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DEPARTMENT OF MINES
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(THIRD EDITION)

REPORT
ON THE
EXPLOSIVES INDUSTRY
IN THE
DOMINION OF CANADA

BY
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EXPLOSIVES INDUSTRY

OTTAWA, October, 1, 1910.

To Dr. EUGENE HAANEL,
Director of Mines, Ottawa.

SIR,—I have the honour to submit the following report on my investigation of the explosives industry in the Dominion of Canada.

Before offering any criticisms or recommendations, I propose to state briefly the more important principles upon which the British regulations are based; these general principles being, in many cases, equally applicable to the regulation of the industry in the Dominion.

(1) *Authorization of Explosives.*—No explosive may be manufactured in or imported into the United Kingdom for sale until it has been subjected to examination by the chemical advisers of the Explosives Department. It is the duty of these gentlemen to satisfy themselves that the explosive is not unduly sensitive to friction or percussion, and that it also possesses a reasonable degree of chemical stability. Explosives which are found to be of the requisite standard are included in the list of authorized explosives as soon as a license is obtained to allow of their being manufactured or imported.

(2) *Manufacture of Explosives.*—No explosives may be manufactured except in an authorized place. A person, therefore, who wishes to manufacture explosives has to obtain a license. By the terms of his license he is only permitted to erect buildings of a specified construction, on the sites shown on a plan attached to his license. The maximum number of work-persons, and the maximum quantity of explosives allowed to be present in each building are specified, as is also the nature of the operations proposed to be carried on in the buildings. The factory buildings are required to be at certain distances from one another, and certain distances must also be observed from buildings and works outside the factory. The distances are determined by the quantity of explosives allowed to be present in the building. A table showing quantities of explosives and distances was drawn up some years ago from data obtained by noting the damage caused by explosions of known quantities of explosive; suitable interpolations were made to render the application of the table practical. Since the adoption of this system of distances, no member of the general public has been killed, and no dwelling house has sustained any serious structural damage by an explosion in any factory. From recent explosions it appears that the distances are hardly adequate where the explosive involved consists of nitro-glycerine unmixed with other ingredients.

Generally speaking, the buildings in which operations of manufacture are carried out are required to be of light construction, having close joined wooden floors and being lined with wood or other suitable material. I will refer to magazine construction under the head of storage.

No responsibility is taken by the Explosives Department regarding the machinery employed, but in the event of any particular type of machine proving to be dangerous, the question of its discontinuance is taken up with the occupier of the factory.

The maximum number of work people allowed to be present in a building is determined by the nature of the operations carried out in the particular building, and, as a rule, varies from two to six. This number is exclusive of the men employed to

convey explosives or ingredients to or from the building and who are essentially non-producers.

I may add that the death rate among the employees has been for a considerable number of years well below 1 per 1,000.

Storage of Explosives.—Magazine licenses are issued by the Home Office for the storage of explosives. As in the case of factory licenses, the terms require that the building should maintain certain distances from the buildings and works depending on the quantity of explosives allowed to be kept. Only half the specified distance need be maintained if the building is screened by substantial earth banks, and if satisfactory screening is afforded by the natural features of the ground the distances are sometimes diminished by 75 per cent. Magazines are almost invariably constructed of substantial masonry or brickwork, as it is considered that if the explosive is of good quality the only dangers to be feared are those which will arise from outside the building. The only objection to this form of construction is, that should an explosion occur in a building not surrounded by earth banks considerable damage may be caused by the projection of heavy debris. In the past thirty years, three magazines have been destroyed by explosions and in no case were any lives lost or surrounding property seriously damaged.

Licenses for the storage of limited quantities (2 tons of gunpowder or 1 ton of high explosive) are granted by the local authorities, if specified conditions as to construction and distances are observed.

Home Office Licenses.—Both factory and magazine licenses are prepared in draft by the applicant in consultation with the Explosives Department. When the draft has been agreed upon, the applicant is given permission by the Secretary of State to lay the draft before the local authority, in whose jurisdiction the proposed buildings are situated, in order to receive their assent. If the local authority give their assent, the draft license is confirmed. If, however, they refuse their assent, an inquiry is held by an officer of the Explosives Department, and the Secretary of State, on receipt of the report, either upholds the local authority or inserts additional terms to cover their objections, or over-rides their decision.

Transportation.—Accidents in transportation are practically unknown and this may be fairly ascribed to the quality of the explosives, the specified method of packing, and the care in handling the traffic. The method of packing and general regulations as to transportation are prescribed in Orders of Secretary of State made under the Act. Railway companies, canal companies, and harbour authorities have, however, to make by-laws regarding the transportation, loading, and unloading of explosives. These by-laws have to receive the sanction of the Board of Trade before they are operative.

Importation.—Only authorized explosives may be imported for sale. A person desiring to import explosives has to obtain an importation license from the Home Office. Before a license is granted he is required to show that he has an authorized place of storage at his disposal. Generally the importer owns licensed magazines, but if not he obtains a certificate from an occupier of a licensed magazine, that sufficient storage accommodation is available for the importation. When the importation is effected, the customs officers take samples which are forwarded for examination and the explosive is deposited in the specified magazines. If the samples are reported on as coming up to the required standard, the explosive is placed at the disposal of the importer. Otherwise, further samples are obtained (if the importer so desires), or the explosive is definitely condemned as being unfit for distribution. In certain doubtful cases the explosive is released, on the importer guaranteeing that it will all be used up in a limited time.

Use of Explosives.—The use of explosives is not governed by the Explosives Act. The use in mines and quarries is regulated by general rules contained in the Mines and Quarries Acts, and by special rules made under those Acts. A Bill was introduced into Parliament last year giving the Secretary of State power to make regulations regarding the use of explosives in construction works, but, owing to the large amount of other legislation before the House, the Bill was dropped.

Home Office Testing Station.—The station was established in 1897 under a section of the Coal Mines Regulation Act, 1896, and the work carried on there must not be confused with the purely chemical work of the chemical advisers of the Explosives Department. The station is used for testing explosives for use in coal mines where danger is to be feared from fire-damp, or coal dust. The test consists in firing charges from a cannon into a chamber filled with an explosive atmosphere of air and coal gas. The details of the test are about to be considerably modified and for this purpose a new apparatus is being erected in the north of England. Only authorized explosives may be submitted to the test and the names of those which have passed this test and the conditions under which they may be used are published from time to time in an Order of the Secretary of State. These explosives are known as Permitted Explosives.

Explosives Industry in the Dominion.

I have had the opportunity of visiting the majority of the more important factories. As was to be expected, the standard of precautionary measures against accidents varied considerably. Any criticism I may make must not be considered as being directed against any particular factory, as I purposely avoided making a detailed inspection of any one plant, feeling that with the very limited time at my disposal, the utmost I could do would be to obtain a general impression as to the conditions under which explosives were manufactured.

As regards the quality of the explosives, I will defer comment until I discuss the question of use, as the only information I have obtained was gained in course of conversation with the users of explosives.

Most of the factories appear to suffer from the defect of having been started in a small way and then added to as the business expanded. Had the probability of expansion been recognized at the commencement, there is little doubt but that the buildings would have been placed in more suitable positions and overcrowding thus avoided. In some instances the quantities in the buildings were considerably greater than the distances from other buildings would allow. This was sometimes due to the fact that explosive which had been operated on was allowed to remain in a building while a second batch was being operated on and a third was being brought into the building. As a general principle, a batch of explosives should be removed from a building as soon as it has been operated on; if the building in which the next operation is to take place is not available, it should be placed in an expense magazine situated at a suitable distance. The chief danger of explosion must of necessity be with the explosive which is being operated on; it is, therefore, unwise, to say the least of it, to expose a second or third batch to the certainty of communicated explosion. In other cases the excessive quantities were due to overcrowding of the factory buildings.

The actual operations of manufacturing nitro-glycerine appear to be generally carried out in one building, owing to climatic conditions, and this entails the accumulation of large quantities, sometimes amounting to over five tons, in one building. The majority of the factories have only one nitrating plant, and I think manufacturers should consider whether it would not be advisable to install a second plant, which could be used alternatively, and thus prevent such large accumulations in one building. An explosion in a nitrating plant must put a factory out of action for some considerable time, unless there is a duplicate plant available.

In some factories there were too many cartridge packing machines in one building. The objection to this practice does not lie in the number of machines but in the large number of men who must be present in the buildings to attend to the machines. In one instance, all the machines in the factory were under one roof, and no less than 15 men were present. Apart from humanitarian objections to the exposing of so many lives to one risk, I am strongly of opinion that it is economically unwise to concentrate all the cartridge packing in one building. I understand that in one factory last year 11 lives were lost, due to explosions which occurred in the packing house. This number exceeds the annual average number of deaths in all the explosives factories in Great Britain. Generally speaking, there appears to be a tendency to allow unnecessary articles to accumulate in danger buildings. The object of the manufacturer should be to reduce the number of moveable implements to the minimum. When it is remembered that a thin layer of most explosives can be exploded by a blow from a comparatively light weight falling a distance of a few feet, the importance of this point will be realized. I may mention in this connexion that I have more than once witnessed the experiment of a thin layer of gunpowder spread on a wooden floor being ignited by a glancing blow from a wooden broom stick.

The presence of iron hammers and other tools is also objectionable. When they are required, they should only be used by a responsible person and should be removed as soon as they are no longer wanted.

Greater care should be exercised to prevent grit getting into the explosive and also to prevent explosive from lodging in crevices in the walls and floors of buildings. The iron framework of machines should be painted to prevent the detachment of rust, which is otherwise almost certain to find its way into the explosive.

I do not think that manufacturers pay sufficient attention to details, and it is only by studying details that it is possible to make the manufacture of explosives relatively safe. Apart from the risk of spontaneous decomposition, which may arise on rare occasions during the manufacture of nitro-glycerine, there is the risk of spontaneous decomposition from explosive dust settling on heating pipes and being left there, and from accumulations of explosive in cracks and crevices. With reasonable precaution these latter risks should be practically non-existent. The heating pipes should be so placed that they are readily accessible to inspection and the walls should be lined with a suitable material; the floor, if not close joined, should also be covered. I understand that rubberoid has been employed both as a lining for the walls and a floor covering by several manufacturers, with excellent results.

Another risk to be guarded against is the ignition of a thin film of explosive by a blow. As I have already stated, as few movable articles as possible should be present in a building. When it is remembered that most explosives when heated are much more sensitive to friction or percussion, special precautions should be taken in drying houses to eliminate this risk, and I think that the explosive should be allowed to cool down to the normal temperature before it is handled or the drying racks removed.

Grit mixed with explosive renders it far more sensitive; precautions should, therefore, be taken to prevent its introduction either by the work persons themselves, or by its adhering to boxes and packages brought into the building. It is impossible to prevent a certain amount of grit entering a building, and this grit will, of necessity, be mostly present on the floors of the buildings; it is important, therefore, to minimize the quantity of explosive spilt on the floor and also to have the floors swept periodically.

In buildings in which explosion is likely to be preceded by fire it is especially necessary to provide adequate means of escape for the work people, and care should be taken that the exits are not blocked by boxes or packages.

Sufficient forethought does not seem to be paid to the wiring of the electric light system. Apart from the dangers of ordinary wear and tear, there is always the risk that the concussion caused by an explosion in a neighbouring building may so dislocate the wiring as to cause a fire.

Storage of Explosives.

I have not had the opportunity of visiting many magazines. In most instances the distances maintained from other buildings were inadequate, owing to the large quantities stored. I cannot help thinking that it would be wiser to erect a greater number of buildings and to store in each smaller quantities of from 25 to 50 tons.

In some instances I found packages of damaged explosive which had been returned by the users. Damaged explosive should be destroyed, as, if left in a magazine, it is liable to be overlooked and if of the nitro-compound class may ignite spontaneously.

Transportation of Explosives.

My attention was drawn to two instances of the transportation of explosives by water, which I think are deserving of comment. In one case, after over 100 tons of dynamite had been loaded into a vessel, a number of cans of gasoline were placed on top of the explosive. Highly inflammable and volatile liquids, such as gasoline, should not be transported with explosive. In another instance, cargoes of explosive were habitually conveyed in a gasoline launch. I do not think it can be claimed that gasoline launches have reached such a state of perfection that the possibility of fire can even be regarded as remote. If such a launch caught fire in a crowded harbour, the results would be disastrous.

Use of Explosives.

In the course of conversation with the users of explosives I have frequently been told that the quality of the explosives manufactured in the Dominion leaves much to be desired. It was asserted that no two charges fired in similar circumstances would do the same amount of work. Except so far as shot firing in coal mines is concerned, I do not think this unevenness of explosive can be said to be a positive danger, apart from the production of an unnecessarily large volume of deleterious gases from an overcharged shot. In the case of coal mines, where there is risk of igniting gas or dust, the danger is very appreciable. A miner will always gauge the weight of his charge by the weakest shot he has fired and the tendency will always be to overcharge. The gases produced from the surplus of explosive not having any work to do will not cool down rapidly, and should they come in contact with fire-damp or coal dust in suspension would probably cause an ignition. It is imperative, therefore, that steps should be taken to ensure an even quality of explosive for use in coal mines.

A thin film of explosive on the exterior of a cartridge, a state of affairs which I frequently noticed in the buildings in which cartridges were being packed into boxes, can hardly be conducive to safety in ramming. In the absence of specific information as to the accidents which occur from the use of explosives, I do not feel that it is possible for me to offer any further comments.

It will not be out of place, however, to give a word of warning as to the misleading effects of demonstrations of the safety of explosives. These experiments generally consist in burning a cartridge in the open or throwing a small quantity on to a fire. Such experiments can generally be performed with blasting explosives without risk. The behaviour of the explosive when confined in a bore hole or when ignited in bulk so that a certain amount of pressure is generated would be a much more reasonable test, but such experiments would not suit the demonstrator as they would be much more likely to result in an explosion. I may instance the case of many of the ammonium nitrate explosives, which are very difficult to ignite in the open, and when thrown on a red hot sheet of iron merely melt, but which in the confinement of a shot hole have been found, under certain conditions, to burn fairly readily until sufficient pressure is set up to cause the unburnt portion to explode.

It cannot be pressed too strongly upon the user of explosives that the function of an explosive is to explode, and that, no matter what assertions are made by an interested person as to the safety of his explosive, all explosives should be regarded as dangerous.

Recommendations.

In the following pages I have acted on the assumption that the Dominion Government has the power to legislate on these matters.

It is not possible for me to mention in detail all the points which I think should be included in the draft bill which is in course of preparation. I propose, therefore, under the above heading, to discuss shortly some of the more important provisions which should be included in the proposed legislation and also to offer some suggestions on matters which, though they do not come directly within the scope of the bill, are of sufficient importance to warrant my commenting on them.

The following are the essential points which I propose to discuss:—

1. Authorization of explosives.
2. Licensing of factories.
3. Control of storage not otherwise provided for.
4. Control of transportation not otherwise provided for.
5. Control of importation.
6. Inspection and sampling.
7. Establishment of chemical laboratory and testing station.
8. Investigation of accidents in factories.
9. Investigation of accidents in storage, transportation, and use.
10. Appointment of staff.

(1) *Authorization of Explosives.*—I think the system in Great Britain should be adopted. It will undoubtedly improve the quality of the explosives manufactured in the Dominion and should thereby have a tendency to diminish accidents in use; it must not be expected, however, that fool-proof explosives will ever be produced. It will also prevent the user being at the mercy of the enthusiastic inventor who persuades him to try a new explosive which has probably been invented many years previously and then discarded on account of its danger or unsuitability.

(2) *Licensing of Factories.*—Factories should be licensed on the principle of limiting the amount of explosive allowed to be present in a building, in accordance with the distances that the building can maintain from the other buildings in the factory, and buildings and works outside the factory. Limitations should also be assigned as to types of construction adopted, the number of work persons allowed to be present, and the nature of the operations to be carried on in the various buildings. If these points are enforced in a reasonable manner, I do not think that manufacturers will find their trade unduly hampered.

As regards existing factories, I do not think the occupiers should be required to immediately conform to the new system, but that a definite time limit should be assigned, so as to admit of the change being made gradually. If, however, there happen to be particular buildings in a factory which constitute a very definite menace to the public safety by reason of their proximity to a city, I think the occupier should be required either to remove the building forthwith, or to reduce the quantity of explosive in the building, so as to diminish the danger zone. It is not possible to lay down a hard and fast rule and each case should be considered separately and treated on its merits.

(3) *Control of Storage.*—The special points to which attention should be paid are the situation, quantity of explosive, and construction. The first and second should be governed by the table of distances. As regards the third, two somewhat antagonistic features have to be considered. First, the building should be protected from dangers from without, such as rifle bullets, and should have security against unlawful entry and fire. Second, in the event of an explosion occurring the projection of heavy debris should be minimized; this feature is probably of greater importance in the Dominion than it is in Great Britain, owing to the fact of the large number of frame dwelling houses which are to be found here, whilst they are almost non-existent in the latter country.

The ideal construction for a magazine would be to have a relatively lightly constructed building, surrounded by substantial earth banks, but it is difficult to make this type reasonably secure against unlawful entry and other dangers from without. It must always be remembered, however, that with the system of the authorization of explosives there should be little risk of the explosive igniting spontaneously, and as no operation should be carried on in a magazine the principal danger of explosion comes from causes outside the building. The results of some experiments carried out in Germany were recently published and the conclusion arrived at by the experimenters was, that a certain type of reinforced concrete gave the best result. It was found that with the particular form of construction very little debris was projected when an explosion occurred in the building, as the concrete was so pulverized that the fragments did not carry any great distance. If funds are available, it would be of considerable value to have experiments carried out on similar lines with buildings constructed to suit Canadian requirements.

In Great Britain there is a statutory requirement that every magazine should be fitted with an efficient lightning conductor; there are, however, no suggestions given as to what constitutes such a conductor. As I understand that parts of this country are frequently visited by severe electrical storms, I think the question of protecting magazines from lightning should be considered. I would venture to suggest that the scientific staff of some of the Universities and representatives of the explosives manufacturers should be invited to co-operate with your Department to inquire into the most efficient and economical system of securing the necessary protection. There is a system of storage in Great Britain, which I have not met with in the Dominion, but which might be found of use where the climatic conditions will admit of it. In the rivers Thames and Mersey vessels are moored at places specially selected by the Harbour Authorities, and these vessels are licensed by the Home Office as Magazines. Where there is a considerable water-borne trade, the use of such vessels as distributing centres might prove of advantage.

(4) *Control of Transportation.*—The control of transportation by rail is in the hands of the Railway Commissioners, and the only way in which the proposed legislation will affect this method of transportation will be as regards the quality of the explosive conveyed. I understand that the regulations adopted by the Commissioners are those promulgated by Col. Dunne's bureau in New York. The great value of these regulations has been amply proved, but being a private concern there are not the same facilities for maintaining the standards of quality of the explosives as will be the case when the authorization of explosives is in the hands of the Government.

I understand that at present it is practically impossible to transport legally small quantities of explosive by rail. It is generally certain that this traffic is carried on, probably in passenger trains, and with detonators and blasting explosive packed together. I would venture to suggest, therefore, that your Department should approach the Railway Commissioners, with a view to discussing the question of recognizing and controlling the transportation of small quantities. I may mention that in Great Britain the railway companies have agreed to transport small quantities of explosive in cars loaded with other freight, when packed in a special manner.

As regards transportation by water or road, I think power should be included in the bill to regulate generally the method of stowage, the method of packing, the limiting of the nature of freight which may be transported with explosives, and the limiting the quantity of explosive transported at any one time, according to the nature of the vessel or vehicle in which the transportation is being effected.

(5) *Importation*.—Before any explosive is imported into the Dominion for sale or use, a sample should be submitted for authorization. The terms of the license for subsequent importations should require the importer to have at his disposal a licensed place of storage, in which the explosive would be detained until the chemical department have satisfied themselves by examination of the samples taken by the Customs that the explosive is of the requisite standard.

(6) *Inspection and Sampling*.—I need only remark that when a factory or magazine have been licensed it is necessary that they should be periodically inspected, to ascertain that the terms of the licenses are being complied with. Similarly, it is essential that after an explosive has once been authorized, samples should be periodically examined to see that the manufacturer is maintaining the required standard. Most explosives deteriorate in quality and chemical stability after prolonged storage. It is necessary, therefore, to obtain samples not only from factories and distributing magazines, but also from magazines in the occupation of the users of explosives. I have reason to believe that the Provincial authorities will be glad to co-operate with your Department in this respect.

(7) *Establishment of Testing Station*.—Apart from the chemical laboratory, which will be in the hands of the chemical advisers of the explosives department, it will be necessary to establish a station for the testing of explosives for use in coal mines. I understand that it is also considered desirable to erect an apparatus for testing types of safety lamps. I would suggest, however, that before deciding on the final details of the tests it would be well to await the conclusion of the experiments which are shortly to be carried out in Great Britain. It may be of interest to state that the Home Government have not contemplated instituting an official test for the so-called rescue apparatus. The word 'rescue' appears to give the general public the idea that after an explosion has occurred in a coal mine it is only necessary for men wearing these breathing apparatus to enter the mine, to enable them to rescue the unfortunate miners who have been exposed to the effects of the explosion and the deadly effect of after damp. I think the more reasonable view to hold as regards the practical utility of breathing apparatus is that their chief scope lies in the direction of coping with fires below ground in the early stages, and it is only in the sense of preventing the spread of a fire which would endanger the lives of those present in the mine that the term 'rescue' can be applied to them.

Apparatus should be installed at the testing station to enable comparisons to be made between the kinetic energy of different natures of explosives and also to determine the velocity of detonation of explosives. Information on these two points should prove of value to the users of explosives, to enable them to select the explosive most suitable for the work which they are undertaking.

(8) *Accidents in Explosives Factories*.—It is of the utmost importance that the explosives department should have full information regarding all accidents which occur in factories either by fire or explosion, even when no personal injuries are sustained. It is often from an accident in which no persons are injured that the most valuable information can be derived. I think that it should be obligatory for the occupiers of factories to report as soon as possible all such accidents, and to leave things untouched as far as is practicable, in case it should be deemed advisable to have the circumstances of the accident investigated by an official of the department.

(9) *Accidents in Storage, Transportation, and Use.*—Accidents which occur by fire or explosion in the storage and transportation of explosives should also be brought to the notice of the department; in those cases in which the storage or transportation comes under the control of the new Act, it may be desirable to have an inquiry held by an official of the department. In other cases, the co-operation of the Provincial Governments and the Railway Commissioners should be sought, in order to obtain as complete a record as possible of such accidents. Doubtless, the Provincial Inspectors of mines will be willing to inform the new department of the results of their investigations. As regards accidents in transportation by rail, the services of an inspector of explosives should be placed at the disposal of the Railway Commissioners, should they so desire it, to assist in carrying out investigations.

By far the larger number of accidents which occur with explosives arise from their use; it is of the utmost importance that all accidents occurring when the explosives are in use should be thoroughly investigated and classified. I have reason to believe that the Provincial Inspectors of Mines will be willing to co-operate with the department by forwarding accounts of accidents occurring in the mines under their jurisdiction. I understand, however, that a large number of accidents occur in works where there is no legislation affecting the use of explosives. I think it would be advisable for the Minister of Mines to take power in the proposed bill to frame rules to regulate the storage and use of explosives in such works, to require the reporting of accidents, and to have investigations made when such a course appears necessary.

It may be of interest to summarize the causes of the more frequently occurring accidents which arise from the use of explosives in mines, quarries, and construction works in Great Britain.

1. *Prematures.*—Often due to the use of short or bad fuse, or the use of straws and squibs to ignite the charge. May arise from a man attempting to light too many shots and thus being unable to take cover.

2. *Hang-fires.*—Often due to irregular fuse, or the ignition of explosive, which burns until sufficient pressure is set up to cause it to explode; this may be due to inferior quality of explosive or a weak detonator. Sometimes due to miscounting shots and returning too soon.

3. *Electrical Prematures.*—Generally due to the shot firer allowing another man to connect the detonator leads to the firing cable, which has been previously attached to the battery.

4. *Ramming.*—Due to frozen nitro-glycerine explosive, broken cartridge leaving a thin film of explosive in the bore hole. Cartridge sticking in the bore hole and being violently forced home. It is of the utmost importance that no explosive which is unduly sensitive to friction or percussion should be authorized for use.

5. *Striking Unexploded Charge when Removing Debris.*—Generally due to frozen nitro-glycerine explosive, or to weak detonator which fails to cause propagation of detonation through all the cartridges, or to the cartridges becoming separated by a layer of dirt in the shot hole.

6. *Boring into a Missed Shot.*

7. *Tampering with a Missed Shot.*

8. *Not Taking Proper Cover.*—In the case of electrical firing generally due to use of too short a cable.

9. *Fumes.*—Either due to defective ventilation, men returning too soon, or ignition instead of detonation of high explosive. The gases evolved by burning

nitro-glycerine explosives are very poisonous. The burning may be originated by weak detonator or inferior quality of explosive.

10. *Preparing Charges*.—Generally due to frozen nitro-glycerine explosive, unduly sensitive explosive, recklessness, or lack of skill.

11. *Ignition of Explosive by Spark*.—Principally confined to gunpowder, where open lights are used below ground.

12. *Socketting or Springing*.—Due to re-charging before sufficient time has elapsed.

13. *Ignition of Fire-damp or Coal Dust*.—Apart from the quality of the explosive, generally due to the firing of two shots, one after the other, without examining for gas after firing the first shot. The firing of overcharged shots is perhaps the more usual cause.

It may be of interest to state that during 1909 over 30 million pounds of blasting explosives were used in mines, quarries, and construction works in Great Britain, and that (exclusive of fatalities from explosions of fire-damp or coal dust) 53 lives were lost thereby.

Staff of the Explosives Department.—The technical staff of the new department should, I think, consist of a Chief Inspector, two Inspectors, and a Chemist. I cannot state too emphatically that the Chief Inspector should have sufficient technical knowledge not only to enable him to administer what must of necessity be a very technical act, but also to deserve the confidence of the explosives manufacturers. As men possessing such qualifications are rare, I would venture to suggest that it would be very unwise to attempt to economize by offering an inadequate salary. As regards the two inspectors, it will hardly be possible to obtain the services of technically qualified gentlemen, and I think it would be sufficient if these gentlemen possessed practical experience of the use of explosives, one of them at least having gained his experience in coal mining. In assigning their salaries, the fact that their work must of necessity be somewhat hazardous should not be lost sight of.

The responsibility of the chemical adviser to the department will be considerable, as in his hands will rest the recommendation for the acceptance or rejection of explosives. When it is remembered that the authorization of an explosive or otherwise, or the condemnation of a batch of explosive which has been issued from a factory may involve large financial interests, it is hardly necessary for me to point out that this gentleman should be possessed of the highest technical qualifications and integrity. The salary of the chemical advisers of the Home Office is entirely dependent on fees, but it would be far preferable if the chemist of the new department were paid an adequate salary so that his whole time should be at the disposal of the government.

It will be necessary to employ a mechanic at the Testing Station, who will be competent to carry out minor repairs to the apparatus, and who would assist in carrying out official tests and experiments. He should also be responsible for the care of explosives stored in the magazine and for apparatus and stores used in connexion with the Testing Station.

I have the authority of Major Cooper Key, His Majesty's Inspector of Explosives, for stating that he will be glad to afford facilities for any person who may be appointed as an Inspector to be attached to the Explosives Department of the Home Office, to enable him to get an insight into the administration of the Explosives Act and the methods adopted for the testing of explosives for use in coal mines. Major Cooper Key also states that he would be glad to make arrangements for the chemical adviser of the new department to work in the laboratory of Messrs. Dupré, who are the chemical advisers of the explosives department. I would strongly urge that these facilities be taken advantage of.

If my proposal as to the regulation of the use of explosives be adopted, I would suggest that two or three gentlemen be appointed as assistant inspectors, whose duty would be confined to the administering of these regulations. Their principal functions would be to endeavour to educate the users of explosives by means of lectures and practical demonstrations to avoid the misuse of explosives, and also to investigate any accidents which might occur.

I have the honour to be,

Sir,

your obedient servant,

A. Desborough, Capt.

H. M. Inspector of Explosives.

MEMORANDUM.

Magazine Construction Committee.

The Committee should consist of a member of the Mines Department, a representative of the Militia Department, a representative of the Public Works Department, and two members of the explosives trade.

The object of the Committee would be to test different natures of construction by exploding from a half to one ton of explosive inside each building, and noting the distance to which the debris is projected.

The Committee should satisfy themselves that each building is reasonably secure against unlawful entry.

I would suggest that the explosive be invariably stacked at one end of the building, so as to leave as great an air space as possible from the other end. This point is especially important where the construction is of concrete.

The types of construction which might be experimented with are as follows:—

1. Expanded metal and cement plaster.
2. German special re-enforced concrete.
3. Log magazine.
4. Any type which the Committee suggest.

I think the attention of the Committee might be directed to the possibility of the expanded metal being carried above the roof, and also being grounded to form an economical system of protecting from lightning.

Transportation of Liquid Nitro-glycerine by Road.

Mr. Lowry, at the recent conference, raised this point with regard to the use of liquid nitro-glycerine in opening oil wells.

When nitro-glycerine was first used on a commercial scale, it was invariably transported in the liquid state. In consequence of the large number of accidents which occurred, the practice was prohibited in all European countries. Alfred Nobel then absorbed the liquid in an infusorial earth, solely with the view of rendering its transportation reasonably safe, and with the intention of extracting the nitro-glycerine by a process of displacement by water when it had been transported to the place at which it was required to be used. He found, however, that for ordinary blasting purposes it was not necessary to use the nitro-glycerine as a liquid, and he called the plastic explosive dynamite. I have been told that it is essential to use liquid nitro-glycerine in opening oil wells, but I do not know if this practice is universal. If it is absolutely necessary to do so, I think that at any rate the nitro-glycerine should not be transported as a liquid but as dynamite. In Great Britain dynamite No. 1 is defined as a mixture of not more than 75 parts of nitro-glycerine absorbed in kieselgur.

A factory license could then be granted to allow of the nitro-glycerine being displaced in the immediate neighbourhood of where it was intended to be used; the operation to be effected in a definite building and to be under proper control and supervision.

Testing Station and Chemical Laboratory.

I attach to this paper a rough specification of the testing gallery which is being erected in England. The sketch drawings mentioned in the specification have been omitted, as there was not time to have copies made before I left England.

The ballistic pendulum is shown in detail on the plan furnished herewith. I may mention that the bob of the pendulum consists of a 13" mortar, weighing 5 tons.

I have not yet received plans of the gun which it is proposed to use in England.

It will be necessary to erect an observation chamber at least 15 yards from the gallery. The front wall should be substantial, and fitted with narrow horizontal windows, suitably protected against the possible, but very remote, chance of a disruptive explosion in the gas gallery.

It will also be necessary to provide several sheds, or a shed divided into compartments, to be used as a safety lamp room, oil store, coal store, coal dust disintegration. Two small magazines should also be erected for the storage of explosives awaiting test, and for detonators.

Narrow gauge rails will have to be laid for use in connexion with the gas gallery and pendulum. It would be convenient if the rails were so arranged that the guns in use could be shifted from the gallery to the pendulum, or vice versa, as required.

At the station in England it is proposed to install a gallery for testing safety lamps; but the details have not yet been settled. The general idea is that the explosive atmosphere will be prepared in the explosives testing gallery, and that a branch gallery of small sectional area will lead from the big gallery through the lamp testing chamber back to the gallery.

The estimated cost in England of the above is £3,000, but I would suggest that a second gun be obtained (cost about £600). These guns are manufactured in the Royal Arsenal, Woolwich.

As far as the chemical laboratory is concerned, the only special feature to be attended to is the provision of a separate compartment, or a small detached building with a north light, in which stability tests will be carried out. It is essential that the atmosphere in which these tests are carried out should not be contaminated with acid fumes.

A very small detached shed of a few cubic feet capacity should be erected to store samples of explosive submitted for chemical examination. It is not advisable to store these samples in the testing gallery magazine, as they will doubtless often be of low chemical stability.

I attach a rough sketch of the disposition of the new apparatus in England.

(Signed) A. Desborough, Capt.