and successfully worked until 1890, when an explosion took place killing forty-four men, and it has remained practically closed since that date.

There is little information available about the earliest of these fires and explosions. Prior to 1869 the workings were damp, except in some of the working-places in the lowest deeps, as water followed the miners from the outcrop. The ventilation by furnaces with upcast shafts not exceeding 300 feet in depth was unable to sweep the huge chambers in this thick coal which were constantly accumulating gas. It is probable that the imperfections of the ventilation by allowing vitiated air to mix with the gas sensibly diminished its inflammability. It is stated that on one occasion the gas came off so strongly that on removing it by a heavy fall of water it fired at the boilers on the surface some 50 feet from the shaft.

The writer appends a copy of the special rules in force at these mines in the year 1840, which are of interest as showing a state of affairs in contrast to the practice of the present day and as showing that then, as now, the use of gunpowder was intimately connected with fire.

The Ford pit after a lifetime of about ten years was the scene of a violent explosion already referred to. In this case the side of the pit in which the explosion occurred had been reported as free from all but traces of gas at one or two points, up to an hour before the entry of the colliers (the testing was done with Clanny lamps, and the faces dated by the examiners).

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The first explosion took place at 6 o'clock in the morning, and blew off the fan-drift cover. The rescue of bodies and the restoration of the ventilation were being successfully carried on when the presence of fire was detected, and shortly after a series of explosions rendered it necessary to close the shafts and seal the landings with water.

All attempts to account for the immediate cause of the explosion are necessarily conjectural, as all were lost who had entered the section that was the seat of the explosion, and the fire prevented a complete exploration after the first explosion. The chief points, however, that were observed by the exploring parties were that the flame of the explosion had not reached within several hundred feet of the shaft-bottom, that immense volumes of dust had been blown towards the shaft, and deposited on each side of the shaft. It appeared that the explosion had passed along a level to the dip of the wagon-road at the shaft-bottom, broken the back of the lamp-cabin, and had ignited coal-dust at the open light always kept there, killed the lamp-man, and showed traces of an explosion back to the shaft, or contrary to the direction whence the explosive wave had originally come. The shaft and approaches were all wet, and gas was unknown in its vicinity. At a distance of about 900 feet from the shaft-bottom the workings were dry and dusty. There appears to be little doubt that this explosion originated from a shot fired by the fireman shortly after the pit began to work; that it was largely assisted by dust, that on arriving at the wet ground near the shaft bottom no signs of fire were visible on boards, canvas, etc., and that the finer particles of dust coming in contact with the open flame at the lamp-cabin about 100 feet from the shaft caused a slight secondary explosion.

The local nature of the explosion at the lamp-cabin was corroborated by the evidence of the wounded man, the position of the broken stoppings and the fact that the stables near the pit-bottom in the path of the first explosion showed no signs of flame. A short time ago the pit was pumped out and attempts made to reopen it, but outbreaks of spontaneous combustion in the old workings have led to a temporary cessation of the work.

This main seam is also worked about 3 miles to the westward by the Intercolonial Coal Co. Its character as regards gas is nearly the same as the similar workings in the Albion mines. On May 13th, 1873, a shot in one of the levels ignited a feeder.

The shot was in the bench or lower of the two slices by which the coal was mined. Owing to some want of care, the shot instead of

loosening the whole of the bench so that it could be readily removed, only broke the coal at the back of the bench next the face. Owing to the violent issue of burning gas through the mass of cracked coal it was found impossible to clear the bench away so as to get at the feeders. In a short time it was decided that the pit would have to be abandoned, but before all the men were got out a terrific explosion occurred causing the death of fifty-five persons. This explosion is believed to have been one of the most violent ever known in the history of coal-mining. After several days' work the openings were sealed. About two years later the mine was reopened, and has been working successfully since. The explosion presumably resulted from some body of gas being drawn upon the furnace fire from the rise-workings owing to a derangement of the ventilation, as several men who were in the workings near the point where the fire started escaped after the explosion. The pit was damp and not dusty.

Gas was given off very abundantly in this mine, and feeders of gas were daily ignited by the shots. In fact, no powder should have been used, but as there was at that time no Mines Regulation Act, it was impossible for the Government to enforce a prohibition in any way at variance with the practice common in other mines less gaseous. At present the improved mechanical ventilation, the use of safety-lamps and roburite have proved so far an effective safeguard, and the amount of gas evolved does not seem to have increased with the depth of the workings.

The main seam is underlain by the deep seam, being separated by 150 feet of shale. The seam is about 20 feet thick. Its character at the Albion mines has been decidedly less gassy than the overlying main seam. In 1858, there was an explosion of gas in the main levels which were in faulted ground. This explosion killed two men and wounded several others, and was entirely a gas explosion as the levels were making gas, and it was very wet out to the shaft-bottom. A similar lighter explosion occurred in 1864.

At the Intercolonial colliery during the latter part of the year 1892 a tunnel, 1,000 feet long, was driven from the 3,200 feet level in the main seam to cut the underlying or deep seam. The explosive used was roburite, and no difficulties were experienced until the lower part of the face of the tunnel struck the top of the seam when heavy feeders of gas were met. Two shotholes were fired in the rock preparatory to

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entering the tunnel in the seam. The shots were fired together by electricity, a sharp explosion took place followed by the ignition of the feeders. The coal took fire, and after efforts were unsuccessfully made to put out the fire, dams were built, and work soon after resumed. Such enquiry as could be made showed that the shots were properly tamped, etc. It would appear that as the shots had not a solid backing of rock, they blew out and fired gas. The shot-firer had reported the place fit to fire shots in. The commission appointed some time before by the Government of Nova Scotia to enquire into the question of explosions reported that the precautions usually adopted in regard to testing for gas when gunpowder is used should not be omitted in the case of roburite or acadia flameless explosive (a local explosive possessing a high degree of safety). In this case considering that a large amount of gas was continually being evolved it would have been more in accordance with the spirit of the report of the commission not to have used any explosive. The instructive fact remains that roburite fired under apparently normal conditions ignited gas. The manager of the mine states that this explosive has been largely used by him and has given general satisfaction. In this connexion the deputy inspector for the Pictou district reports in the same year that flames had been seen by a number of parties from both these explosives.

It may be mentioned that the tunnel was dry, that the strata were composed of fireclay and blue shale, and that dust played no part in the explosions. After the face was recovered the seam was cross-cut, and as the drainage of gas was very heavy it was allowed to stand pending the drivage of a place downhill from the crop workings.

This seam was the seat of a very unusual explosion on August 8th, 1893. A small mine had been in operation for some years and dip works were being extended on the pitch of the seam to meet the tunnel—already referred to as the seat of an explosion caused by roburite. Owing to unusually dry weather the supply of water for the colliery boilers grew scanty. First, the working of the mine was abandoned, and then as the supply of water grew smaller, the steam was shut off the Schiele fan, and recourse had to natural ventilation. This was of course not counted on as effective as the seam was very gassy, but no danger was feared as the mine was closed and would not be entered again until the ventilation was restored. Naturally the mine filled with gas. On the day referred to, a heavy thunderstorm passed over the pit, a discharge of lightning injured several buildings close to the pit, and ignited the gas in the mine causing a heavy explosion. The discharge had presumably struck the iron pulley-wheels,

and followed the steel rope down to the cage which was standing about 20 feet from the bottom. The flash would occur at this point, and in an atmosphere almost undoubtedly filled with explosive gas. This accident, fortunately, accompanied by no loss of life, shows conclusively the effects of lightning, the pit being closed, and no person in the vicinity, and the explosion coinciding with a heavy lightning discharge.

The third seam underlying the deep seam about 85 feet was, on January 15th, 1888, the scene of a very violent explosion.

During the summer, part of the pillars in a panel in the third seam were drawn beneath the cage pit-workings at a point where a fire had been built off about the year 1872. This fire was believed to have been extinguished, and no danger was anticipated. After several pillars had been drawn the fall ran up to the cage pit-workings, hot stythe came into the third seam, and finally some of the stone that fell was found to be sensibly warm. The panel was built off at once, a work of no great difficulty, as there were only five openings. The temperature of the interior of the panel did not increase for several weeks, and it was believed that the fire would be extinguished. One Sunday morning, smoke was found in the returns, and shortly after a very violent explosion took place which destroyed the bankhead, and reduced tubs, brattice, etc., to matchwood. The side of the pit in which the explosion occurred was built off, and no further trouble has been experienced. The immediate origin of the fire is unknown. But the presence of smoke in the return before the explosion would make it appear probable that a fall or a slight explosion broke one of the stoppings, and that the furnace in the third seam drew gas from the upper seam upon the fire. Presumably the effect of the explosion was increased by dust, although the mine would not be classed as dry and dusty.

In the eastern part of the Pictou district the McBean seam is worked by the Vale colliery. On February 18th, 1885, an explosion occurred causing the death of thirteen men. It was claimed by the management that it was caused by dust alone from a blown-out shot. After a very careful enquiry it appeared most probable that it was due to a small body of gas and extended by dust. The writer quotes the report of the deputy inspector, Mr. Maiddin, in whose charge the enquiry was placed.

The seam which dips at a heavy angle was opened by a slope which had been for some time working through the 1,800 feet levels, and was being sunk for a new lift. The sinking was down about 500 feet below the 1,800 feet level. While sinking, back slopes are driven on each side of

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the main slope in the following manner:—Heads are driven right and left, at intervals of about 60 feet as far as the line of the proposed back slopes. The back slopes are formed by connecting the faces of these heads by shoots or rises driven up hill from each head. It was known that these shoots when driven up off the air would gather gas. The air for the section of the mine in question entered by the main slope.

On the west side of this slope, at the 1,300 feet level, there were two check-doors which, when shut, sent the air direct to the dip, but when opened allowed most of the air to take a short cut to the fan. These doors were placed to allow the timber to be taken from the slope, and to be carried to the head of the shoots to be lowered to the working-places in the level below.

Men were engaged in this work at the time of the explosion, and it is believed that some derangement of the ventilation at this point allowed gas to accumulate in a head in the sinking, in which a miner named Foley was working about 100 feet from the face of the sinking; and that the restoration of the air-current, which was strong and sharp, forced the gas upon Foley's lamp. He was burned to a crisp, while the men nearer the face were almost untouched by fire. The timbers in the slopes from the head in which Foley worked down to the face of the sinking gave unmistakable evidence that the explosion came from above, while the timber up the slopes from Foley's head for 400 feet to the 1,800 feet level gave like evidence that the explosion came from below. At the 1,800 feet levels the check-doors were destroyed, and signs of the explosion found for about 400 feet from the slope. The stoppings all along the slope were blown out, and the slope badly wrecked, but at no point did the explosion extend over a few hundred feet to the right and left of the slope. The floor of the main slope in the sinking was damp, but there was much dust on the timbers in the slope, and the coal gave off a good deal of dust under a vertical pressure of about 1,200 feet. The explosion found the mine at the height of the winter in its driest condition. When the water which had gathered at the face of the sinking was removed a shothole was found. A very careful examination into the matter failed to produce any evidence that the hole had been charged. The explosion had followed the line of least resistance, viz., directly up the slope to the open air, and resembled one at the bottom of a shaft.

In the absence of the explanation afforded by the fact that on previous occasions the accidental neglect in shutting the doors on the 1,300 feet level had caused an accumulation of gas in the sinking, and by the fact that at the time of the explosion the doors in question were more or less open, it might have been reasonably urged that it was a dust explosion.



On February 21st, 1891, an explosion accompanied by heavy loss of life took place at the Springhill mines, Cumberland county. At this point three seams are worked by three slopes: all the workings had been connected by tunnels, but those leading into the north seam had fortunately been built off before the explosion. The seams dip at an angle of about 27 degs., and are opened by slopes, with levels at convenient distances apart. From the levels places are driven to the rise on the full pitch of the seam, and horizontal bords turned away. The tubs are raised and lowered, between the bord-months and the level, on platforms worked by counterbalances.

The seat of the explosion was in the No. 6 and No. 7 balances of the 1,900 feet west level of the east slope, at the face of the working of this section. These balances, about 600 feet in length, extend on the full pitch of the seam from the 1,900 to the 1,300 feet levels, and take the coal from the usual horizontal bords or working-places.

These balances were connected with the 1,300 or stony-level, and were ventilated by air from the lower level, which was divided between the balances and uniting at the 1,300 feet level ventilated the workings above that level, and passed to its outlet beyond the faces of the workings above the 800 feet level. The air was provided by a downcast fan, and appeared to be ample for the extent of workings. Repeated examinations appeared to indicate that the explosion started from a point about the centre of No. 7 balance (the furthest in balance) and to have gone up and down the balance, wrecking the working-places branching off from it. Also to have penetrated into No. 6 balance through the lower working-places in it, which had been worked through into No. 7 balance, and in a similar manner to have wrecked that and the working-places branching off from it. As the connexions between the top of the balance and the 1,300 feet level were comparatively small, the force of the explosion extended but a few feet through them into that level. The openings into the 1,900 feet level being larger, the explosion was felt severely at the foot of the balances, and the two levels were wrecked into their faces a distance of about 400 feet, and towards the slope for a distance of about 1,500 feet. The force of the explosion was slightly felt at the bottom of the slope, and did not attract attention at the surface, except by a momentary agitation of the fan at the east slope and a slight puff of air at the west slope in the underlying seam, which was connected by a tunnel with the east slope seam, a few feet from the top of the No. 6 and 7 balances. The explosion ignited some canvas-brattice and boards in No. 6 balance, but this fire was extinguished without difficulty.

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The workings of the No. 7 balance were naturally very dusty, and were systematically watered, an ample supply of water being led through them by pipes from a large pump standage or lodgment on the upper level. The water that made on the 1,300 feet level was used for watering No. 6 and 7 balances. The watering was effected by putting a valve on the pipe in each working-place in No. 7 balance, so that a coal-box, holding a barrel, could be run under it and filled, and the orders were that it should be thrown on the roof and sides of the working-places. Water was also allowed to run into the bords, and the shot-firers were instructed to see that the vicinity of the shot to be fired was damp. The amount of water available, and the directions for its use, should, in the writer's opinion, have kept the stationary dust well damped.

The reports show that the workings in No. 7 balance were free from gas on the morning of the explosion, and the available evidence points to the fact that there was no lying gas up to the time of the explosion, as the brattice-men who had completed their special work in other parts of the slope were killed by the explosion in the lowest bord of the balance on their regular rounds for the purpose of testing stoppings, brattice, etc. Evidence was given to show that the levels had been making gas for some time, but the ventilation was good, and no accumulations were permitted.

From the evidence produced, the directions to the shot-firers, night-men, brattice-men, etc., were adequate, and properly carried out. There appeared in some instances to have been latitude allowed by shot-firers to miners in respect to charging holes before they were examined. In the writer's opinion, when the supervision of shot-firers is considered necessary, no hole should be charged before it is measured by the shot-firer and the amount of powder used should be subject to his opinion. The writer is the more inclined to this opinion in reviewing this matter, as the evidence tended to show that the "flaming" shots referred to in the investigations were in some instances contributed to by a want of attention in placing the hole and the charges of powder.

In the No. 7 balance locked lamps were used, except by the cage-runner in the counterbalance, who was allowed to use an open light. The author does not know that this in any way contributed to the explosion, but it may be conceived that in the case of an explosion driving before it and beyond its own sphere of ignition, a mixture of dust and gas, an open light might be instrumental in starting a second explosion. It is further to be remarked that the men employed, who are furnished with locked lamps, are naturally inclined to be sceptical as to their value if they know that within a short distance open lights are permitted.

From the evidence taken it appeared that the manager, Mr. Swift, who was killed by the explosion, his assistant, the underground managers, and other officials were careful and attentive, and that daily reports and check reports were used.

In the No. 7 balance, when the bords were first started, the coal was worked to its full height, having a bench of about 4 feet, then a stone band, and above that about 3 feet of coal. After the bords were driven in a short distance, the fall coal and stone were left in and the bench only was worked. This coal was not worked with powder, but as the face advanced it was necessary to blow down from 12 to 18 inches of the stone, to make room for the tubs to get near enough to the face to permit of their being loaded with coal. The stone was blown down in the low side of the bords, over the rails, and stowed in the high side. A row of props along the middle of the bords held the rest of the stone up. There was consequently little shot-firing done in the balance workings. The stone is about 2 feet thick, a coarse sandstone, with streaks of coal sometimes 2 inches thick. It was shown in evidence that usually the holes for the shots in the stone were bored in the coal streaks and were in some cases partly in stone and partly in coal.

It was shown that on the day of the explosion a shot was to be fired in this stone in the No. 3 bord in No. 7 balance, and that Thos. Wilson, the shot-firer, left the bottom of the slope about a quarter past twelve o'clock, saying he had to go to No. 7 balance. The explosion occurred shortly before one o'clock, a time having elapsed, in the opinion of the witnesses, sufficient to have allowed him to reach this point, to have made the necessary preparations, and to have fired the shot. His body was found, with those of the men working in the bord, near the entrance to the place. The shot in the stone had been fired. This, coupled with the direction of the course of the explosion, showed with reasonable certainty that it had its origin in the bord, and that the shot fired by Wilson was the direct cause of the explosion.

The suggestion was made by Mr. Madden, the deputy inspector, who was at hand at the time of the explosion, and rendered valuable aid to the rescuing and exploring parties, that the immediate seat of the explosion was to be sought in the stone itself. After examining the bords in question with him, the writer is of opinion that his suggestion offers the readiest explanation as to the source of the catastrophe.

The bord is 14 feet wide, and the stone is carried by a row of props in the middle. These props were set by the miners as they advanced the face, to hold the stone, which was not of a specially strong character, con-

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sequently, as the stone was not blown down until it became troublesome to move the tabs, there were always props along the side of the shots, and between the shots and the face. The effect of these props was to partly confine the shots to the low side of the bord.

As the stone was in layers, and had streaks of coal in it, examination showed that it was more or less fissured across the bord, and hung on the props, the natural effect of the shots being to blow in along the layers, to compress the props, and to cause the stone to bag between the props and the high side. That this effect was produced is shown by the fact that large quantities of this stone fell in the workings of No. 7 balance, the props being knocked out by the explosion although very short, and partly supported by the stone stowed in the high side. The hole that was fired in No. 3 bord, was, so far as could be estimated, from 2 feet 9 inches to 3 feet long. The end of the hole was in stone. The charge of powder appeared to have filled 18 inches of the hole. The shot threw down about three-fourths of the stone it was designed to dislodge, and left the balance split by the heel of the shot, and a prop near the back of the hole. There was a lype in the stone on the low side of the bord, which may have helped to lessen the desired effect of the shot.

The weight of evidence appeared to be that there had been an over-charge of powder.

It would appear that the expansion of the layers of the stone afforded space for the accumulation of gas, which would not be readily dislodged by the air-current, and an unusual opportunity of accumulation, owing to the fact that the pit was idle the preceding day. That the shot gave evidence of having been a more or less flaming one; that it ignited the gas lodged in the roof stone; that this combination of gas and powder flame acting on an atmosphere charged with a small percentage of gas and fine floating dust derived from the lower bords, caused an intense flame sufficient to propagate itself until it reached an intensely explosive state and self-supporting, swept the two balances and the adjacent levels.

The general opinion of the witnesses was that the shot-firer was a careful man, and there is evidence that the explosion was not like that of a body of gas. Men working in the lower seam under the seat of the explosion, and separated by a few feet of measures, stated that as usual, they heard a shot fired above them. Then after an interval of a few seconds it was followed by a series of detonations which appeared to shake the roof over their heads. The face of No. 3 bord inside the shot was found to be free from dust and sign of fire. The explosion broke

only a few coal tubs, and did not do much more than dislodge the props. Almost immediately after the explosion men were able to go straight into the faces of the levels, past No. 6 and 7 balances. Their lamps burned well, although they were themselves affected. These facts point, in the writer's opinion, rather to the comparatively slow progress of a dust-supported explosion than to the sudden clap of an ignited inflammable body of gas and air.

The evidence of Enoch Cox, who worked in No. 1 bord, on the same balance, supports this view. He testified that some time previous to the explosion a shot was fired in this stone that filled his working-place with flame, and ignited the gas in the stone, so that it required some effort to extinguish it. It is fair to state that the management declare they never heard of this, and that it was never reported to them.

The mine had been carefully examined on the previous day by the deputy inspector, and two days before a committee of the men had examined this mine and were quite satisfied with the ventilation and the precautions taken to keep the workings damp.

These notes give a brief account of the principal explosions that have occurred in our coal-mines. The writer has a personal knowledge of all the mines, and has been able to enquire personally into the facts connected with most of them. So far his experience has been that no explosion in Nova Scotia can be attributed to coal-dust alone, but a number of them have had their area and their destructiveness to life materially increased by coal-dust.

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SPECIAL RULES IN FORCE IN PICTOU CO. FIFTY-FOUR YEARS AGO (1810).  
INSTRUCTIONS.

Rule 1.—The overman, and at least one of his deputies or assistants, shall examine all the bords and other working-places every morning before the colliers go down. They shall meet the colliers and other workmen at the bottom of the shaft, and if they have found any gas or other cause of danger in any of the bords, shall caution the colliers belonging to such bords and give them such instructions as they deem necessary.

Rule 2.—Whilst the pit is at work an overman or deputy shall always be present at each face of the works, viz., one on the north and one on the south side, so that in case of an alarm of fire or any other accident the overman or deputy shall always be at hand or within call.

Rule 3.—When the day's work is finished the overman or his deputies shall remain in the mines for the purpose of going through every bord and carefully examining them after the colliers have left, so that no blower or gas may be left burning, or any fire concealed amongst the fallen coal.

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Rule 4.—Every bord shall be furnished with a fire-bucket marked with the number of the bord, a coarse bag for beating out gas, and a tub or open-headed cask to contain 40 or 50 gallons of water. The fire-bucket and the bag shall be in charge of the colliers of each bord, who shall pay for or replace them if lost.

Rule 5.—Every panel, consisting of six bords, shall be furnished with a small cannon, which shall be kept at some convenient spot in the lowest board. The overman and deputies shall keep the cannon clean and dry and ready for use. They shall also keep the tubs constantly full of water in each bord.

Rule 6.—Every bord shall at all times be furnished with a safety-lamp, which shall be examined by the overman at least twice a week, and in case of any injury being done thereto, more than common wear, the cost of the lamp shall be charged to the colliers, in whose care it is placed.

Rule 7.—Any collier meeting with a cutter or fissure which yields gas, or with anything unusual in his bord, shall immediately report the same to the overman or deputy.

Rule 8.—No collier shall be allowed to put in more than one shot or blast at a time, into any bench or fall, without permission from the overman.

Rule 9.—After blasting either a fall or bench, the coal shall be turned back, so that no fire may be concealed amongst the loose coal, and before the colliers leave their bords they shall be careful that no blowers or gas are left burning.

Rule 10.—No collier shall work in any fiery bord unless there are other colliers working in the adjoining bords at the same time.

Rule 11.—The coal shall not be blasted or a naked light used on any pretence whatever in any bord or working-place in which the overman has forbidden gun-powder or naked lights to be used.

Rule 12.—Every person employed in the pits on passing through any air-door or trap-door shall always close it after him.

Rule 13.—No person shall unscrew his safety-lamp (where such are used) excepting when and where he is ordered or directed to do so by the overman or his deputy.

Rule 14.—When a blower or body of gas is fired by a shot or otherwise, which cannot be at once extinguished by the ordinary means, notice shall be sent without delay to the overman or deputy; and in the meantime the colliers from the adjoining bords shall be called in to give assistance.

Rule 15.—On the arrival of an overman or deputy at the fire, all the colliers and other persons who may be present or sent for shall act under his orders, and use every exertion to carry them into effect.

Rule 16.—The extinguishing-engine shall be kept in a proper house near the pit-top, and a bell of not less than 28 lbs. weight shall be hung upon the pit-frames at No. 1 shaft, with a rope leading to the bottom of the shaft, for the purpose of making signals from below without loss of time.

Rule 17.—The overman or deputy on his arrival at a fire shall, if he considers it necessary, cause the bell to be rung for the extinguishing-engine, and to give notice to the manager, or deputies, or other persons who may be on the surface, whose duty it is to be present, that they may immediately go down.

Rule 18.—In all cases of fire a most determined effort must be made with the extinguishing-engine; beyond this it is impossible to frame any rules that will apply generally. The manager and his assistants must then decide what further measures to adopt.

Rule 19.—The overman or the deputies who shall have gone through all the bords after the workmen have left the mine shall report personally to the manager, the general state of the works, and particularly whether the cannon, buckets, water

tubs, etc., are all in readiness for any emergency, and in case the manager shall be absent they shall enter their report in writing in a book kept in the office for that purpose.

Rule 20.—No deputy shall at any time whilst on duty in the pits, during working hours, leave his appointed station until relieved by another deputy, to whom he shall report the state of the works under his charge, together with any instructions he may have received from the overman.

Rule 21.—At all times, whether there is any apparent danger or not, the foregoing rules shall be strictly adhered to, without the slightest relaxation, the object being to protect the lives of the workmen, as well as the works themselves; and any person neglecting, or in any way evading them, shall, if the manager thinks proper, be dismissed from the service.

The PRESIDENT said that Nova Scotia appeared to have suffered severely from explosions. Some of the mines appeared to be very gassy and also to contain dangerous dust, but Mr. Gilpin did not attribute any of the explosions to coal-dust alone. Blasting with gunpowder seemed to have been the most frequent cause of ignition, and in one case feeders of gas were ignited by roburite. The report of the Royal Commission on Explosions from Coal-dust in Mines had focussed opinion on the subject, and their recommendations involved further legislation, which it was important should be based upon facts—so as to secure a maximum of safety without placing unnecessary hindrances or restrictions upon the mining industry. The experiments of the Explosives Committee of the North of England Institute of Mining and Mechanical Engineers were likely to throw much light on the relative safety of the various new explosives. The first report of this committee was now in the press and would shortly be published in a form obtainable by all members of The Federated Institution of Mining Engineers. The explosion attributed by Mr. Gilpin to roburite appeared to have been caused by the ignition of gas when a seam of coal was cut into by a stone-drift. This was a very interesting explosion if it were clearly established, as it appeared to be by the account, that it was actually due to roburite fired by electric fuze.

Mr. H. BIGG-WITHER wrote that the circumstance mentioned in Mr. Gilpin's paper was reported to him, and, as far as he could recollect, he was informed that the shots were fired in very broken strata which was full of gas. The conclusion he came to at the time was that the shots were placed in holes where there was actually gas, so that to all intents and purposes they were nuntamped shots. He might mention that the roburite used was manufactured in Canada from ingredients supplied by the Roburite Company.

Mr. E. GILPIN, Jun., wrote that in Nova Scotia they had not yet grappled directly with the dust problem, preferring at present to seek safety in exclusion, as far as possible, of explosives. All the dusty mines are gassy, and in most no explosives are used. Roburite was undoubtedly the cause of the explosion referred to as occurring when a coal-seam was cut by a stone-drift. A full account of this explosion and subsequent extinguishment of the fire has been written by Mr. C. Fergie, the manager of the colliery.\* The writer encloses a copy of the Mining Regulations of Nova Scotia bearing on the use of explosives:

(8.) Any explosive shall only be used in the mine underground as follows:—

(a.) It shall not be stored in the mine.

(b.) It shall not be taken into the mine, except in a case or canister containing not more than six pounds.

(c.) A workman shall not have in use at one time in any one place more than one of any such cases or canisters.

(d.) It shall not be taken into or be in the possession of any person in any mine or district of a mine, and shall not be used except in accordance with the following regulations, during two months after any inflammable gas in quantity sufficient to show in a safety-lamp has been found in three consecutive days in any such mine; namely:—

(1.) Either in those cases of stone-work or sinking of shafts in which the ventilation is so managed that the return air from the place where the explosive is used passes into the main return air-course without passing any place in actual course of working; or

(2.) When the persons ordinarily employed in the mine are out of the mine or out of the part of the mine where it is used.

(3.) Where a mine is divided into separate districts in such manner that each district has an independent intake and return air-way from the main air-course, and the main return air-course, the provisions of this rule with respect to explosives shall apply to each such district in like manner as if it were a separate mine.

(e.) A competent person or persons shall be employed for the purpose of firing all shots during three months after any inflammable gas has been found in any such mine or district of a mine, or under the provisions of sub-section (d). He shall, before firing any shot, carefully examine the place where it is to be fired and the places adjoining. A shot shall not be fired after the first of January, 1892, except by or under the direction of a competent person appointed for the purpose and holding an underground manager's, overman's, or shot-firer's certificate.

Provided, however, if at any time the inspector of mines, together with any persons experienced in the composition or use of explosives, who he may associate with himself for the purpose, shall report that any explosive is free from danger, the Lieutenant-Governor may, by Order in Council, determine that the restrictions of sub-section (d) of this section shall not apply to such explosive, and in such cases such explosive may be used so long as said Order in Council remains in force.

The Commissioner may, upon representation made to him in writing by the owner, agent, or manager of any mine, that the finding of inflammable gas in three

\* *Transactions of the Nova Scotia Mining Society*, vol. i., part 4, page 44.



consecutive days, alluded to in this rule, in any such mine is exceptional, and that the mine is damp, and not dry and dusty, cause an examination to be made of such mine by the inspector, and may order that the use of any explosive is *absolutely* under this rule only if inflammable gas is found in two consecutive days during two consecutive weeks.

Up to the present time these special rules have been found to lead to increased attention to ventilation, etc.

The PRESIDENT then said that he had pleasure in moving a vote of thanks to Mr. Gilpin for his interesting paper.

The vote was unanimously agreed to.

DAL-MINES.

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