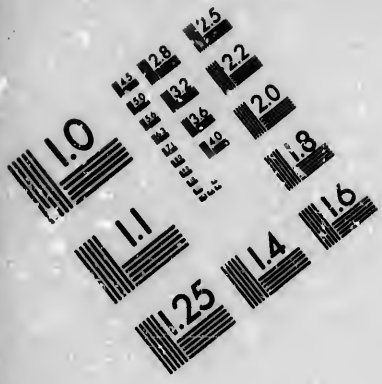

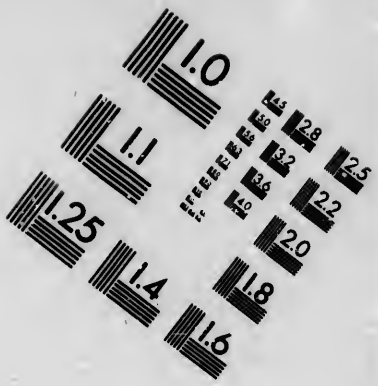

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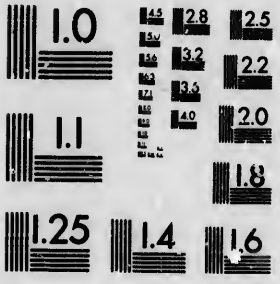

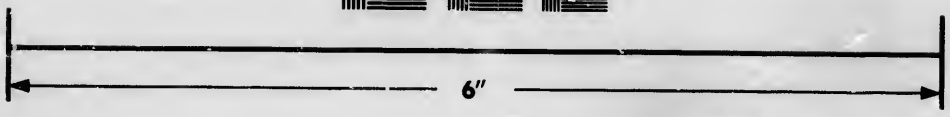

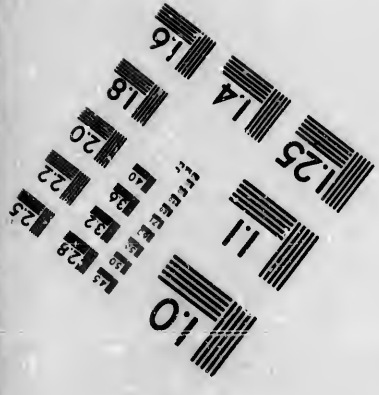

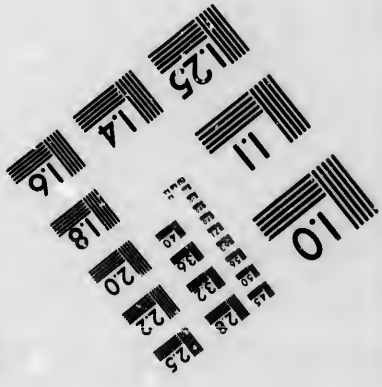

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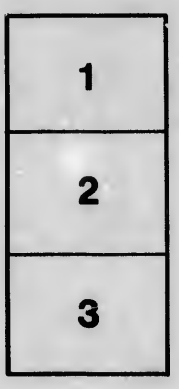

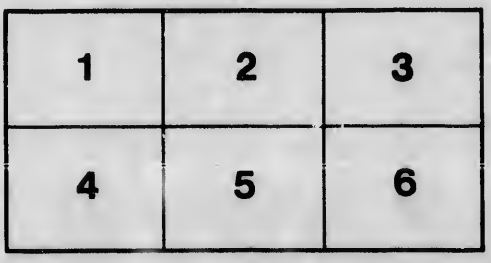

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THE USE OF SAFE EXPLOSIVES IN MINES.

PART II. THE RESULTS OF EXPERIMENTS.

By E. Gilpin Jun., M. Can. Soc. C. E.

To be read on Friday, 14th October, 1892.

The question of the use of explosives in the provincial coal mines was forced on the attention of the Nova Scotia legislature by the explosion at Springhill. Here apparently no trouble had been spared by the Company to protect its workmen. The locality in which the explosion originated was worked with safety lamps, the shots were fired under the direction of skilled men specially appointed for the purpose, and then at long intervals, not for loosening the coal, but to remove a few inches of stone in part of the roof. Copious watering was resorted to for laying the dust wherever the workings were not naturally damp. In spite of these precautions it appeared upon a careful enquiry that a charge of gunpowder had partially done its work, had flamed out, and the heat acting upon an atmosphere containing dust and gas gave rise to a very serious explosion. This showed that the mining practice of firing charges of gunpowder in places where dust and gas could be present was dangerous in spite of the precautions regarding its use.

After deliberation the Legislature enacted that when gas was found in any mine, in quantity sufficient to show in a safety lamp in three consecutive days, no explosive could be used for two months.

Provision was however made, that the Governor-in-Council could, upon the recommendation of a commission, including the Inspector and persons skilled in the use and composition of explosives, that any explosive was safe, relax the act in respect to explosives in favor of such safe explosive.

In considering the practical application of the use of explosives in coal mines, the first point to be settled is what constitutes a "gassy" mine, that is a mine in which the use of gunpowder becomes unsafe. The theoretical definition is that any mine in which gas is known to be given off may present it in volume sufficient to be ignited either alone or in connection with dust by the explosion of gunpowder. As a matter of fact small percentages are known by special tests to be present almost continuously in mines, although they cannot be detected by the best safety lamps in use. In all parts of the world in well ventilated mines, gunpowder has been continuously used for years with impunity in the presence of these minute percentages of gas. In such mines provided that they are damp, and free from dust, there is little danger even from excessive charges, or blown out shots of powder, so long as the ventilation is adequate.

Such mines when carefully managed and under proper discipline gradually and by imperceptible degrees, pass, as they are worked at an increased depth, into what may be termed the second stage, that of an increased evolution of gas, and usually of a greater degree of dryness. When this stage is reached a deficiency of ventilation in any district, coupled with dryness of the workings, produces a state of affairs highly dangerous in the

event of flaming or blown out shots. The third stage is that of deep workings, which add to the dangers of increased exudation of gas, and general dustiness, those of extended fracture of the strata suddenly introducing volumes of gas directly into the workings or pressing it out of the old goaves. Under these conditions prudent management introduces safety lamps and abolishes the use of gunpowder. The second stage is the most dangerous, as when the conditions of safety and danger are balanced, a trifling mishap paves the way for a disaster.

Mining practice has so long sanctioned the use of open lights and high explosives in mines that have reached the second stage, that the reaction now setting in, in favor of their restriction, promises to seriously affect the economic exploitation of some coal beds. The Prussian Commission went so far as to classify as "gassy," mines in which gas had been detected once in two years. It is therefore apparent that in almost every district there are mines varying in their degree of danger. Any hard and fast rule, for example, precluding the use of high explosives whenever gas is found, would not affect the mines of the third stage, but would greatly increase the cost of the coal from the comparatively non-gaseous mines. In the case of many mines giving off little gas, there are serious expenses, off setting the cheapness with which the coal is mined, such as faults, steepness of dip, the presence of stone, weakness of the roof, etc. Such mines would find it difficult to produce coal, if explosives were abolished.

As it was apparent that a mine at any given time fairly classed as not "gassy" might in a few days on cutting a fault, giving off gas, or entering a disturbed section of coal, become decidedly "gassy" it was considered that the limitation imposed in the act would give a fair warning of danger arising in the usual conditions of mining. In the case of mines naturally damp, and decidedly free from gas, permission was also made in the act that any local and temporary detection of gas would not exclude the use of powder until it became evident that the increased proportion of gas was likely to prove permanent.

It must also be remembered that explosives play an important part in mining in addition to their employment for loosening the coal. Faults have to be penetrated, often through stone, tunnels must be driven to connect seams, roofs and pavements have to be removed, etc. These operations when expedited by the use of gunpowder or high explosives, have frequently proved very dangerous, and the source of serious explosions in the presence of gas and dust. So much is this the case that there is evidence tending strongly to show that, in haulage planes containing much dust, and presumably almost entirely free from gas, shots fired to bring down portions of a stone roof have caused disastrous explosions. Still such operations are essential to working coal mines, and their cost would be enormous if they had to be performed by manual labour only.

Upon a careful consideration from every point of view of the difficulties surrounding the problem, it appears that the total prohibition of explosives would be almost impracticable, and result speedily in the closing of mines already compelled to use every economy to make both ends meet in the face of competition.

Under these conditions the importance became evident of ascertaining if there was any explosive that could be safely used in the presence of gas and dust, in order that the exploitation of the Provincial mines might not be injuriously affected. The International and Acadia collieries, in Pictou County, had for some time used Roburite, at first imported from England, but afterwards supplied from a branch factory in Halifax, working under the company controlling the patent in Canada.

The commission appointed to enquire into the subject, under the provisions of the act already referred to, comprised the Inspector and several mining engineers and practical miners familiar with the three principal mining districts of the Province. The Commission met several times at Stellarton, in Pictou

County, and experimented in the collieries of the Acadia Company, and appointed a sub-committee to experiment in Cape Breton.

The general value of the explosives tested before the Commission at Stellarton, may be gathered from the following selection of experiments, conducted under the supervision of members of the Commission.

Two parties submitted explosives. The Acadia Powder Company of Halifax, which had been for some time engaged in the investigation of flameless explosives suitable for use in gaseous mines, produced two grades of a dynamite explosive, claimed to be rendered flameless by the addition of certain chemicals. As the explosives were experimental, it was not deemed necessary at that stage to consider their percentage composition. The Roburite Company submitted Roburite as manufactured by them at Halifax, giving its composition as 18 per cent of chloro-dinitro-benzole and 82 per cent of nitrate of ammonia. It may be remarked that the secretary of the English company intimated later that the compound as manufactured there did not contain over 12½ per cent of chloro-dinitro-benzole, and that presumably it was made in Halifax of the same strength. The commission up to the date of its preliminary report, has dealt with the question of exact composition of explosives only in a general manner.

It may be remarked that in these experiments, the shots were fired with detonators, ignited by a victor battery.

1st Experiment. Two 6 oz cartridges of roburite were placed on the ground on the same wire, and covered with a few shovelfulls of dry slack coal. Both shots gave a short bright flash.

2nd Experiment. One 6 oz cartridge of grade "B," and a 3 oz cartridge of grade "C," of the explosives of the Acadia Powder Company, were connected to the same wire, placed on the ground and covered with slack as before. On firing there was a flash from grade "C" cartridge, but none from grade "B" cartridge.

3rd Experiment.—A 4 oz cartridge of roburite, covered with four inches of slack coal, gave a flash on being fired.

These experiments were made on a dark night, and as far as possible under the same conditions.

The tests were continued in the McGregor pit of the Acadia Coal Company. A number of holes were bored in firm coal, in the high side of a level, in a five foot seam, about half way between the roof and floor. The holes were three feet six inches deep, and from 1½ to 1¾ inches in diameter.

1st Experiment.—Charge 7 oz, explosive "B," hole tamped with clay for 25 inches. Shot blew the outside tamping off for a depth of 18 inches. No light visible.

2nd Experiment.—Charge 4 oz. roburite. Hole tamped with clay for 20 inches. Shot blew out tamping. No light visible.

3rd Experiment.—Charge 4 oz explosive "B," hole tamped with clay for 20 inches. Shot blew out tamping. No light visible.

4th Experiment.—Charge 7 oz explosive "B". No tamping. Shot gave bright flash.

5th Experiment.—Detonator of Acadia Powder Company fired outside the hole alone and uncovered, gave flash.

6th Experiment.—A 4 oz cartridge explosive "B" with detonator in rear of cartridge, and pushed in the back of the hole, gave slight flash on being fired.

In the opinion of those witnessing these experiments, the flash observed when the explosives where fired, without tamping, was not greater than that due to the detonator, except perhaps, in the case of the fourth experiment in the McGregor pit. It is probable that the greater or less amount of flash visible in a number of experiments, may be due either to a lack of uniformity of the explosive mixture, or to the detonators not occupying, in each case, the same position in the cartridge. The fact was evident that the explosives, fired unconfined, did not give a flame, but a very brief flash of light. The blown out shots did not flame, nor did they give a light, a very slight tamping being apparently enough to delay the progress of the explosion long enough for the flash to have disappeared, when the rupture of the enclosing

matter took place. It may be imagined that the sudden compression of the air in the vicinity of the charge might produce visible heat, in a manner parallel to the gnition of gunpowder by sudden compression of air in a cylinder.

Numerous practical experiments were made in this pit, substituting the new explosives for gunpowder in the ordinary working of the coal. These showed that as soon as the workmen understood the changed methods of apportioning the charge, tamping, etc, they got equally good practical results. As a specimen the following memo gives the particulars of a shot fired in one of the regular working places of the McGregor pit.

Working place 15 feet wide. Bench 6 feet by 7 feet, by 3 feet 9 inches high. (1575 cubic feet.) Hole 5 feet deep, 2 feet 6 inches from the higher side, (the seam dipping about 1 in 3) level, and on bottom of seam. Charge 18 oz. "B" Explosive. First half of hole stemmed with clay, rest with slack coal. The shot was satisfactory. Coal hard and compact, and the bench had a layer of stone on top 9 inches thick.

The committee appointed to experiment in Cape Breton coals, which are softer than those of Pictou, reported that, in spite of their meeting with objections on account of cost, and prejudices in favor of the long established gunpowder, their opinion was that these explosives could readily replace gunpowder in that district.

At the close of the year the Commission submitted a preliminary report to the Governor-in-Council, in which they state that they had selected two of the explosives submitted, as apparently safe and adapted for coal mining, and that they had confined their enquiry solely to the question of safety in blasting, but had not gone into the question of cost, or of safety in manufacture, transportation, or storage, and that no investigation had been carried into the composition of these compounds pending the results of certain changes recommended by the Commission as calculated to render them safer.

The Commission recommended that any of the four explosives, approved of by the French Minister of Public works, August 1st, 1890, be allowed to be used, and any other explosive, not yielding as the product of its detonation any combustible matter, such as carbon, nitrogen, etc, or having its temperature of detonation higher than 1500° C. if employed in coal blasting.

Recommendations are also made as to the proper length of tamping. Arrangements were made for the issue of licenses to manufacturers, testing of samples, firing by electrical fuses by low tension electricity etc.

Since the report was made, samples of ammonite have been received from England. This explosive is put up in thin metallic cartridges to prevent the action of moisture on the nitrate of ammonia. The explosive, which is highly spoken of in England, is likely to prove expensive, where it comes into competition with other explosives, which can be supplied to the miner fresh from the factory, if not as well protected from dampness. Opportunity has hitherto been afforded only of testing this explosive in Cape Breton, and the results were not conclusive, but further tests will be made in Pictou County, where more experience has been gained in handling new explosives.

The Acadia Powder Company have improved their explosive, and are experimenting with an addition which has, it is claimed, the power to effectually waterproof their ammonia nitrate. Their new compound is substituted for the grades "A" & "B" referred to in this paper. The compound contains under 20 per centum of dynamite, and has in addition to the nitrate of ammonia, a chemical, which, stable in itself, is calculated to neutralize any trace of acid that may be present. So soon as the changes in the explosives are finished, the Commission will probably resume its work, and it is hoped will be able to recommend, at least two explosives superior in safety to any yet introduced in England or on the Continent.

NOTE.—The final results, analyses, etc., will be shortly submitted.