

WASC 2317

WAI 0649

ACCIDENT  
INQUIREY

13-12-1893

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ACCIDENT  
INQUIREY

7-5-1894

REPORT  
OF THE  
COMMITTEE  
ON  
EXPLOSIONS  
AT  
WALTHAM  
ABBEY  
DEC. 13. 1893  
AND  
MAY 7. 1894







DIRECTOR GENERAL  
OF FIREWORKS  
21 MAY. 94

ROYAL GUNPOWDER FACTORY  
REGISTER No. ....  
22 MAY. 94  
WALTHAM ABBEY

# FIRST REPORT

OF THE

COMMITTEE APPOINTED TO ENQUIRE INTO  
THE ACCIDENT OF THE 13TH DECEMBER,  
1893, AT THE ROYAL GUNPOWDER FAC-  
TORY, WALTHAM ABBEY,

AND INTO

THE CONSTRUCTION, &c., OF THE DANGER-  
BUILDINGS AT WALTHAM ABBEY

AND

THE ROYAL ARSENAL, WOOLWICH,

TOGETHER WITH

MINUTES OF EVIDENCE AND APPENDICES.

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*Presented to both Houses of Parliament by Command of Her Majesty.*

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FIRST REPORT

COMMITTEE APPOINTED TO ENQUIRE INTO THE ACCIDENT OF THE 13TH DECEMBER 1893 AT THE ROYAL GUNPOWDER FACTORY, WALTHAM ABBEY.

AND INTO

THE CONSTRUCTION, &c., OF THE DANGER-BUILDINGS AT WALTHAM ABBEY

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NAMES OF MEMBERS OF THE COMMITTEE.

---

*Chairman.*

Lord SANDHURST, Parliamentary Under Secretary of State for War.

*Members.*

Sir FREDERICK ABEL, Bart, F.R.S., &c.

Colonel V. D. MAJENDIE, C.B., Her Majesty's Chief Inspector of Explosives.

Major-General F. T. LLOYD, C.B., R.A., Deputy Adjutant-General of Royal Artillery.

Mr. R. H. BRADE, *Secretary.*

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REFERENCE.

Copy of terms of reference to the Committee appointed to conduct the enquiry into the recent explosion at the Royal Gunpowder Factory, Waltham—

74

Gen. No.

3626

- (1.) To enquire into the cause of the accident.
- (2.) To suggest any means which they consider should be adopted to ensure safety.
- (3.) To report on the construction of the danger buildings throughout the Royal Gunpowder Factory, and to recommend any alterations required for greater safety to surrounding buildings in case of fire or explosion.
- (4.) To extend the enquiry as to (3) to the Royal Arsenal, especially with reference to the factories which now surround the danger buildings and to the locomotive traffic around them.

Approved by the Secretary of State on 16th January, 1894.



v

# Enquiry into the Accident of 13th December, 1893, at the Royal Gunpowder Factory, Waltham Abbey.

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## FIRST REPORT.

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Secretary of State,

The terms of the reference to the Committee appointed by you on 16th January, 1894, in consequence of the accident which occurred at the Royal Gunpowder Factory, Waltham Abbey, on the morning of the 13th December last, are as follows:—

1. To enquire into the cause of the accident.
2. To suggest any means which they consider should be adopted to ensure safety.
3. To report on the construction of the danger buildings throughout the Royal Gunpowder Factory, and to recommend any alteration required for greater safety to surrounding buildings in case of fire or explosion.
4. To extend the enquiry as to 3 to the Royal Arsenal, especially with reference to the factories which now surround the danger buildings and to the locomotive traffic around them.

Your Committee observe that the enquiry entrusted to them by this reference is twofold:—(a) The one portion bears upon the circumstances and cause of the recent accident, and the means to be suggested to prevent a recurrence of a similar accident, and (b) the other portion, of a more comprehensive scope, relates to the condition and regulation of all danger buildings belonging to the Ordnance Factories at Waltham and Woolwich. They have accordingly conducted their proceedings with the view to be in a position to report to you separately on these two divisions, and, considering (a) to be the more pressing, they have taken at once all the available evidence necessary, in their opinion, to the elucidation of this branch of the enquiry, and they beg to now lay before you their report thereon.

The Committee, as a first step, visited the Royal Gunpowder Factory and inspected the scene of the accident. They afterwards held meetings at the War Office, and have examined the Superintendent and other members of the staff of the factory, besides a number of men employed in the class of work which was being carried on in the building destroyed, including the only man who succeeded in escaping without injury. They also examined Colonel A. Ford, one of Her Majesty's Inspectors of Explosives.

### I.—CIRCUMSTANCES OF THE ACCIDENT.

The accident took place at 2.35 a.m., on the 13th December, 1893, at No. 2 cam house, situated on the portion of the factory grounds at Waltham Abbey, called the Lower Island. The weather was stormy, a strong wind blowing, and rain falling heavily, but there was no lightning. The scene of the accident was a building which appears to have been erected in 1846 or 1847, and was used as an incorporating mill until 1887, when it was converted into a cam house. It was made entirely of wood, with the exception of a brick wall at the south end, and the roof was boarded over, fastened with iron screws, and covered with tarred felt. At the time of its conversion the building, including the roof, was lined throughout with varnished match boarding, and the floor was covered with hides, all fastenings being effected with copper nails.

11, 845, 1202  
240-1, 503-4

Appendix I.  
507, 515

244, 505,  
508-9



Another alteration made at the time of the conversion was the elevation of the floor of the house to accommodate the cam-machines. This caused a difference of 9 or 10 inches in the levels of the floor and the outside platforms, and, in fact, at each entrance there was a well or recess caused by this difference of level. The building was lighted by electricity, the lights being outside the windows and the wires carried on earthenware insulators. It was provided with a lightning conductor and was heated by hot-water pipes.

A water-wheel, enclosed in a compartment between the two portions of the house in which the machines were placed, supplied the motive power. The sides of this compartment were of wood, and there was no opening in the partitions except to the extent of  $\frac{1}{16}$ th of an inch round the shaft connecting the wheel with the machines. The wheel was worked by the fall of water from a stream (the head stream), which ran on one side of the building into another stream (the tail stream), at a lower level, on the other side.

The two divisions of the house were connected by a covered wooden corridor, from each end of which an open platform reached down to the edge of the head stream. Both corridor and platforms were of the same construction as the house, but the floors were not covered with leather. The boards forming them were laid with openings of about  $\frac{1}{8}$ th of an inch between them, and were constantly kept wet.

The corridor and platforms were lighted by one electric lamp, which was placed in the centre of the corridor opposite the wheel.

Each portion of the house was provided with a door in each corner opening outwards, and fastened by a rope and counterweight.

The door in the south-east corner of the south end opened into a small room where the workmen put on their "clean" shoes. This room was of wood, with the exception of the roof, which was of slate, and of the one side which was formed by the brick wall running the length of the south end of the building.

With the exception of parts of the shoe room, and the dirty mats at the doors on the west side, the whole building was "clean." The shoe room was mainly dirty, but contained "clean" islands, so to speak, in the form of small wooden moveable platforms, or stools, on to which men stepped from the house when going temporarily into the shoe room, thus avoiding the removal of their "clean" shoes. The mat in this room is stated by the master worker to have been "dirty," though the men seem to have regarded it as "clean." The covered boats which conveyed the grain powder to the buildings and removed the finished prisms, also are "clean" with the exception of a small compartment answering the same purpose as the shoe room in the house.

The operation in progress at the building at the time of the accident was the pressing of grain powder (E.X.E.) into prisms by means of cam-machines. Two views of one of these machines, together with a description of their construction, are given in Appendix II. Briefly, the machines are provided with an upper and a lower set of plungers, which move vertically to and from each other, each pair meeting in a receptacle or channel in a fixed table called the bush-block, the receptacle being called the matrix or "bouche" (bush). The grain powder is carried forward and dropped into the bushes by a carrier or charger, which is itself fed from a hopper, and the powder is compressed into prisms by the approach to each other of the two plungers.

The charger moves backwards and forwards horizontally, and, besides serving to carry the charges from the hopper to the bushes, pushes forward the prisms as they emerge from the bushes after having been pressed. The lower plungers contain pins or drills, which pass upward into holes in the upper plungers as the two sets approach each other. The machine works automatically by means of eccentrics or cams.

The four machines in No. 2 cam house pressed in succession, there being in each end of the house a "tell-tale" showing the working of the machines in the other end. The machines were worked so as each to complete four pressings a minute.

The hopper is filled with powder from a barrel which stands behind each machine, a copper bowl being used for the purpose. The powder is brought to the house in open barrels, covered with pieces of sacking, by the covered

Nature of work carried on in No. 2 cam house.

boats already referred to, along the head stream to the platform which leads down to it. The barrel is lifted from the boat on to the platform, trundled on its chine along the platforms to the house, where it is again lifted up the step on to the floor, and then finally trundled to a position behind the machine. At Waltham each machine is looked after by two men, one of whom stands behind the hopper; his duty is to fill it and to work the lever which stops the machine, while the other, who stands in front of the machine, watches the working of the charger and plungers, and puts on to a rack the prisms as they are pushed off. At No. 2 cam house these men were subject to the supervision of a foreman, who, in addition to this duty, gauged the prisms on the racks and determined the density of a proportion of them.

At the time of the accident the machines were all at work, and a boat was alongside from which the two boatmen were supplying the house with powder.

Occupation, &c., of men at the time of the accident.

There were thus in or at the building eleven men, *i.e.*, two workmen to each of the four machines, the foreman, and the two boatmen.

The work hours of the night shift were from 6 p.m. to 6 a.m., but on this occasion the men came on an hour earlier, and would have left off an hour later, in order to make up time to enable them to take a holiday on Boxing Day, which is not a Government holiday. They had worked continuously with the usual interval for a meal at 11 o'clock. They were all dressed, according to the regulations, in a suit of lasting cloth over a suit of private clothing kept in the factory.

The evidence of Skinner, the one man who escaped uninjured, and the statements which some of the other men made before their death to Mr. Findlay, the master worker, show the succession of events immediately connected with the accident. Reference to the plan given in Appendix I. will further illustrate what the Committee here give as their version of the events, and will show the approximate position of each man at the time of the explosion. The position assigned on the plan to the boatman Watts will be explained later.

Skinner was in the north end of the house, in front of No. 5 machine. He heard a report in the other end of the house "like a 7-pr." He also saw a flash through the door opening into the corridor at the south-east end of his compartment, which was more or less facing him. He at once turned to the door behind him, and, before he got out, heard a second explosion. He had only reached the trees a few yards from the house when "the whole thing seemed to go at once; I heard, however, no more than a rumbling noise, because I was so near it." This account is corroborated by the statement of the foreman Bailey, who was close to Skinner at the time, and who speaks of hearing a rumbling noise which excited the attention of the men in the north end of the house, followed by another noise accompanied by a flash, whereupon all the men started to run out of the house; and he adds "I had got clear of the house before it exploded, but appeared to have been blown in the water while running away." Two men (Biss and A. Carr) working at the drum house 100 yards away also heard three reports, the second occurring while they were changing their boots, which they proceeded to do immediately on hearing the first, and they heard the third after they had run nearly the distance between the drum- and cam-houses.

Of the men in the south end of the house, Rudd and Rudkin could only say that they saw a flash and nothing more; they got clear of the house and into the river (*i.e.*, the head stream), out of which they were helped, the former by Hare and the latter by A. Carr and Biss. Clayden saw a flash come, as he says, from his machine as he was turning away from it towards the north to put prisms on the rack beside him; and Larman, who was similarly engaged, says the same, adding that "when the explosion took place Clayden and myself ran out of the house and got into the river," *i.e.*, the tail stream, "where we were found" by A. Carr and Biss. Watts alone of all the men did not get out of the house, and must have been killed almost immediately. Lastly, Hare, the second boatman, who was apparently on or by the boat, says "the first flash was seen" (presumably he means by himself) "coming from the south end. I went to the door of the boat and took off my "clean" slippers, when I was knocked in the river."

According to all the evidence Watts must have been in the south end of the house at the time of the accident. Bailey, going from the south to the

1254-61

343-4, 1783

53

50

706, 718

750, 1008

490

Appendix I.

720-2

723, 891, 897

723-4

725

790

490

Appendix VII.

1610-11

Appendix VII. and 490

490, Appendix VII.

1572

490, Appendix VII

490

417

247-54

541

542-3

557, 620, 1407

267

632-4

1881

1535

1535-7 1748,

268-9

Appendix II.

783-4

343

376, 1619

37, 485-6



north end, met him wheeling a barrel towards the former, just opposite the 490 water-wheel, and had time to walk to the north side of No. 5 machine before the first report was noticed. Allowing a little extra time for the work that 790 Watts was doing, including the lifting of the barrel up the step, he must have about reached the spot indicated on the plan at the time when Bailey reached Appendix I. No. 5 machine and heard the first report, and this was the spot where his body was found by the fireman Jackson. It seems clear that Watts was rendered 1124 unconscious, if not killed on the spot, immediately on, and perhaps by, the first 1180 or second explosion.

Character  
of acci-  
dent.

From the evidence given it appears that the character of the accident was more that of a fierce fire than of an explosion. Watts showed signs of explosive injury, and Bailey speaks of being "blown into the river," while Hare says he was "knocked into the river." Reports were heard at the drum house, 100 yards Appendix VII. away; and it is also said that a report was heard up at the Superintendent's and 32. house. On the other hand, the nature of the injuries of the men, excepting 10 Watts, and the damage to the structure—both of which will be referred to in detail later,—as well as the character of the explosive material, point rather to a fire than to an explosion. At any rate there was no violent explosion, for the 277-81 trees near were not affected, nor were windows broken in a building distant 34 yards. The fireman, who lives 5 minutes' walk away, heard no report until 533 after the fire had been burning 20 minutes; and the water tanks over the mills 1175, 1178, across the stream were not capsized, though they are so balanced as to be 1198 liable to disturbance by the shock of an explosion. 1198

The amount of powder which exploded or burnt was about 1,200 lb. The quantity missing after the accident was found to be 12 barrels, each being calculated to hold 100 lb.; but they were never actually full by a few pounds, and the exact amount is therefore nearer 12 times 90 lb., or 1,080 lb. Of this 284-5 the greater part is stated to have been in the form of prisms, *i.e.*, 8 barrels in this form and 4 full of grain, as the boatmen had cleared the house of prisms, 286 and had already taken two barrels of grain into the north end, *i.e.*, one to each machine, while Watts was taking a third barrel into the south end, and a fourth still remained in the boat. There would probably have been some grain in the 490 hoppers, but beyond this small quantity and the four barrels the rest would have been in the form of prisms.

## II.—RESULTS OF THE ACCIDENT.

### A.—Injury to Men.

As has been stated, there were 11 men in or immediately about the building; five were in the north end, five in the south end, and one at the boat.

Of those in the north end, one, Skinner, escaped uninjured; another, Carr, working opposite him at the same machine got away with his clothes on fire, 727 and although Skinner threw water over him he was badly burnt and has been in hospital since then until about the 7th March. He has, however, recovered. Bailey, as has been already stated, got out of the house but was blown or fell into the water (the tail stream), where he remained for nearly an hour, until he was 490 rescued by the fireman Jackson and a man named Brown. He appears not to 1179, 1224 have been much burned, but mortification set in; he died on the 19th 1225-6 December at 12.45. Jennings got away into the head stream, but his escape 490 was delayed by his having tripped over the shafting in making for the door opposite to him instead of the one behind him. He also thus met the force of the explosion from the boat, but was not so much injured but that, after 1612 having been helped out of the stream by Hare, he could walk up to the shifting room. He died, however, the next day. Massey got away and was assisted by 490, Appen- Skinner, but died the same day. dix VI. 727, Appen- dix VI.

Of the men in the south end, Clayden and Larman ran out of the house by the doors behind them, and got into the tail stream, whence they were pulled out by Biss and A. Carr. They were badly burned, but conscious, and each made a statement about the accident; the former died the next day, and the latter on the 18th December. Rudd and Rudkin escaped by one or other of the two doors behind them, and got into the head stream. The former was Appendix VII.

490 helped out by Hare, and walked with him to the shifting room. He was very severely burned, and died the next day. The latter was rescued by Biss and A. Carr, and died the next day. Watts did not escape; his body was found by Jackson, after a minute search, lying on the face, with the head to the north, about 2 or 3 feet from the machines. The body had fallen, apparently, through the burning floor into a brick trench, and was very much burnt. "Part of the left side of his head was blown off, and his arms and feet and part of his trunk were burned away." Subsequently one of his hands was found in a spot between the north end of the house and the head stream; it was not burned but had been blown off. Lastly, Hare was knocked from the boat into the river, but was able to get out and rescue Jennings and Rudd, and walk up to the shifting room; he died on the 19th December.

Thus of the 11 men only one escaped uninjured, and only one has recovered from his injuries.

### B.—Structural Damage.

1. The building being mainly of wood caught light readily, and was blazing freely within 10 minutes of the first explosion; 20 minutes later there was a slight explosion, but with the exception of the windows of the building there appears to have been no damage due to explosion. The roof remained on and the walls standing. The fire did not, however, burn itself out; it was extinguished by the firemen, but the house has been so damaged that it has had to be pulled down. The tarred felt roof blazed, and its liability to be blown about in the high wind constituted an additional danger, which, however, the fireman successfully met. The only sound part of the structure remaining is the brick wall at the south end, which is not even cracked.

2. The water-wheel continued to revolve until the roof fell in and a beam jammed it.

3. The machines also went on working for some time after the house took fire. A screw, doubtless from outside the inner roof fell into one of the bushes in No. 2 machine, the plunger of which bush was afterward found to be broken; otherwise all the machines were in good working order after the accident, except of course for the dirt which in the progress of the fire, &c., got into them.

4. Lastly, the boat has been rendered useless; the hood was blown off, and there is a leakage at one side.

## III.—PROBABLE CAUSE OF THE ACCIDENT.

In considering accidents of this sort, it is often possible to be guided to the probable cause by some decided indication as to the point of origin.

In the present case, unfortunately, the indications are to some extent contradictory. The Committee are able to say positively that the first explosion occurred in the south compartment, but beyond this they are unable to go with any confidence. The only available direct evidence would seem rather to indicate No. 2 machine as the point of origin, the statement, namely, made by Clayden before his death to the effect that a flash came from his (No. 2) machine; but, on the other hand, it may be urged that a flash proceeding from any part of the house situated in the direction, relatively to Clayden, that his machine occupied, might easily appear to him to have proceeded from, *i.e.*, to have originated at, the machine itself. There is, indeed, some ground for considering the barrel of E.X.E. powder which Watts was rolling in, at the time, as the probable spot where the explosion originated; for, on the one hand, Watts alone, of all the injured men, had undoubtedly sustained injuries due to an explosion (as distinguished from mere burning), and the experiment recently carried out at Woolwich, and described in Appendix XV., has demonstrated that the ignition of a barrel of the E.X.E. powder is attended with very marked explosive effects. On the other hand, there seems no *prima facie* reason why, if the explosion originated at one of the machines, Watts should not have been able to get as far away from the effects



as, at any rate, Rudkin and Rudd did, whose position some of the witnesses and the plan indicated as having been nearer to the machine, and further from the doors, than Watts. As a matter of fact, Watts was killed, and his remains, as already stated, showed evidence of explosive violence; while Rudkin and Rudd were not explosively injured; although severely burnt, they both effected their escape from the building, and did not die until the following day, 14th December. It is conceivable, of course, that Watts may have been stupefied or knocked down by the first explosion, and that he lay in the vicinity of the barrel when it exploded, and received from its explosion further injuries, whereas Rudkin and Rudd were able to get out before the barrel exploded; indeed, the two last-named men may have been sitting, as one witness suggested, on the seats on either side of Watts, being thus actually nearer the doors.

Appendix I.  
473, 1782

Biss's state-  
ment in Ap-  
pendix VII.  
490, 1232,  
1585, Appen-  
dix VI.

1586-91, but  
see also 1777-  
83.

It is also significant that in the experiment at Woolwich, when the E.X.E. powder in the barrel was lighted at the top, it produced no fracture of the platform, or crater, or other damage; while, when the powder was ignited at the bottom, a sensible increase of violence of explosion occurred, which determined the fracture of the platform. This result would seem to indicate that if the accident had originated, say, by friction of the barrel on the floor, there would have been a more violent explosion, and more marked effects than were actually experienced; whereas, if the barrel had been fired by a burning prism projected on to the powder, the results would have been probably more closely in accord with those which were observed.

Appendix XV.

The Committee are thus really without anything to guide them positively as to the initial point of the explosion; they know that it occurred in the south end, but whereabouts in the south end the evidence leaves them in doubt.

Examina-  
tion of  
various pos-  
sible causes.

The Committee are, therefore, driven to approach the examination of the question from another direction, and to adopt the course which has before been usefully followed in enquiries into accidents of this character, and when the origin of the disaster is not immediately apparent, viz., that of setting forth the various possible causes which might operate to bring about such an explosion, and then, by a process of elimination, disposing of those causes which could not be connected, however remotely, with the case immediately under consideration. In Appendix XVI, will be found a list, which the Committee believe may be regarded as fairly inclusive of all possible sources whence accidents in the manufacture of gunpowder could proceed. An attentive examination of this list shows that in the present case a very large proportion of these possible causes may be confidently dismissed. An examination of the evidence which the Committee have received appears to justify the conclusion that the actual causes of the accident may be sought among the following:—

Appendix  
XVI.

1. Defective working of machine.
2. Use or fall of tool or implement.
3. Lucifer match.
4. Presence of grit or other foreign substance.

1. *Defective Working of Machine*

With regard to this as a possible cause, the Committee may say at once that this is generally acknowledged as a risk.

Appendix XI. contains the substance of the replies received from gunpowder makers in the United Kingdom as to the results of their experience with cam-machines, and their testimony can hardly be regarded as, on the whole, favourable to these machines. It will be observed that in some cases they are stoutly condemned, while in another case, where the experience has been favourable, considerable stress is laid on the importance of keeping them at all times in thoroughly good order, a qualification which obviously suggests the existence of risk under particular conditions. The evidence given in the same appendix as to the behaviour of these presses in Germany shows, too, that under particular conditions their use may be attended with active risk.

Appendix XI.

The experience of one important English firm, derived from an experimental trial of these machines was so unfavourable that at considerable pecuniary loss they abandoned their use, and it will be observed that the particular defects signalized, were the "continual jamming and breaking of the plungers and pins," defects which it is abundantly clear from the evidence had occurred over

353, 1096, and  
the evidence of  
the mechanic,  
Mr. Johnson  
(1636-1724).

and over again with the Waltham Abbey presses. That the breaking of plungers constitutes no imaginary risk is clearly shown by what occurred at Messrs. John Hall & Sons cartridge factory at Nottingham, in 1880 and 1881, when two accidents occurred, one (in 1880) fortunately unattended with serious consequences, the other (in 1881) resulting in the loss of three lives. The circumstances of these accidents are fully detailed in a special report by one of Her Majesty's Inspectors of Explosives. It will be sufficient to say that the first, certainly, and the second, beyond reasonable doubt, were caused by the chipping of metal from what the Committee understand to have been bronze plungers.

Special report,  
No. XXXII.,  
dated 9th  
March, 1891.

Indeed, it must be evident to anyone familiar with the subject, that the fracture of a plunger is a contingency which in no circumstances should be regarded with equanimity—as in fact it had got to be regarded at Waltham Abbey. Nor should the circumstance that plungers have frequently broken in the Waltham Abbey presses without causing an explosion, remove the anxiety which such a defect undoubtedly justifies, as that circumstance goes no further than showing that the exact conditions necessary to produce an explosion were not present in those cases. It is noticeable that at the Eastwood Factory above mentioned, "chipping" of the plungers had occurred, not infrequently, before such an occurrence actually gave rise to the explosions of 1880 and 1881. Indeed, it is probably within the experience of all powder makers that things may and do happen without explosion or other serious result, which under other circumstances might be expected most certainly to produce them.

The Committee have no hesitation in expressing their opinion that if the breaking of the plungers and the bending of the pins to which several witnesses have borne testimony, cannot be guarded against, machines known to be liable to such defects should not be worked; and if the evidence of Mr. Johnson, the mechanic, is to be accepted as conclusive, those contingencies cannot be guarded against.

1677-80

When, however, they come to consider the question of whether it is probable that this particular accident was due to such a cause, the Committee are disposed to dismiss the hypothesis, for the very sufficient reason, as it appears to them, that it was positively asserted in evidence that, after the explosion, the machines were (with an exception to be presently mentioned, and making allowance for the dirt and débris arising from the explosion) in a condition in which, with the application of a little water, they might have been at once set to work. The exception was a screw which had got into a bush of No. 2 machine, the plunger of which bush was found to be jammed down and broken; but the Committee were able to satisfy themselves that the entrance of this screw into the machine had undoubtedly succeeded, not preceded, the explosion. The screw was identified as being of the same kind as others which were found on the floor after the fire, having evidently fallen out of some part of the roof of the building exterior to the wood lining; it was, therefore, not possible of access to the interior until the lining had been more or less destroyed or opened by explosion or fire, or otherwise. It is most probable that the presence of this screw in the bush, while the machines continued to work after the explosion, caused the jamming and the breaking of the plunger. It would at any rate have been a most extraordinary coincidence that the only screw (or foreign body) which fell into a bush after the accident should have fallen into the particular bush which had a broken plunger. So far as the Committee have been able to gather, the machines, with their plungers and pins, were in proper working order at the time of the accident.

131, 423, 1222

1667, 1717  
422-4

513-17  
426, 513-17,  
1718-23

783-7, 1717

Probably the evidence as to the generally efficient condition of the machines after the accident may be accepted as fairly conclusive that the explosion was not the result of their having become clogged. Such a defect, if of a serious character, could hardly have failed to be apparent after the event, and must have continued to impair the efficient working of the machines.

Appendix VII.

1331-5, 1525-7

The Committee had some evidence as to the heating of the pins, and it was suggested that this heating might be dangerous. The Committee do not share this view. None of the evidence was conclusive as to the pins or any of the working parts having become heated to a temperature above that at which the naked hand could be borne on them, or something considerably under 212 degrees Fahrenheit, while gunpowder cannot be fired under about 540 degrees Fahrenheit.



2. Use or fall of Tool or Implement.

There was ample evidence before the Committee that at least three steel tools, or so-called spanners, were present in the building, and that the workmen had access to them and were in the habit of using them; and although the Committee have no evidence before them that the accident was caused by the fall of one of those spanners, it is proper to remark that accidents have occurred in this way, and that the presence of these implements in the house constituted a risk which might have given rise to such an accident as that under notice. Appendix VIII. contains a list of several accidents caused by tools and implements, and among them is one which occurred in March, 1872, at Messrs. Bickford, Smith & Co.'s fuze factory at Tuckingmill, Cornwall, which strikingly illustrates the risk to which the fall of a steel tool in a building containing gunpowder may give rise. On that occasion eight girls lost their lives. The accident at Factory 15, in 1878, as described in that Appendix, is also instructive.

362, 803-4, 1297, 1514, 1659-60, 1845-7 Appendix III.

But the evidence also points unmistakeably to the existence of a practice which experience shows is attended with risk—the practice (namely) of effecting alterations or adjustments in, or quasi-repairs to, the machines while powder was present in the house; and even it must, we fear, be believed while powder was present in the machine itself, and certainly without the machine having been previously washed out. In the judgment of the Committee, such a practice—indeed any adjustment or repair or alteration of a machine by anyone, except a competent mechanic, and then only when all powder has been removed and the house and machine have been washed out, is open to the gravest objection. Evidence has been laid before the Committee by the Department of Her Majesty's Inspectors of Explosives that numerous accidents have been due to this cause, of which an instructive list is given in Appendices VIII. and X. Among them the accidents at Factory 29, in 1883; Factory 19, in 1886; Factory 23, in 1887; Factory 2, in 1890; Factory 20, in 1891; and Factory 15, in 1893, merit particular attention. And the language of the Explosives Act, 1875, is extremely emphatic on this point. Section 10 (5) lays down: "Before repairs are done to or in any room or other part of a danger building, that room or part shall, so far as practicable, be cleaned by the removal of all gunpowder, and wholly or partly mixed ingredients thereof, and the thorough washing out of such room or part; and such room or part of the building, after being so cleaned, shall not be deemed to be a danger building within the meaning of these rules until gunpowder or the wholly or partly mixed ingredients thereof are again taken into it." It will be seen from Colonel Ford's evidence that Her Majesty's Inspectors of Explosives attach very great importance to the strict observance of this regulation, and in the opinion of the Committee it is one of such paramount importance that the widest possible meaning should be assigned to the word "repairs," so as to include any adjustment or alteration of a machine necessary to its more efficient working.

Appendix VIII.

373-5, 1000, 1085-8, 1095, 1098-1100, 1693-1700 770-82, 1306-7

Appendices VIII. and X.

1972-5

3. Lucifer Match.

In cases of this sort the possible presence of a lucifer match must always be a matter inviting suspicion and investigation, and such suspicion can only be disarmed by evidence tending to show that the precautions adopted at the factory are of such a character as to render the presence of a match almost a physical impossibility. It might, at first sight, be supposed that the well-known and certain danger to which the presence of matches in a gunpowder factory gives rise, would be a sufficient guarantee that men who valued their lives would most readily co-operate to ensure their rigorous exclusion. Unfortunately, experience is all the other way. Her Majesty's Inspectors of Explosives (as we learn from Her Majesty's Chief Inspector, himself a member of this Committee) have on several occasions found workmen with matches in their possession in danger buildings. Probably every gunpowder maker in the kingdom could furnish testimony to a similar effect; and one such case occurred at the Roslyn Gunpowder Factory so recently as the 24th October, 1891, when a match was discovered in the drying-house,\* and at a time when, owing to the

\* See Annual Report of Her Majesty's Inspectors of Explosives, 1891, page 30.

fact that only the year previously no less than eight lives were lost by two explosions in this factory, it might reasonably have been supposed that the workpeople would have been specially alive to the value of precautions adopted for their safety. Three cases of the discovery of matches, suspected to have been maliciously introduced, at Messrs. Curtis's & Harvey's Hounslow factories, in the autumn of 1886, are referred to in the Special Report on the serious accident which occurred at that factory in the following spring.\* Also matches (as the Committee learn from the evidence) have been found in the past in the danger buildings at Waltham Abbey. Experience in mines is probably even more striking. Over and over again have accidents (often of a most dangerous character) been traced to men smoking, or striking a match, or opening their safety lamps.

1787-8

In short, if one thing is more clearly established by experience than another it is, that precautions, even of the most obviously necessary character, cannot be depended on to be adopted or observed by the workpeople themselves, but must be enforced by some special device or regulation.

The Explosives Act, 1875, directs that in regard to the exclusion of matches this is to be effected by the "use of suitable working clothes without pockets . . . searching, and otherwise, or by some of such means," (Section 10 (8)); and no pains are spared by Her Majesty's Inspectors of Explosives to secure the full observance of this regulation in private factories. The General Rule above referred to, which is required to be posted in every danger building, itself operates in this direction, while the particular method (whether by "working clothes without pockets, searching, or otherwise") to be observed is distinctly defined, either by the licence or by the Special Rules. Moreover, in the best regulated factories a responsible person is required to sign a daily report or book to the effect that the workpersons' clothing has been properly searched (female searchers being appointed where women are employed), while Her Majesty's Inspectors of Explosives themselves at their visits (which are always unexpected) personally search a very large majority of the workpeople and see that their clothing is free from pockets; but even these cumulative precautions have not always sufficed to secure the exclusion of matches.

1959-60

The evidence before the Committee goes to show that the precautions adopted at Waltham in regard to this important point fell very far short of those which have been found necessary, and by no means excessive, at private factories. Indeed, the evidence has clearly established that great laxity has prevailed in this direction.

Apparently it has been hitherto deemed sufficient to rely upon the following precautions to exclude matches or other dangerous articles:—

1. A search by the police at the gate.
2. A change of clothing in the dressing room.
3. An inspection, by the foreman of each house, of the men under his charge.

The Committee are not prepared to say that if these precautions were invariably enforced to their full extent they would not reasonably suffice; but the evidence shows that they were very far from being applied in a strict or efficient manner; and it further appears that those who are responsible for the discipline and safety of the factory were under an entire misapprehension in regard to the manner in which one at least of these precautions was carried out.

930

Appendix IV.

Taking first the search at the gate; it appears from the evidence of the Inspector of Police that, speaking roughly, only about one-tenth of the workpeople on entering are searched daily, and on eight occasions in a period of only seven months (from 25th June, 1893, to 25th January, 1894) men were found with matches. It is not an unreasonable inference that among the remaining nine-tenths unsearched were several, it might perhaps be suggested a similar proportion to those discovered, who passed with matches undiscovered.

Search by the police at the gates.

\* See Special Report, No. LXXVIII., 31st May, 1887, pages 14 and 15.



It certainly would, in the judgment of the Committee, be a highly unreasonable assumption to believe that the eight men out of the one-tenth searched were the only men in the whole number employed who had matches, and, indeed, it is in evidence that in some cases matches have recently been found in the factory. It is proper to ask what became of those matches which there can be no doubt must have passed in. On this point the Committee will have to remark further on.

It is also somewhat significant that of the eight cases of discovered matches no less than five occurred since the accident now under notice. The Chief Inspector of Police explains this by the fact that these were new hands, not so well acquainted with the regulations, or so habituated to leaving matches behind, as other and older employes. But on the other hand it might reasonably have been expected that the disaster of the 13th December would have brought home to the minds of all, whether old or new hands, the importance of precautions of this character, and the Committee feel constrained to remark that, in their judgment, the circumstance of these discoveries since the accident does reasonably suggest that the stringency of the inspection may have been less before than it has been since the accident.

Indeed, the reply of the Inspector of Police to two of the questions appears to distinctly point to considerable inefficiency in the system of searching. He said, "The police do not actually put their hands into the men's pockets." "Do you make them turn out their pockets?—No, a man is liable to be searched by his foreman after entering the factory." Accordingly, the so-called searching in many cases obviously amounts to little more than passing the hand down the outside of the clothing, which would be unlikely to ensure the discovery of a single match, or to an enquiry of the man whether he has matches about him, and seeing that the penalty is dismissal, it is not difficult to anticipate the answer in such cases. Indeed, it must be a matter of surprise that, under such a system, any matches, except perhaps when a man had a box full, have ever been discovered at all. But further, it appears that the contractors' men, on the barges and elsewhere, who enter the factory, are never searched at all; although these men are by no means confined to their barges or vehicles while in the works. It seems therefore abundantly clear that so far as the search at the gates goes it can be of little avail to secure the exclusion of matches.

But the danger-building men pass into a shifting room, where they have to change their over- and under-clothing, and put on clothes without pockets, or with the pockets sewn up, and without metal buttons or buckles, and, in the case of the oversuit, unflammable.\* A man is present, day and night, in this room, to see that these instructions are carried out. But it is obvious that it is impossible for one man to see that every one of a large number of men, amounting, it was stated to the Committee, sometimes to 200, conforms in all particulars to the regulations, especially in regard to such a detail as the absence, or effective sewing up, of pockets. And as the shifting-room man is under no obligation to make a report, or to sign a book or otherwise certify to the discharge of his duty, it is not difficult to understand that his examination of the men's clothing would readily become of a more or less perfunctory and easy character, in view especially of the physical impossibility of its effective discharge.

And this brings the Committee to enquire how it comes that if these shifting-house men properly discharge their duty, no matches have ever in a single instance been found by them. If, as has been shown, out of a proportion of one-tenth of the number of men, eight cases of the discovery of matches have occurred within a few months, while we know that in other instances matches have certainly found their way into the factory, what, it must be asked, became of the other matches, which no reasonable person can doubt must at one time or another have been brought by the unsearched nine-tenths into the factory? No evidence was tendered to the Committee to show that on any single occasion matches had been found by the searchers in the shifting room, and this circumstance appears to the Committee conclusive as to the

\* The oversuit is provided by the Government, the under-clothing by the men themselves.

futility of the search, at that point, to ensure the non-introduction of matches; while it suggests also the comparative futility of this part of the system for ensuring the non-use of pockets, &c.

But a third line of defence existed, or was supposed to exist, against the introduction of matches, and that was the search of the men by the foremen at their respective houses. Apparently this was largely relied on by the staff at the factory, and the evidence given by those who are responsible for management and discipline, was to the effect that in their belief this duty was daily and rigorously discharged. In the course of the enquiry this view was completely upset, for one of the foremen employed (alternately with the foreman who was killed) in the cam house made the following reply to a question, "We did not trouble much about it" (i.e., the searching) "on night duty; we generally did the searching in the day time, every Monday morning, and as we took turn and turn about for day or night duty, that made the searching only once a fortnight."

This entirely disposes of the efficiency of this part of the supposed protective system, and if that were not so it certainly is completely disposed of by the admission of another foreman, that it would be quite open to a workman to go back to the shifting room, say during the meal hour, and, if he felt cold, to put on a waistcoat or some other article of underclothing.

Whether the boatmen were searched at all, or if so, by what official, was not made clear to the Committee. It further appears that no proper report was required of the foreman, scarcely a verbal report, certainly not a written one, that he had discharged the duty of searching the men. The master millman's duty was to go round at night (a duty only occasionally as it appears, discharged very late in the night), and he put his head in at the different doors and asked if all was correct, and if the foreman replied "Yes," he was satisfied. Much the same sort of thing occurred during the day shifts, the visits being then made by some representative of the master worker.

But one of three things is clear. Either the foreman who stated to the Committee that inspections were made only about once a fortnight, entirely misunderstood his duty as regards the searching, or he had, let us say, a different conception of it from that entertained by the managing staff of the factory, or he reported falsely on every occasion except the one day a fortnight when he had made his search. Indeed, if this foreman's evidence be correct ("we did not trouble much about it" (the searching) "on night duty"), it would appear that on no occasion of night duty could his report have been put forward as inclusive of searching, though according to the managing staff it was understood so to be. It should be added that the Superintendent was unable to refer the Committee to any written rule or regulation requiring daily searching. Obviously, therefore, and without pursuing this branch of the subject to greater length, it is clear that the whole system of search designed to secure the exclusion, was very weak and ineffective; and although the Committee are not in a position to say that the accident of the 13th December was due to the presence of a match, they feel it their duty to express their decided opinion that under such a condition of things as has prevailed at Waltham Abbey, it was quite possible for an accident to have resulted from such a cause. Indeed, it will be seen from the Superintendent's evidence that he is himself inclined to refer the accident under discussion to that, as the most probable cause.

4. Presence of Grit or other Foreign Substance.

The Committee are by no means satisfied that the precautions adopted at Waltham Abbey for the exclusion of grit or other foreign substance from the danger buildings have been adequate to that end; indeed, such conditions as the existence of long-uncovered gangways, on to which grit would be liable to be blown or deposited; the presence of dirty mats at the doorways; the arrangement of moveable boards or planks to enable the workmen to enter and use the "shoe hole" attached to the house without removing their "clean" shoes; the presence of what is called a "clean" mat in the shoe hole, or, as the Committee understand, a mat on to which "clean" shoes may be placed, though the shoe hole itself, in which the mat lies, is "dirty"; the use of the shoe hole on occasion for the taking of meals; the possible re-introduction of dirty,

Search by the foreman of the danger-building.

69, 88-9, 383, 407-8, 478, 1857-9

1502

1140-8

1750-07

1000

902-4

1004-70

1857-9

1704-6, 1857-9

1800

Appendix VI.

1009-4

1054-0

1885

1812-6,

1730-1

1003, 1010

1857

1857

1859, 1876-7

Search in the shifting-house



perhaps gritty, sponge cloths into the danger buildings; all constitute gaps in a scheme of precautions for preventing grit and foreign substances from finding their way into the buildings, irrespective of any such deliberate violation of the regulations, as, in view of the laxity which has been shown to exist in regard to the searching of the men, to the exclusion of pockets, &c. (especially at night), may not unreasonably be supposed to be not only possible, but even probable.

There are always in gunpowder factories additional risks of the accidental introduction of dangerous foreign substances, which no system of precautions, however complete or however rigorously enforced, can absolutely provide against.

Thus the master worker mentioned to the Committee that there had been found in a "green charge" in the mixing house, since the accident, a "pebble about half the size of a pea"; on other occasions foreign substances have been found in the prisms themselves. As showing the liability of dangerous foreign substances to find their way, notwithstanding all precautions, into danger buildings, and even into the gunpowder itself, reference may be fitly made to a list of objects, which was handed in to the House of Commons Committee on Explosives of 1874 as having been "found at various times in the gunpowder works at Waltham Abbey or in barrels of gunpowder at the Government establishments at Purfleet and Woolwich, and at present deposited at Waltham Abbey."\* The Committee think it worth while to reproduce this list, for the purposes of the present report, as an appendix.

Probably any gunpowder maker of experience could furnish testimony in support of the view that the absolute and effective exclusion of grit and dangerous foreign substances is by no means easy; and if in any particular cases—as in that under present notice—the precautions directed to that end prove on examination to be more or less defective, while the occasional violation of regulations cannot, in face of the evidence collected, but be reasonably assumed, it becomes obviously impossible to eliminate the possible presence of grit or other foreign bodies from those causes which may have been operative in bringing about the accident of the 13th December.

The Committee regret that they have not found it possible, on the evidence, to arrive at a more definite conclusion as to the precise cause of the accident. The most careful attention which they have been able to bestow on the subject does not enable them to do more than say that in their judgment it is unlikely to have resulted from the defective working of the machines, seeing that they were found in good working order after the accident, but that it most probably arose from one of the three following causes:—

1. The use or fall of a tool or implement.
2. Lucifer matches.
3. Presence of grit or other foreign substance.

#### IV.—SUGGESTIONS FOR THE PREVENTION OF ACCIDENTS.

It remains for the Committee, in connection with this branch of the inquiry, to consider what steps should be adopted to prevent similar accidents in the future.

It would, in the judgment of the Committee, be inexpedient were they to attempt to prescribe precautionary measures in detail. To do so would not only tend to weaken the proper and necessary responsibility of the Superintendent, but would also have the effect of applying hard-and-fast rules where elasticity and an intelligent adaptation to varying conditions are absolutely essential to efficiency, if not to safety.

But the Committee can have no hesitation in stating that the result of this inquiry, though it has not enabled them to place their finger confidently

\* Report of House of Commons Committee, 1874, Appendix 19, pages 366-7.

on the actual cause of the accident on the 13th December, has served the useful purpose of bringing to light very grave defects in the system of discipline and precautions prevailing at Waltham Abbey, and the urgent necessity for a comprehensive revision of the regulations and for the adoption of disciplinary measures for their more rigorous enforcement.

How far the defects of the existing arrangements may be connected with the frequent (too frequent, as the Committee think)\* changes of Superintendents in the past, is a question which the Committee have not felt themselves authorized or competent to pursue. They, however, very decidedly believe that it is impossible for an Officer, however talented and in other ways experienced, to take charge of a place like Waltham Abbey at short notice, and to familiarize himself with all the minutiae of precautionary detail upon the strict fulfilment of which the lives of the workpeople depend at any moment. Again, in the case of a Superintendent newly appointed, it is scarcely to be expected that he will forthwith proceed (even although impelled thereto by his better judgment) to overhaul and revise regulations made or accepted by his more experienced predecessor, and to which the permanent managers of the department raise no objection. He naturally hesitates to disturb existing arrangements, even where he thinks they might be revised with advantage, except upon some strong cause shown, or after he has himself acquired the experience necessary to enable him to act with confidence.

In other manufacturing departments a similar liability to fatal consequences does not necessarily ensue from any want of familiarity with detail on the part of a newly-appointed Superintendent. At Waltham Abbey, or wherever explosives are manufactured or handled, not merely may the productive efficiency of the factories be impaired by such want of familiarity, but the lives of the workpeople may be imperilled.

The Committee understand that it has been recently arranged that appointments in the Ordnance Factories shall be held during the pleasure of the Secretary of State, subject to review every five years. The Committee are therefore, strongly of opinion that the office of Superintendent at Waltham Abbey, or wherever explosives are manufactured, should not be subject to frequent avoidable change. They consider it important, moreover, that, when a Superintendent of such a department is to be appointed, special regard should be had to his particular fitness and his technical qualifications for the post he is selected to fill, and that this condition should be regarded as the primary governing consideration in determining his continued occupancy of the post.

The Committee are also of opinion that it is desirable that Waltham Abbey and other factories where explosives are manufactured, manipulated, or stored, should be subject to some system of independent and skilled inspection. When the Explosives Act, 1875, was passed, Section 97, which exempts Government factories from its operation, was, it is understood, adopted in a very large degree, because it was considered that the Government department principally concerned, viz., the War Office, could be depended on to secure throughout its factories, without having recourse to the machinery provided for private factories, the same beneficial results which the application of the Act, and the introduction of an independent system of inspection were designed to effect in the civil establishments.

With this view the Committee are disposed to concur.

But if it should be found impracticable to secure, through the independent action of the War Department, results corresponding to those which the action of Her Majesty's Inspectors of Explosives has accomplished in the private factories, then, in the judgment of the Committee, it would certainly be in the highest degree expedient that the question of subjecting the Government establishments where explosives are manufactured, manipulated or stored, to the inspection of Her Majesty's Inspectors of Explosives, should be taken into serious consideration.

Turning now in the direction of less general recommendations, the Committee think they will be most usefully discharging the duty with which they have been entrusted by you if they indicate the more prominent defects which this enquiry has brought to light.

\* The Committee understand that there have, within the past 20 years, been four different Superintendents.



They desire, however, emphatically to guard against the impression that the defects hereinafter mentioned constitute an even approximately exhaustive list. The enquiry has been mainly concentrated upon the particular building and class of work connected with the particular accident under enquiry, and with the sufficiency or otherwise of the regulations in relation to the same. It is quite conceivable, or even probable, that further and fuller enquiries into the working of the factory as a whole would disclose other defects. And this consideration alone would operate to indispose the Committee to put forward anything which could lay any sort of claim to be regarded as a detailed scheme of reform.

The defects which came most prominently under the notice of the Committee are the following:—

1. The excessively large number of persons allowed to be present within a single danger risk.

Excessive number of persons in cam house.

It has been shown that at the time of the accident no less than 11 persons were present in the cam house, and that to this circumstance the resulting deplorable loss of life is directly attributable. It is true that the operation was considered a safe one. But that it was not wholly free from risk had been already established by other accidents in the compressing of gunpowder into pellets or prisms, which had occurred in the private factories of the United Kingdom, and of which the Waltham Abbey authorities can hardly have been ignorant, seeing that they are all recorded, and more or less commented on, in the reports of Her Majesty's Inspectors of Explosives.

Appendix X. contains a list of seven such accidents in nine years, causing the loss of eight lives and injuring two other persons, and the Committee are of the opinion that whether the risk, *i.e.*, the probability of an accident, be great or small, the practice of allowing a large number of persons to be within that risk is objectionable. In private factories the numbers of workpersons in pellet, or prism, houses are narrowly limited as is shown by Appendix IX.

Appendix X. See also Appendix XI.

2. Defective system of searching to ensure exclusion of matches, pockets, &c.—This point has been dealt with at considerable length in connection with the examination of the probability of the accident having been caused by a lucifer match, and the Committee have little to add to what they have already stated on the subject.

Defective system of searching.

They will confine themselves to repeating that in their opinion the existing arrangements require to be immediately, completely, and rigorously overhauled, and that searching should in the future be so carried out, whether by night or day, as practically to render the presence, in a danger building, of pockets in any part of the clothing, or of a lucifer match, or steel, or iron, or other dangerous article, an impossibility.

3. Absence of any system of effective visitation or inspection of the danger buildings.—Whatever may be the case in the day time, it appears clear to the Committee that at night the danger buildings are left very much to themselves. The Committee do not desire to be understood as expressing their opinion that the master millman neglected his duty of visiting the houses at night, but it is quite clear that his visits were in a large degree matters of form, and that when his visit had taken place, which it generally did early in the night, all observation or control from the outside was at an end. They consider that all night visits should be checked by tell-tale clocks or some other mechanical device, and should be made the subject of daily written reports; and, in their judgment, whatever visits may be paid by the master millman or other officials, it would be judicious to supplement them by occasional and uncertain visits by inspectors wholly independent of the masterworker and his staff.

Inadequacy of existing system of supervision of danger buildings.

4. The system under which repairs and adjustments of machinery are effected (in some cases by the workpeople) without clearing the house of powder, and even sometimes without clearing the machine to be operated on, has already been strongly commented upon, and evidently calls for vigorous reform, which should even go to the length of forbidding the presence of any tools or

Grave defects in system of repairs of machinery and use of tools.

implements (not essential to their ordinary work) being placed where the work-people can have access to them. Moreover, a system of daily reports from the chief mechanic as to the condition of the machines and the frequency with which they are overhauled, would seem to be called for in the interest of more thorough efficiency.

5. The arrangements with regard to the removal of the oily sponge cloths were shown to the Committee to be defective, and the practice in this respect differs, as it appears, from what the managing staff of the factory understood to be the rule. In the judgment of the Committee no arrangement can be regarded as satisfactory which does not ensure (as the Explosives Act, 1875, enjoins in the case of private factories) the removal of all oily rags or cloths immediately after use. Section 10 (4) says:—"Charcoal, whether ground or otherwise, and oiled cotton, oiled rags, and oiled waste, and any articles whatever liable to spontaneous ignition, shall not be taken into any danger-building, except for the purpose of immediate supply and work, or immediate use in such building, and upon the cessation of such work or use shall be forthwith removed."

Disposal of oily rags and cloths.

Compare 674-6 and 1801-6 with 662-6 and 1882.

8080

6. The arrangements for the exclusion of grit have been signalled as defective in many particulars, and the Committee feel strongly that very comprehensive reforms are needed in this direction.

Arrangements for exclusion of grit.

7. The practice of occasionally taking meals in the "shoe hole" is obviously open to such grave practical objection that the Committee are quite at a loss to understand how it could have been permitted to obtain, and it is scarcely necessary to say that it should be absolutely prohibited.

Taking meals in "shoe hole."

8. The rules and regulations have been shown to be, in many respects, very imperfectly adapted to the ends for which they have been framed, and to be open, as Colonel Ford's and other evidence have shown, to considerable criticism in regard to their language, arrangement, and to omissions; moreover, the Committee have been unable to obtain any satisfactory evidence that these rules (such as they are) are properly brought under the notice of, and impressed upon, individual workmen.

Unsatisfactory character of existing rules.

667-0, 648 1785-0 1885-0

9. Further, a system must be regarded as defective when a breach of the rules carries with it no definite penalty, short of dismissal, while in the case of contractors' men and others not in the Government employment, not even this penalty appears to attach to their non-observance.

Absence of proper system of penalties.

10. The limits of quantity of explosive assigned to any danger building do not appear to include the quantity in process of removal to and from the house, and on this point the Committee would direct attention to the provisions of that part of Section 24 of the Explosives Act, 1875, which practically effects the inclusion within the allowed quantity of all gunpowder "within the radius of 20 yards from the building, and in course either of removal from the building or of removal to the building for the supply and work thereof."

Limits of quantity of explosive to be more carefully defined.

Further, the Committee think that the limits of quantity allowed in (as well as all rules affecting) any particular building should be kept conspicuously posted up therein (Explosives Act, 1875, Section 10 (6)).

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11. Some evidence was laid before the Committee as to the existence, in the factory, of a building (a granulating house), the roof of which is unlined, and which the Superintendent has in consequence refused to use. In the opinion of the Committee the Superintendent was quite right; no danger building should exist which is not "so constructed or so lined or covered as to prevent . . . the detaching of any grit, iron, steel, or similar substance in such manner as to come into contact with the gunpowder or ingredients thereof in such building" (Explosives Act, 1875, Section 10 (2)).

Lining of danger buildings.



As to handing over danger buildings for repair.

12. The Committee are not satisfied that the arrangements under which houses are handed over to the Works Department for repair or alteration, and are again restored to their use as danger buildings are satisfactory. At any rate no specific regulations dealing with this point have been brought to their notice.

The matter may be one of grave import, on the one hand, as regards the risk to the employés of the Works Department which might result from an incomplete removal of all powder and powder dust, or from the insufficient washing out of the house before the repairs were undertaken, or, on the other hand, as regards the risk which would arise if the house were again taken into use as a danger building before all articles of exposed iron or steel or other dangerous substances had been carefully removed. Here again the provisions of the Explosives Act, 1875, Section 10 (5), may be usefully referred to.

Some well considered regulations on this point should be prepared, which should be strictly enforced.

SANDHURST,

F. A. ABEL,

V. D. MAJENDIE, *Colonel,*  
*Her Majesty's Chief Inspector*  
*of Explosives.*

F. T. LLOYD, *Major-General, D.A.G.*

R. H. BRADE,  
*Secretary.*

25th April, 1894.

LIST OF WITNESSES.

Day of Examination.	Name, &c.	Pages of Evidence.
26th January, 1894 ..	Dr. W. Anderson, F.R.S., Director-General of Ordnance Factories ..	1
26th " " ..	Colonel W. McClintock, R.A., Superintendent, Royal Gunpowder Factory ..	1
26th " " ..	Mr. Findlay, Master Worker .. ..	6
27th " " ..	Colonel M. T. Sale, C.M.G., R.E., Superintendent, Building Works Department .. ..	12
27th " " ..	Captain H. Huleatt, R.E., Second Assistant, Building Works Department ..	12
27th " " ..	Captain F. L. Nathan, Officer in charge of Danger Buildings .. ..	13
27th " " ..	Mr. H. Skinner, workman .. ..	17
30th " " ..	Mr. H. Craggs, Chief Inspector of Police	20
30th " " ..	Mr. A. Beales, master millman .. ..	22
30th " " ..	Mr. W. J. Chittenden, foreman .. ..	24
30th " " ..	Mr. Edward Jackson, chief fireman ..	26
30th " " ..	Mr. A. W. Brace, boatman .. ..	27
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# Enquiry into the Accident of 13th December, 1893, at Royal Gunpowder Factory, Waltham Abbey.

WAR OFFICE,  
FRIDAY, 26TH JANUARY, 1894.

*Present.*

Lord SANDHURST, *Chairman*

*Members.*

Sir F. A. ABEL, Bart., F.R.S.  
Colonel V. D. MAJENDIE, C.B., Her Majesty's  
Chief Inspector of Explosives.  
Colonel F. T. LLOYD, C.B., R.A.

Mr. R. H. BRADE, *Secretary.*

Dr. WM. ANDERSON, *examined.*

1. *The Chairman.* You are the Director-General of the Ordnance Factories, I believe?—Yes.
2. Are you at all intimate with the circumstances of the late explosion at Waltham Abbey?—No, not from personal knowledge.
3. Who would be the proper officials to give us evidence with regard to that?—Colonel McClintock, and the master worker, Mr. Findlay, and also, I think, Captain Nathan, the Officer in charge of the danger buildings.
4. Do you think Captain Nathan would be in a position to advise us as to what means should be adopted to prevent such accidents in future?—Yes.
5. Have you any suggestion to offer with reference to the general subject of this enquiry?—Many of the danger buildings at Waltham have been in existence for a very long time, and I am not prepared to say that they are quite in accord with modern ideas as to the construction of such places. For instance, the particular building in which the accident occurred was not, I think, sufficiently sub-divided to provide against occurrences of that kind. There ought to have been only one machine in each room, and the rooms ought to have been divided by brick traverses, whereas the four machines were practically in one room, and I think the great loss of life was due entirely to that arrangement.
6. *Sir F. Abel.* Although the buildings are old the machines have been put there only lately, have they not?—In 1887.
7. Do you know what those buildings were formerly used for?—No, I have no knowledge of that. I have always been told that the operation which was being carried out at the time of the accident was a perfectly safe operation, and from what I can make of the evidence in the case I think the machines had nothing to do with the accident.

*(The Witness withdrew.)*

Colonel W. McCLINTOCK, *examined.*

8. *The Chairman.* You are the Superintendent of the Royal Gunpowder Factory at Waltham Abbey, I believe?—Yes.
9. Is your responsibility limited to the powder factory?—I have charge of the nitro-glycerine and the cordite factory, as well as the powder factory.
10. With reference to the late explosion at Waltham, when did you first get notice of it?—The explosion actually occurred at about 35 minutes past 2, in the morning of the 13th December. At about 20 minutes to 3 my wife awoke me saying she had heard an explosion, and she said she had also heard a continuous knocking at the door of my assistant's house at the opposite side of the street. I imagined at once that something was wrong, and on looking out of the window I saw that the buildings were burning. When I got to the place the engine was already there trying to put the fire out. I was told that a lot of men were hurt, and shortly afterwards Captain Nathan and Mr. Findlay came down to the place.



11. *Sir F. Abel.* What sort of night was it?—Blowing a hurricane and raining hard, and when I got there the wind was blowing pieces of the burning roof away towards the river. After I had been down there about half-an-hour a man in the tail stream was heard calling for help, and it turned out to be Bailey; he must have been in the water a long time before we heard him. Bailey was the foreman in charge of both ends of the house, and his duty was to go from one part to the other to see that all was going on all right.

12. *The Chairman.* How many men were working in this particular building when the explosion took place?—The house was divided into two parts, a north end and a south end, the division being caused by a water wheel in the centre. On each side of the water wheel is a wooden wall. The house itself is of wood except the south gable end which is of brick. The explosion took place in the south end, but we do not know what caused it; from there the fire spread to the north end.

13. What was it that injured the men, the explosion or the burning?—One of the men, Watts, found in the south end may have been killed by the explosion, but he was burned so much that this cannot be known. Some of the other men were also badly burned, but the men in the north end were not so badly burned. One of the men saved himself by running at once, but those who hesitated lost their chance.

14. Have you any depositions of the men who have since died?—I think some of them made some statements to Mr. Findlay. One of the men, named Skinner, who got away before the others, was not hurt at all.

15. *Sir F. Abel.* Where was he?—In the north end.

16. *The Chairman.* Was there more than one explosion?—Skinner says he heard two explosions. There must have been some interval of time between them, and that would be the time it took for the powder in one hopper to communicate with the powder in the next machine.

17. Would not the fire of one explosion be communicated to the other powder almost instantaneously?—Are the hoppers kept closed at the top?—They were open then, but now we have them covered.

18. *Colonel Majendie.* What we want to find out is (1) exactly when and how the accident occurred; (2) the quantity of gunpowder, whether in the form of grains or prisms, which exploded or burnt; (3) the effects of such explosion as regards (a) personal injury, (b) structural damage, and (c) injury to machinery and other damage (photographs illustrating these points would be useful); (4) the various possible causes of the accident. Could you hand in a statement dealing with those various points in detail?—Yes, certainly. (See Appendix VI.) I have here the statements of the other men who worked the machines, and I think, probably, they will be useful to the Committee. (See Appendix VII.)

19. Later on they may be. How many men were killed?—There were 11 men about the house at the time, nine of them were killed, but the other two are at present alive.

20. Are those two unable to throw any light upon the cause of the explosion?—Yes.

21. With regard to the structural damage, have you had any photographs taken?—After the fire was put out some were taken.

22. Is there any photograph of the house as it was before the accident?—No.

23. Are there any drawings of it?—It is a very old place, it used to be a mill.

24. How was the house constructed?—It was of wood, and the roof covered with tarred felt.

25. Was the flooring of wood?—Yes, and covered with leather.

26. What was the thickness of the intervening partitions?—Boards of about half an inch thick, I think; I have not examined them very carefully, but I could get the information from the Engineer's Department.

27. *Sir F. Abel.* Were these machines in the house

when you took up your appointment as Superintendent?—Yes, they were started in 1887; I can give you the date on which each machine was set to work.

28. Before that time, was the house out of use, or was it used as a mill?—Whether it was used as a mill up to the date of the machines being put in I cannot say; I did not take up the work until October, 1892. When I got down to the place on the morning of the accident, the whole place was a mass of flame, but there was not a single board blown from the roof, or from the walls, the building was quite intact except the windows.

29. How long did the fire last?—Up to about 4 o'clock in the morning, I think.

30. *Colonel Majendie.* You have referred to two explosions; did you personally hear any?—No, I did not. Skinner says he heard two small explosions in the south end of the building before the explosion occurred in the north end.

31. Does he say that the accident originated in the south end?—Yes, there is no doubt about that. I think Carr has also said the same, but he has not been questioned much, as he is ill still.

32. *Sir F. Abel.* Does the building form two distinct rooms?—There are two distinct rooms, with a covered connecting passage. [The witness then explained the plan to the Committee, pointing out the two streams, the position of the boat, and the landing platform. See Appendix L.] The men in the drum house, about 100 yards from the south end, had time to change their shoes and run some distance before the north end explosion took place.

33. *Colonel Majendie.* Were the partitions blown down?—Not that I am aware of.

34. In what direction was the wind?—It was blowing from the east.

35. Was the rain being blown upon the platform?—That platform was completely covered in.

36. Might there have been any powder upon that platform from spillage?—That is very unlikely.

37. Loose powder was carted about there?—Yes, but in barrels covered at the top.

38. Are closed barrels used?—No.

39. *The Chairman.* Are the barrels filled so full as to be capable of spilling as they go along?—No, they contain about 90 lbs. of powder, and that comes up to within about 3 inches of the top.

40. *Colonel Majendie.* They are 100-lb barrels, containing only 90 lb.?—Yes, that is so.

41. Was the boat destroyed?—No, but one-half of the top was blown to bits, and the other half shifted forward.

42. Can we get any evidence as to how much was in the boat at the time?—No, I think not, because the boat men are dead.

43. *Colonel Lloyd.* When you went down to the building on the morning of the accident, did you notice whether the windows were blown in, or blown out?—I did not notice that, nor did I see any glass about the place at all. The window in the south end is blackened on the outside, but that may have been done by the fire.

44. *The Chairman.* Would the glass have been blown into the water?—Yes, perhaps so.

45. *Colonel Majendie.* Have you arrived at any conclusion as to what caused the explosion?—No.

46. Can you state the quantity of powder lost?—About 1,200 lb., I think.

47. Can you divide that amount between the different places; that is to say, between the boat, the barrels which were in the process of being conveyed from one place to another, and the rooms where the powder was being used?—The regulation amount to be in the house was 200 lb. for each machine. The boat had dropped grain at the north end, and had taken away the prisms, and was in the course of repeating the operation at the south end when the accident occurred. There might have been as much as 1,600 lb. between the boat and the two ends, but as a matter of fact, there was only 1,200 lb.

48. Are copies of those regulations as to the quantities which are supposed to be in the houses posted up in the buildings?—Yes; here are copies of all the regulations posted up in the buildings [handing in the same. See Appendix V.].

49. *Colonel Lloyd.* Was the boat carrying powder for any other building?—No, it was employed solely for that building.

50. *Colonel Majendie.* At what time do the shift men go to work?—In the ordinary course of things they work from 6 to 6, but as it was just before the Christmas holidays when they are allowed to make up the time spent as a holiday on boxing-day (which is not a Government holiday), they were, at that time coming an hour earlier, and going an hour later, and so working about 14 hours a-day. As a matter of fact, they did not work the whole 14 hours, because they have time off for changing their clothes, and they also have time for a meal in the middle of the night.

51. Who was the actual foreman in charge at the time of the accident?—A man named Bailey, one of the killed.

52. Had he any assistant foreman?—No.

53. Did he do any work at all?—No; his duty was to see that the work was going on all right, and he also had to take the density of the prisms.

54. Had he a machine for doing that?—Yes.

55. At which end of the building was his machine?—At the north end.

56. Then he would not require to leave the house at all?—No, he could pass from one end to the other by means of the covered passage.

57. Do the printed regulations deal with the question of the clothing?—Yes.

58. Do you know, as a matter of fact, whether the men on this occasion were dressed in clothing required by the regulations?—I believe they were; I do not think they would dream of going into the house without having the specially prepared clothing on. All men are supposed to keep a suit of old clothes in the shifting house, which they put on in place of their ordinary clothes when they come in, and then they put on their lasting suit over that.

59. Who sees to that being done?—The foreman is supposed to see to that, and I believe he does see to it; the foreman searches the men on their coming into the house.

60. Does that rule apply everywhere throughout the factory?—Yes.

61. Do they go out in the dinner hour?—They change their shoes when they go into the dining room.

62. Do they always dine in the factory?—Yes.

63. Does a man leave the factory at all from the time of first coming in to the time of finally leaving?—No.

64. Therefore, if his clothing is right when he begins, he has no opportunity of altering it?—That is so.

65. Do you know whether the clothing is invariably inspected by one of the foremen every day; for instance, is there any book containing a record showing that he has carried out his duty?—No, there is no such book.

66. Have you, since you have been there, had any cases of men being improperly dressed brought under your notice?—No.

67. Have you had any cases of men having pockets in their clothing?—No, but since the accident I have had the case of a man who had a pocket hole that was not sewn up.

68. Was there anything in the lining?—No, not in that case.

69. Have you had any cases of men having improper articles found upon them?—Yes I have discharged eight men for having matches.

70. Before or since the accident?—Three before, and five (three in one day) since the accident.

71. Where had they got the matches?—In their waistcoat pockets in their own private clothes. The policeman at the gate searches a percentage of the men when they are coming in; those men said they had not got any matches on them, and when the policeman found the matches they looked surprised.

72. *Sir F. Abel.* Is there any reason for supposing that the searching is more strict since the accident than it was before?—Yes, I have given the Inspector of Police directions to be very particular.

73. *Colonel Majendie.* Where would the private clothing be taken off?—In the shifting room.

74. Would there be anything to prevent a man putting on other clothing in the meal hours?—A man would not be allowed to go into the shifting room during the meal hour.

75. Do they really go there?—No, the man in charge of the room is told to report anyone going there.

76. *Sir F. Abel.* Is the room locked up?—No.

77. *Colonel Majendie.* Supposing a man were cold, would it be possible for him to make an alteration in his clothing in the course of the day?—A man might do that; but the foreman himself, and also the man in the shifting room, would be neglecting their duties if they allowed a man to do so.

78. Would a foreman miss a man in the meal hour?—No; it would be possible for a man to go there then.

79. When and where does the man in the shifting room have his meal?—I cannot say, but probably in the shifting room.

80. The instances in which you have found matches have always occurred before the men got into the factory?—Yes.

81. And therefore in the clothing which, if the regulations were properly carried out, would not be worn in the factory?—That is so.

82. There has been no case of finding matches on a man when at work?—Not in my time.

83. Is there anybody charged with the duty of supervising the foremen, and seeing that they actually do the searching they are required to do, by suddenly making a raid upon the men working in the various buildings, and making them show their pockets?—Yes, if considered necessary.

84. Has it ever been considered necessary?—I have not known of men being searched in the danger buildings.

85. Have you done it?—No; we have very often searched the buildings.

86. Does Captain Nathan do it?—He searches the buildings very often.

87. Does he make it a practice of searching the men at uncertain times?—I think not.

88. *The Chairman.* Does the foreman search all the men to see that they have no pockets, or only every second man?—He is supposed to search them all.

89. Practically there are two searchings, but the first one, I understand, applies only to a percentage?—Yes.

90. *Colonel Lloyd.* What is the percentage?—About 50 per cent. per week.

91. *The Chairman.* Have you ever found any matches lying about within the factory grounds?—Yes; we have found some near the gun-cotton factory and some near the cordite factory.

92. *Colonel Lloyd.* What is the penalty for a man found with matches?—He is discharged on the spot.

93. *Colonel Majendie.* That would apply whether the matches were found at the gate or in his clothing in the danger buildings?—Yes.

94. Supposing a man arriving at the gate finds that he has some matches in his pocket, how can he exculpate himself?—He can hand them over to the policeman.

95. He gets no punishment for doing that?—No.

96. The special clothing worn is supplied by the War Office, is it not?—Yes.

97. Is it made without pockets?—Yes. I am very anxious now that the men should have underclothing for putting on supplied by the War Office, so as to avoid having any private clothing at all.

98. *Colonel Lloyd.* Is there any reason to suppose that a man would shove a box of matches under his shirt?—It would be a dangerous thing to do; besides which, he might be found out.

99. *Sir F. Abel.* Have you ever had a case of surreptitious smoking brought under your notice?—No; I have never found anything of that kind.



100. *The Chairman*. What is your arrangement with regard to latrines?—There are dry earth closets.

101. Have you ever found men smoking there?—No.

102. Do they smoke after meals in the dining-room?—No.

103. *Colonel Majendie*. Is the special clothing universal in every danger building?—Yes.

104. How are the dining rooms warmed?—Those which are not near a danger building have an ordinary open kitchen range, but those which are in a dangerous position are warmed by gas.

105. Would a man working in a danger building be allowed to go into the room which has the fire?—Yes.

106. Where did the men who worked in the house where this accident happened have their meals?—Their dining room was about 80 yards from where the accident occurred.

107. How was that heated?—By gas.

108. Were those men in the habit of going to their night meal together?—Yes, they all went together, the foreman as well.

109. Would they be allowed to bring any portion of their meals into the danger buildings?—No.

110. Would they be allowed to bring a kettle for tea into the danger building?—No, that would be contrary to the rules.

111. Have you ever heard of any irregularities of that sort?—No.

112. How long had the foreman been foreman of that particular house?—For a considerable time, before I went to Waltham.

113. And had the men been in the house for some time?—They had all been there for more than one or two years.

114. Then there were no recruits, if I may so call them, in the house?—No.

115. Is there anything in the regulations with reference to repairs to the machinery or to the buildings?—In what way?

116. Supposing a machine was found to be out of order, what steps would the foreman, or the workman, or any person who discovered the defect, take to put it right?—The machine would be at once stopped; if it were night time it would have to remain till the next morning, but if it were day time the repairs would be taken in hand at once.

117. Is that formulated in some written order?—No, I think not.

118. If a man found anything wrong with a machine would he be acting wrongly in repairing it then and there himself?—Yes.

119. Is he forbidden to do so?—Yes.

120. Where is the regulation that forbids him to do it?—I cannot say that there is any regulation, but that is the rule. A mechanic is kept specially to do such things as that.

121. Would the foreman carry out such a repair himself?—No.

122. Have you had any cases of that rule being transgressed?—No.

123. Would any instruments be allowed to be kept in those places for repairing the machines?—There would be a spanner there for screwing up the machines.

124. Whose business would it be to do that work?—The mechanic's.

125. Then the mechanic would not have to bring all his tools to the house?—No.

126. *Sir F. Abel*. Would he be close at hand?—Yes, in the day time, but at night the machine would have to be stopped if anything went wrong.

127. *Colonel Lloyd*. Would the repairing of one machine cause the stoppage of all the other machines in the same house?—Yes.

128. And would all the powder be removed from the house while that was going on?—Yes, that is the rule.

129. *Sir F. Abel*. What is the object of keeping a spanner in the house if the men are forbidden to use it in any way?—It is to obviate the necessity of carrying all the tools about, I suppose.

130. *Colonel Majendie*. Would not the presence of the spanner be to some extent a temptation to the foreman?—All the machines were working when the explosions occurred, a spanner could not be used when the machine was in motion.

131. How do you know that all the machines were working?—The firemen who got down there first told me that they were working; the wheel was working the whole of the time, and it was only stopped by the roof falling in.

132. *The Chairman*. What were the machines used?—Cam machines.

133. Are they so constructed that part of the machine comes down, and part comes up in pressing a prism?—Yes, two parts meet together in order to press the grain powder into a prism.

134. There is a drill, is there not, in the centre of the prism?—Yes, a pin runs up the centre of the bottom plunger, and enters the bottom of the top plunger.

135. It sometimes occurs, does it not, that these machines get clogged?—Yes, that is a characteristic of these machines; the dust gets down between the pin and the plunger.

136. How is the clogging discovered first of all?—They would find that out by the friction, and the stiffness in the working of the machine.

137. Would the prism be faulty in shape in any way?—No.

138. What are the pins made of?—Gun metal.

139. How are they cleaned?—They are washed out with water.

140. Who does that?—The men themselves, under the supervision of their foreman.

141. In the case of one of these machines getting clogged, would that necessitate calling the foreman, or would the men put it in order again on their own account?—The whole of the machine would have to be stopped in order to wash it out, and I presume the men would call the foreman.

142. *Colonel Majendie*. I see that some of the rules refer to particular houses; here for instance are the rules for the cam house, are those the only rules applicable to that house?—Besides the particular rules, the "general" rules would also apply to the particular houses.

143. Is there anything else posted up?—No.

144. How are the prisms taken away?—They are taken away in covered trays.

145. Where do they take them out?—Through *this* door (see Appendix I.), and along the passage to the boat; the boat which brings the grain takes away the prisms.

146. But the powder is in the form of grain when it comes here?—Yes.

147. Has it been dried?—No.

148. What amount of moisture would it contain?—About 8 per cent.

149. What particular powder is it?—E.X.E.; it is rather a quicker powder than the brown powder.

150. What is it used for?—For the 6-inch B.L. gun, and I think also for the 12.5-inch M.L. gun.

151. Had that particular powder been made up for some time in this particular house?—Yes; we made it for seven months last year, the work of the house had then to be stopped in order to get in a new waterwheel, and I think we had been working again about three weeks when the accident happened.

152. Had there previously been any other accident in this house?—No.

153. And, with regard to the powder used at the time of the accident, was it in all respects similar to what had been used before?—Yes, there had been no variation.

154. With regard to the ingredients, do you know whether they were the same as you had been using for some time?—Yes.

155. Had you changed at all the sources of supply?—No.

156. Can you tell us what precautions are taken in order to prevent any foreign substances getting into

the powder?—The sulphur is put through a sieve, the charcoal is also put through a fine mesh; the saltpetre is not because it is damp, but the mixed ingredients, after mixing, are put through a sieve.

157. In that sifting, after mixing, have you found any foreign substances?—Yes, about three days after the explosion I found, in the sieve, a pebble, about the size of a pea. It is a long time since we found such a thing as that.

158. Can you say at all where that came from?—No, I have no idea.

159. I suppose the ingredients, from the time of sifting, are all kept in clean houses?—Yes.

160. Are all your powder buildings wood lined, are they lined with anything?—Yes, with only one exception, but I have not used that house because it is not lined; my predecessor declined to use it, and I have done so, too.

161. The ingredients are sifted, and the foreign matter presumably excluded, but in what are they carried from one house to another?—After the mixing they go to the mills sometimes by tram, sometimes by boat; the boats are always covered.

162. Then nothing could fall in while the boat was passing under a bridge, for instance?—No.

163. And are trams similarly covered?—Yes. In some instances the ingredients go to the drum house, and then they do not want milling for so long; but otherwise they go straight to the mill.

164. Do you think the houses are properly constructed as far as the lining goes; is there any opportunity for bits of brick or other particles getting into the mixture?—Not in the houses we use at present.

165. But with regard to those you were using at the time of the accident?—One of the granulating houses had a slate roof, and I have asked that that roof may be replaced.

166. Had this powder been through that granulating house?—I cannot say.

167. Is that a new house?—No, it has been in existence for some years.

168. Can you tell us how the house where the accident occurred was lighted?—By electric lamps, and they were entirely outside.

169. Did the wires pass into the house in any way?—No.

170. *Sir F. Abel*. Were the electric lights enclosed in water?—Some of them, not all.

171. The enclosure in water would prevent even a remote possibility of fire getting into the house?—Yes, and it would also prevent the powder dust staying about the lamp.

172. *Colonel Majendie*. Was it at all a dusty house?—No; though, of course, there might be some dust from the prisms.

173. Was there any dust about outside?—No.

174. Had you been in any way concerned with putting up the electric light?—No.

175. Has that been put up since you went there?—It has been altered since I went there.

176. Are you satisfied with it?—Yes.

177. So far as you could see, was there anything in the electric light that could endanger the place?—No.

178. Do you propose to hand in any description or drawings of the machines?—I can hand in some photographs and descriptions of them if required to do so.

179. Are there any working drawings of the machines; who supplied them?—They were got from Germany. When we got them first they were made entirely of steel, but we found that in the working they got quite rough.

180. *The Chairman*. Had you any accidents with them when they were all steel?—No. The steel bushes, and pins, and plungers were all removed, and replaced with others made of gun-metal, and that was found to be an improvement. We found that the saltpetre acted injuriously on the steel.

181. *Colonel Majendie*. Will you supply us with working drawings of the machines if possible?—Yes.\*

182. Are you, as Superintendent, personally responsible for the working of the machines?—Yes.

183. Have you been satisfied with these particular machines?—Yes, quite.

184. Have you received any complaints with regard to them?—None whatever, except after the accident.

185. What were the complaints then?—At the inquest, two of the men said the pins got heated.

186. And no fault of that kind was brought to your notice before?—No.

187. *Sir F. Abel*. Was there not some statement made at the inquest to the effect that a plunger was destroyed?—After the accident a plunger was found broken, but it was evident it must have got broken after the accident took place. A large iron screw, about 2 inches long, was found in between the bush and the plunger, and we think it must have fallen from the roof, because such a thing could not possibly have got into the room in any other way.

188. *Colonel Majendie*. Had you ever received reports as to broken plungers before that?—Yes; about three days before the accident a plunger broke, and the mechanics had to put in a new one. They are now made of phosphor-bronze, or gun-metal.

189. Who replaced it on that occasion?—The fitter.

190. Do you know the man?—Yes.

191. Before he replaced the plunger, was the house absolutely cleared of powder?—I should imagine so.

192. It ought to have been?—Yes.

193. Is it a usual thing to replace plungers during night work?—It takes some little time to do it.

194. Can a foreman do it, or must a mechanic do it?—The foreman, I think, could do it.

195. *Sir F. Abel*. Is a spanner the only instrument required?—A turn-screw and a spanner.

196. *Colonel Majendie*. Were they both kept there?—Yes.

197. Have you known many cases of accident in this class of house before?—No, none except the breaking down of machines.

198. I understand it was a stormy night. Was there any lightning?—Not that I saw.

199. Have the buildings lightning conductors?—Some of them have, but I do not think this building had one.

200. *Colonel Lloyd*. Was it an open slate roof?—It was a wooden roof covered with tarred felt.

201. Was any mortar or cement used in its construction?—No, except in the south gable end, which was of brick.

202. *Sir F. Abel*. Was it whitewashed inside?—No, I think not; it was match-lined and varnished.

203. *The Chairman*. Do you think that felt roofs are dangerous?—Yes, I think they should be replaced by zinc.

204. I understand the floor was covered with leather?—Yes.

205. How was it kept down?—It was nailed down with copper nails.

206. *Colonel Majendie*. Where is the nearest building with any fire in it?—The water warder's cottage and the dining room are about 70 yards off, towards the north.

207. If there were sparks would they be carried towards this building?—No; there is no coal fire allowed in either of these houses, only gas.

208. Where was the nearest chimney of any sort?—The steam mill, which has a high shaft, about 130 yards off.

209. Have you any locomotive engines running in any part of the works?—No, none at all.

210. So far as you know was there any external source from which a spark could have reached the house?—No.

211. What are your regulations with reference to the use of cotton waste and things of that sort?—

\* The witness subsequently supplied the Secretary with photographs of a cam machine which are to be found in Appendix II.



None is allowed in the building at all; there is a receptacle outside the building where they can put the sponge cloths; cotton waste is not used.

212. Where did that receptacle stand with reference to this particular building?—It was at a safe distance from the building.

213. What lubricating oil do you use?—We use a machine oil which appears to be a sort of mixture.

214. It is not wholly a mineral oil?—I think not, but I cannot say accurately.

215. So far as your knowledge goes is the work as carefully carried out at night as in the daytime?—Yes.

216. Is it the case that night work has been stopped since the accident?—No.

217. Do you see any reason why it should be stopped?—No. I should like to point out that we have had only four fatal explosions since 1840. The first happened in 1843, at 2 o'clock in the afternoon; the second in 1870, also at 2 o'clock; the third in 1890, at 6 o'clock in the morning; and the fourth last December, in what may be called the middle of the night; so you see only one explosion has taken place in the night since 1840.

218. *Colonel Lloyd.* Is any inspection made by any outside official at uncertain times of the night?—Yes, the master millman has to go through all the houses in the night. Occasionally my assistant goes through the houses, and I do the same.

219. Does the master millman make any reports of his visits?—No, not to me, but he might to the master worker.

220. Would he be the official who would notice any irregularities?—Yes, but there is no check upon him.

221. *Colonel Majendie.* Have you a system of tell-tale clocks?—No.

222. With regard to the men working in the house had you any personal knowledge of them, could you say whether they were in a proper mental condition?—I believe they were all intelligent and steady men.

(The Witness withdrew.)

Mr. FINDLAY, examined.

236. *The Chairman.* You are employed in the Royal Gunpowder Factory, I believe?—Yes.

237. What is your position there?—I am the master worker; I have the management of the men in the gunpowder branch, and also of the men in the gun-cotton branch.

238. Is your position equivalent to that of a general manager in a private concern?—Yes.

239. For how long have you been employed at Waltham?—33 years last December. I entered as an apprentice under my father; I worked in every department as an apprentice first, and then afterwards as a workman. My father was master worker there before me.

240. *Colonel Majendie.* How long has this house been used for its present purpose?—Since 1887.

241. What was it used for before that?—Formerly it was what was called the No. 10 mill, it was one of the older mills, and was used as an incorporating mill with two pairs of runners.

242. Was the construction of the house at the time it was a mill similar to what it is now?—No; at the time the cams were placed in it the building was match-lined with a wooden false roof over that.

243. What was the construction of the building at the time of the explosion?—Felt roofed outside, I think.

223. Had you any idea that any of them had, say, a desire to commit suicide?—I have had no knowledge of that.

224. Had they been working there for some time, and were they sane and sober men so far as you know?—Yes.

225. They had to come in at 5 o'clock, I understand?—Yes.

226. Could any of them get out at night?—Only if one of them became ill, and then the foreman would have to pass him out.

227. *Colonel Lloyd.* It appeared, I think, in the report of the inquest, that there was some heat in the machines, will you state to the Committee the temperature at which gunpowder explodes, and say what reference that would have to the temperature of the machines on which a man could only just bear his hand?—I think you cannot bear your hand on anything over 150 degrees, and gunpowder, I understand, ignites at somewhere about 500.

228. Have you ever heard of any instance in which one of these cam machines exhibited such heat that a man could not bear his hand upon it?—No; two men stated that at the inquest, but I have by me the evidence of a number of men in contradiction of those statements.

229. Will you append that to the report you are going to make for us?—Yes (see Appendix VII.).

230. *Colonel Majendie.* Were those men paid piece-work, or time-work?—There is no piece-work whatever.

231. Were they then being paid at the rate at which they had usually been paid?—Yes.

232. There has been no alteration recently in their rate of pay?—That is so.

233. Then they would have no pecuniary advantage in hurrying their work?—No, they had ample time to get their task through.

234. If a man saw a machine damaged would he have any personal interest in correcting that without sending to the mechanic?—No, none.

235. Would he lose any pay by such damage?—No nothing at all.

254. Would that completely close the hole?—The woodwork comes close round the shaft up to within, perhaps, one-sixteenth of an inch.

255. *Colonel Majendie.* Those partitions were not calculated to resist an explosion, were they?—No, they were not put up with that idea.

256. Was the floor covered with leather?—Yes.

257. All over?—Yes.

258. With regard to the passage which ran along in front of the house, was there leather on the floor there?—No, only wood, it was a clean floor.

259. Was the floor all on the same level?—No, the old mill floor was covered with another floor, and I should say that was about 9 inches or 10 inches above the old floor; the floor was really made level to the base of the cam machines.

260. Then in bringing powder into the house, one would have to step up a little?—Yes.

261. How did the men bring the powder into the house?—There is a platform direct from the river here. [The witness then described, by means of the plan the procedure followed in bringing powder from the boat to the house, and said there was a slight variation to the usual course on the night in question (the platform from the water to the house at the south end of the building not being used) which he understood from one of the men was owing to the very high wind that was blowing.]

262. Was the proper way of getting a barrel along to roll it on its chime?—Yes.

263. Have you, in the course of your experience, ever known men to take barrels along in any other way?—No, I have never seen a man drag a barrel along.

264. How would a man get it on to this step (see spot marked B' on the plan, Appendix I.)?—He would tilt it half way up, and move it on the side or lift it.

265. *Sir F. Abel.* Do you think there would be any possibility of a man stumbling there, and the barrel being thrown down, and the man falling on it?—No, and even if he did, I fail to see what harm would come of it.

266. *Colonel Majendie.* Could the man see?—Yes.

267. How was the passage lighted?—There was an electric lamp opposite the middle of the water-wheel which showed a light in the passage itself.

268. *Sir F. Abel.* In bringing the powder into the house would a man always have clean shoes on?—Yes. [The witness then pointed out on the plan the position of the places for changing boots, and said he had found the boatmen's dirty boots on board the boat, which proved that they had not put on their clean boots in one of the rooms.]

269. *Colonel Majendie.* Is the inside of the boat treated like the inside of a powder mill?—Yes, certainly.

270. About what time after the accident did you reach the works?—The explosion occurred at 25 minutes to 3, and I arrived there about a quarter past.

271. Did you see anything on the remains of the man Watts which pointed to an explosion as distinguished from burning?—I could not tell, he had no limbs, he was burned almost to a cinder.

272. Were any of the others injured as much as he was?—No; I think he was killed on the spot where he was. [The witness then explained, by means of the plan, how the men got out of the various buildings, and how they were able to assist each other.]

273. Was there any evidence of the explosion of any quantity of gunpowder at any other part than where the body of Watts was found?—When I got to the place it was in flames, and I had no means of seeing anything more than any one else could see.

274. Is there any evidence of a crater here (i.e., where the body of the man Watts was found, see Appendix I.)?—No.

275. Was any portion of a barrel found there (i.e., where the body of the man Watts was found, see Appendix I.)?—No.

276. Was anybody able to see what Watts was doing at the time of the explosion?—The wounded men told me as much as they knew of what happened. [The witness then described, by means of the plan, how and where Watts and Bailey were employed at the exact time of the explosion (Bailey in passing from the south to the north end of the building met Watts rolling a barrel of powder into the south end), and also what action the other four men took at the same time.]

277. *Sir F. Abel.* They used E.X.E. grain, did they not?—Yes.

278. Does that produce any violent effect, even if exploded in a granulated condition?—No.

279. It differs very much from the ordinary S.G., does it not?—Yes, and the density of the grain in this condition is such that it burns as slowly as a prism; in fact, the density of the grain very nearly equals that of the prism.

280. And in addition to that, how much water would it contain?—About 4 per cent.

281. Then you could not possibly expect to find a crater?—No, we can hardly say it exploded, it burned; and that is shown by the fact that some men working in the drum house had time to put on their boots, get their electric lamp out of their cupboard, and get within 30 yards of the house before the other explosion took place.

282. *Colonel Majendie.* When Bailey met him, was Watts rolling a barrel?—Yes.

283. How much did the barrel contain?—About 90 lb.

284. Can you say what powder was in the boat?—The boatmen had emptied one house, and the man was taking a barrel of grain towards the other; I find there are about 12 barrels short of what was in the boat and what was in the house.

285. Do you think that the whole stock of powder that went off was 12 times 90 lb.?—Yes.

286. And nearly all of that was in the form of prisms, was it not?—Except those two barrels which had been put in the north end, one barrel Watts was rolling and one in the boat.

287. Is the boat very considerably injured?—Yes; but the bottom of the boat is not hurt, although it leaks a little at the side. The half of the top where the barrel of powder was is pushed off the top.

288. If there had been anything approaching an explosion the boat would have disappeared, would it not?—Yes.

289. Even with the explosion of 100 lb.?—Yes.

290. *Colonel Lloyd.* Is any part of the boat to be seen now?—Yes, one half of it, the other half is broken to pieces.

291. *Colonel Majendie.* When were you last in this particular house?—On the Monday, the accident occurring early on the following Wednesday morning.

292. Were the same persons there on the Monday as were employed there on the Wednesday when the accident happened?—I was there at the time of the day shift only, and not when the night shift was there.

293. Were those men accustomed to being employed in the same house?—Yes.

294. Were they familiar with the whole of the working of the house?—Yes.

295. Were any of them new hands to this particular work?—No, they were old hands at it.

296. How long has Bailey, the foreman, been working in that house?—Ever since it started, in 1887.

297. Was he a good man?—Yes.

298. What would you say with regard to the others?—They were the best lot of men we ever had.

299. Was there anything strange in the conduct of any of them, anything which attracted your attention?—No.

300. *Colonel Lloyd.* Would especially good men be selected for specially hazardous employments?—These four men were selected on account of their good conduct and ability.

301. As a rule are hazardous employments given to selected men?—Yes; we select all our men.

302. *Colonel Majendie.* Did you regard this as a



specially dangerous house?—No, nothing beyond the general danger attaching to the making of gunpowder.

303. *Sir F. Abel.* I believe you went to Germany to see the working of these cam machines?—Yes.

304. And you came to the conclusion that they were safe machines?—Yes.

305. And were the machines in this house similar to those you saw working in Germany?—Yes, generally.

306. Had they been altered at all?—Yes, we had taken the steel pins and bushes out, and put phosphor-bronze ones in their places. Those alterations were made upon my recommendation. I found that in the working the steel pins got scored.

307. Will you describe generally the principle of the cam machine?—The press consists of six moulds which are made of bronze; the grain is fed into them by a sliding table, having six fillers of gun metal, which are themselves fed from a hopper, into which the grain is poured; the table moves backwards and forwards, and besides serving to carry the charges it pushes forward the prisms after having been pressed. There are two sets of plungers of bronze, top and bottom; through the latter, which serve as guides, pass the bronze needles which form the channels. The upper plungers have holes into which the needles pass when they come down to give the pressure. The whole is worked by means of eccentrics.

308. Did you hear of any accident with those machines having occurred in Germany?—No, and they went in and out of their houses with dirty boots.

309. *Colonel Majendie.* Were those alterations in the machines made long since?—Yes, we did not work them in their original form for long.

310. How long had this house been engaged with this particular class of work?—We worked it from the 1st of April, of last year, up to the end of September, and then we had to put in a new water-wheel, the other being a very old one, which had belonged to No. 10 mill. With the new wheel, we had been working six weeks when the accident happened.

311. And during that time had there been any special alteration made?—No.

312. And no accident of any kind from explosion or from fire?—No.

313. With regard to the stuff you were making, had you any cognizance of the sources from whence the saltpetre, and sulphur and charcoal were derived?—The saltpetre belonged to someone else, but the charcoal and sulphur were in my charge.

314. And on the night of the accident, were the charcoal and sulphur the same as had been used since the house was reopened?—Yes.

315. Were they subjected to the same sort of examination?—They were passed through a 32 mesh, and then when they were mixed with the saltpetre, the whole of the mixture was passed through another sieve.

316. The object of that was, I presume, to exclude dangerous foreign substances?—Yes.

317. Have there been any, or many, cases in which you have found something?—No, we have never found anything except bits of wood, or a copper nail.

318. Has anything been found since the accident?—Yes, we found a stone on the mixing house sieve, a pebble about half the size of a pea.

319. Can you suggest how that came there?—No.

320. What was it found in?—In the mixture of saltpetre, sulphur and charcoal, but as the two latter had been passed through a 32 mesh, the supposition was that it might have come in in the saltpetre, but we cannot say for certain.

321. There have been, I suppose, from time to time all sorts of things found in the ingredients at Waltham Abbey?—I do not know.

322. Do you not know of a room where a number of such specimens were kept?—We have found such things in the powder, but not in the composition.

323. Have you in this particular composition and powder found anything at any time?—No.

324. Does the powder go into any unlined house

during the mixing of the ingredients?—The mill is an unlined house, it has only a single roof.

325. What is the roof made of?—Wood, the walls are of brick.

326. Are they lined?—No.

327. Whitewashed?—Yes.

328. *Sir F. Abel.* Is the wooden roof whitewashed?—I do not think so. I think it is only painted.

329. *Colonel Majendie.* Are the walls in such a condition that any brick particles could become detached from them?—No.

330. Could any particles become detached from the roof?—No.

331. What is the next house?—The breaking-down house, which is of wood and iron.

332. Could any grit become detached there?—No.

333. What is the next house?—The press-house, that has a slate roof lined inside with wood, and so has one of the granulating houses, but not lined inside, but this particular powder did not pass through that house.

333a. Are you satisfied with an unlined roof?—No, I am not.

334. *Sir F. Abel.* Is that granulating house a modern house?—It is an old house, about 50 years old.

335. *Colonel Majendie.* Has it ever been lined?—No.

336. Is it now used?—It has not been used since the accident.

337. What is the next house?—The dusting house, which is also of wood.

338. *Sir F. Abel.* Are the hoppers of the cam machines provided with lids, or are they open?—They are open.

339. *Colonel Majendie.* How are the linings fastened on in the houses you have detailed; are they nailed on?—The new houses have iron girders, with iron screwbolts supporting the girders, but the iron bolts are covered with leather.

340. Do you think it at all possible that a nail, or a portion of a nail, may have fallen from the roof of any one of those houses into the powder in passing?—No, I think not.

341. Will you tell us what happened after the powder was brought into the house?—Rudkin would put it into the hopper. [The witness then explained how the man carried out the various operations, pointing out that the amount of powder put into the hopper considerably affected the process of output and the density of the prism.]

342. How much does the hopper contain?—As near as possible 40 lb.

343. What is the hopper made of?—Gun metal. The man in front of the machine sees that the charger comes over the bushes and sees that the charger pushes the prisms off; he then puts the prisms on a tray. There are 24 prisms turned off in a minute.

344. Are they arranged on the trays by hand?—Yes, a full rack holds 280 prisms. That is all the men have to do while they are actually at work; and the order is, if anything gets out of gear—for instance, such as a charger not coming far enough over to push the prism off, or say a plunger did not come forward enough to push a prism out—then the machine would have to be stopped. The object of having two men there is to see that those two operations are properly carried out. [The witness then explained, by means of a diagram, how the working of the levers was carried out when the charger or the plungers got out of order.]

345. Had you had any complaints from anybody about anything regarding the machines?—No, no complaints. Sometimes I went in and asked Bailey, "is everything all right?" and perhaps he would say "yes," or "one of the pins got stopped up and took a little longer to clean."

346. Had you any complaints about the pins getting bent?—No. In 1887 the pins were constantly broken, because when the powder gets dry in the plunger the pin is snapped off at once; we therefore made holes in the plungers, and water was put in to clean them

347. *Sir F. Abel.* Are they washed periodically?—The foreman has the discretion of cleaning them after one, two, three, or four cases, but four is the outside limit.

348. They do not wash them until they have a difficulty with the machine?—They always wash them when they have done four cases of prisms; but they do not wash them before that unless there is a difficulty.

349. *Colonel Majendie.* Have you had any complaints made to you about these machines being dangerous?—No.

350. Was not something said about them at the inquest?—Yes, about the pins getting heated; but that was not true.

351. Such a thing has not, at any rate, been represented to you?—No.

352. Would it have been Bailey's business to have represented that to you?—He would not have waited to represent it to me; if he had only thought there was something wrong he had written instructions to stop at once.

353. *Sir F. Abel.* Is the breaking of plungers of frequent occurrence?—Yes.

354. To what is that due?—To the metal, I think.

355. Does the fracture occur suddenly?—Yes, either in the coming up or going down.

356. *Colonel Majendie.* What happens when a plunger is broken?—It disables the machine, and no work can be carried on.

357. When a plunger breaks in one machine, is the whole house stopped?—No, not the whole house; that particular machine is stopped independently of the others.

358. *Sir F. Abel.* When a plunger does break what is done?—If it is in the daytime, the engineer comes and replaces it by another one.

359. *Colonel Majendie.* Does he remove all the powder out of the house?—Yes, every portion of it.

360. Is the house washed out?—No.

361. *Sir F. Abel.* Does he bring his tools with him?—Yes.

362. Then what is the object of a steel spanner being left in the house?—There are a lot of spanners belonging to these machines which are always hung up in the house.

363. But why, if there is only one man dealing with the spanners, does he not bring them along with him, the same as he brings his other tools?—Those tools may be used by the foreman; if he found that the plungers got compressed he would undo the two screws, and put some packing under.

364. Supposing the foreman were not there, would one of the men take it upon himself to do that?—No.

365. *Colonel Majendie.* Are the men forbidden to do that?—Yes.

366. Is there any written order?—No.

367. How does a man know that he may not do it?—There is a foreman in charge of the whole thing, with instructions that he is the only one to do it.

368. But not written instructions?—No.

369. *Sir F. Abel.* Is there any other tool besides a spanner kept in the house?—Yes, a hammer and another spanner, to alter the wedges on the cross-head.

370. Would the foreman do that?—Yes.

371. *Colonel Majendie.* Would he be required to clear the house of powder to do that?—No, because sometimes the cross-head wants to be altered every five minutes.

372. *Sir F. Abel.* What is the object of that?—The density of the prism alters, and the crosshead has to be altered accordingly.

373. *Colonel Majendie.* Would he clear the house before using the spanner to alter this wedge?—No.

374. Is that a steel spanner?—No, it is a metal one.

375. But, in using a steel spanner for that, would he clear the house?—No.

376. *The Chairman.* How is the powder put into the hopper?—By a copper bowl, out of the barrel.

376a. Would the powder be littered about at all?—No, it is practically a clean house.

377. *Colonel Majendie.* All the men in the danger

buildings throughout the factory have to wear a special suit of clothes, have they not?—Yes, a frock, trousers, and a cap.

378. Is it a flap cap?—Yes.

379. Do they wear those special clothes over their ordinary clothing?—Over the clothing to be worn in the powder house, and we require that there shall be no iron buttons and no pockets in that private clothing.

380. Where is that private suit kept?—In the shifting room.

381. Has each man a locker?—At the present time there is one locker between every two men.

382. A man never takes his Government clothing out at any time?—That is so.

383. Whose business is it to see that the men have got on proper clothing underneath their Government clothing?—There is a man specially appointed to the shifting room, a day man and a night man. The man does not inspect every one, but, of course, he looks to see that they have changed their clothes. The foreman looks also to see that the men have changed their clothes, and that they have no pockets.

384. Does the foreman or the shifting-house man keep any record of that?—No.

385. Where is the shifting-house?—Two hundred yards from this house.

386. *Sir F. Abel.* Do the bargemen go through the same operation of changing?—Yes.

387. Where do they change?—Near the Superintendent's office.

388. Who keeps a watch upon them?—A man there.

389. *Colonel Majendie.* When did Bailey look at his men?—When they came to work first.

390. In the house?—Yes.

391. Had they any chance of changing back into improper clothing during the course of the day?—No, they could not do that.

392. Have you had any instances of men being reported to you for having pockets in their clothes?—No.

393. Never in all your experience?—No.

394. And you yourself have never found a man with them?—No.

395. Nor with metal buttons on their clothes?—No.

396. Or buckles on their braces, and things of that sort?—No. I have myself cautioned almost every man upon those points when they first came.

397. You say that Bailey would look at his men every day?—Yes, each foreman is supposed to do that, and they are asked if they have done it.

398. Are those rules as strictly observed at night as they are in the day?—Certainly.

399. Have you any reason to doubt that?—No.

400. *The Chairman.* We understand that the master millman goes round the works?—Yes, we have two, one for the day and one for the night; they work alternately.

401. Do they inspect the men in the same way as you might do occasionally?—No, not on going round in the night time.

402. Is there any check upon that master millman to show that he has been round?—He reports verbally, not in writing, to the other man coming on in the morning, and says whether all is right or not.

403. *Colonel Majendie.* Do you think there is any objection to the night work?—I do not see any objection to it.

404. Do you think that the men can be quite as easily supervised at night as in the day time?—Yes, especially as we use the electric light.

405. I understand that there have been cases of men being found coming into the works with matches on them?—Yes, that is so.

406. But never a case of a man being found in the works with matches in his possession?—Only one case during the 13 years that I have been the master worker.

407. Have there been many cases of matches being found in the works but not on the men?—I have



myself repeatedly found matches about the grounds, but I am of opinion that they were carried in on the men's boots. The men on coming to work feel in their pockets to see if they have any matches, and if they have they throw them down on the ground outside, and then other men coming in are liable to tread on those matches and so bring them into the works on the soles of their boots.

408. If a man finds he has matches in his pocket when he gets to the gate, what does he do?—Gives them to the policeman; in fact, they are asked the question.

409. Every man?—No, not every man.

410. *Sir F. Abel.* On what occasions have men been dismissed for having matches in their possession?—The policeman has always the power to search a man, and if a man is found to have matches after he has been asked, and says he has none, then he is reported, and dismissed at once, but if a man gives up his matches on being asked, then he is let alone.

411. *The Chairman.* Were the matches you picked up about the grounds live matches?—Yes.

412. *Colonel Majendie.* Have you had any cases of matches being found since the explosion?—Yes; we have sent away three men and one boy for that reason. The men had been taken on only in the last fortnight, and when they came they were particularly cautioned against carrying matches, and they were told that if they did smoke they were never to carry matches in their pockets. It appeared they had been smoking over-night, and had put the matches in their pockets, and had forgotten them.

413. You think they did not keep them there intentionally?—Certainly not.

414. *The Chairman.* Do you admit of any excuse?—No, none at all.

415. *Colonel Majendie.* Are you satisfied with the electric light?—I am satisfied so far as regards that house.

416. Had that been altered?—Yes, some time before; it was entirely outside the house.

417. I understand there was no other means of lighting except by the electric light, and no means of heating the place?—Yes, there was some heating done by means of pipes.

418. Where was the steam generated?—In a boiler, about 100 yards off.

419. Were there any fires at all near this house?—No; there used to be a large fire in the dining-room, but about 18 months ago we had it done away with, and we put a gas-stove in instead.

420. Could there be any place at all near there from whence a spark could be derived?—No, that would be impossible.

421. Have you tried to find out the cause of the explosion?—Yes.

422. Have you found out anything with regard to the machines which you think suspicious?—No; when it got daylight on the morning of the accident, we went and examined the machines, and we found that one of the top plungers had got jammed in the bush with a large iron screw that had evidently come out of the old building somewhere during the fire, because the machines were working after the accident.

423. What evidence had you that the machines were working after the accident?—The Colonel saw them and the firemen saw them, and I saw them as the building kept falling in; they were all working.

424. They could not have worked with a broken plunger jammed as that was, I presume?—No, that was broken afterwards; the screw fell across the bush and that is why the plunger was broken.

425. Have you got the screw?—Yes.

426. Has it been shown to the Officers of the Works Department?—I do not know; it could not have tumbled into that place until the lining had got burned. There were eight or nine of those screws lying about, some on the same machine, and some on the next machine; I picked up five myself.

427. And you think they had nothing whatever to do with the machine?—No.

428. Has anything occurred to shake your confidence in these machines since the accident?—No.

429. Have you heard of any accident elsewhere in the process of pressing prisms?—No.

430. Do you not know that one happened at Dartford some few years ago?—Yes, but I believe that was not a cam machine; that was a hydraulic press, something similar to our own, except that they had compensating plungers. That accident happened, I believe, while they were pushing the prisms out.

431. There was no explosion in that case, was there?—No.

432. Were all the prisms burned?—No, only that one, I believe.

433. Then may we take it that the results of that explosion would rather tend to strengthen your impression that this was not a very dangerous house?—I do not consider it dangerous.

434. Was the question ever mooted, or discussed between yourself and the Superintendent, or anybody else, as to reducing the number of persons in that house?—That could not have been done without taking away some of the machines.

435. Could not the machines have been divided?—No, the house was not big enough for that.

436. But with regard to this particular building, has the question of placing as many as eleven people in one building at all occupied your attention?—No. The only thing that comes to my mind is this: if four cam machines are put up again, then they should be separated, one in each room, and there should be brick traverses between all the rooms.

437. Do you know how this work is carried on in private factories, and the number of men in each house?—I do not know any place, except Chilworth, and even then I cannot say how many men they have there.

438. Do you know of any place where they have as many as eleven people in one house at one time?—No.

439. *Colonel Lloyd.* Do you consider the operation of pressing much more dangerous than the operation of granulating?—I think granulating is very much more dangerous than pressing.

440. What is the pressure put upon the powder in making prisms?—No one can tell you that.

441. *Colonel Majendie.* You had an explosion in the press house some years ago, had you not?—Yes, in 1870.

442. That was not during the operation of pressing, was it?—No, it was in unloading the presses; it was supposed to have been due to a flaw in the plates, caused by some sandholes.

443. Have you ever had an explosion in the granulating house?—No.

444. Do you know what quantity of powder you have made with those machines?—We have turned out 70,000 barrels of the E.X.E. powder.

445. Have you made any other powder than that?—Yes, some 1,500 barrels perhaps.

446. Where do you press your black powder?—We do not press any at all, but we press some brown powder in the moulding house.

447. Are any hand lamps of any description used in this place?—There was one at either end of that building.

448. Were they electric?—Yes.

449. What sort?—Similar to the one sent to you at the Home Office.

450. Had they been altered at all?—No; they were not being used at the time.

451. How do you know that?—Because Bailey told me so. He was the least hurt of any one, and he was quite sensible until within an hour of the time when he died.

452. Was that with reference to the lamp at the north end?—Yes.

453. Did he speak to you about the other lamp?—He said that, as the machines were working, the men would not have any occasion to use the lamps; they would not use a lamp unless they wanted to do something to a screw, and they could not do that while the machines were working.

454. Then the lamps were only for use in an emergency?—Yes.

455. You say the explosion occurred just here in this circle [pointing to the position on the plan where Watts's body was found. Appendix I.]?—Yes. [The witness then again (see Question 276) explained, by means of the plan, what Bailey and the boatman were doing at the time of the explosion, and also pointed out where the explosion occurred. He also explained his reasons for believing the explosion occurred at that particular place, and he explained how and in what direction the men moved when they heard the noise].

456. *Colonel Lloyd.* Did the men throw themselves into the river, or were they blown in?—I think they all threw themselves in.

457. *Colonel Majendie.* Were the burning prisms thrown any distance?—Yes, because a man there [pointing to the plan] was hit in the back by one.

458. Was the place scorched at all by the burning prisms?—No; I think it was raining hard.

459. *Colonel Lloyd.* Were the sashes blown out?—Yes, there was glass outside.

460. *Colonel Majendie.* The men get a meal in the night, do they not?—Yes.

461. At what time?—Twelve o'clock.

462. How long are they allowed for that?—Half an hour.

463. Do they all go at once?—Yes.

464. Do they ever bring cups or glasses into the house?—No.

465. *Colonel Lloyd.* Would they change their shoes in going into the dining room?—Yes.

466. *Colonel Majendie.* Have you ever known a case of the men bringing their food into the house?—No, I have never seen any food in the house during the whole course of my experience.

467. *Sir F. Abel.* Is there any possibility of the men smoking in the dining room at night?—No.

468. *Colonel Lloyd.* Would they have access to the dining room at night?—Yes, they could get there, but not without the foreman knowing it.

469. *Colonel Majendie.* Who lit the gas in the dining room?—It is alight all day while the man is there, and he leaves it alight when he goes away at night.

470. Would he light it with a light, or with a match?—He would go to the boiler with a lamp if he wanted a light; but, as a matter of fact, the gas jet is never out, nor is the stove put out.

471. Was there any dust outside the house?—No, there is no dust in this powder at all, it is a very clean house.

472. Were any remains of the barrel Watts was moving found at this part [pointing to the position on the plan where Watts's body was found. Appendix I.]?—No, nothing in the house at all except the timber fallen from the roof.

473. Watts could have got out, could he not?—Yes, he had the best chance of the lot.

474. Supposing anything happened to his powder?—He could not get away then.

475. Had he been accustomed to do this work for some time?—Yes.

476. *Colonel Lloyd.* What proportion of the men are searched at the gate?—I could not tell you; I have nothing at all to do with that.

477. They are not all searched at any rate?—No.

478. Therefore there may be some presumption that a man could get into the factory with matches in his possession?—Yes, but only as far as the shifting room.

479. Are the cam machines made in pairs?—No, they are single machines.

480. There is then no reason why they should not be worked in separate rooms?—No.

481. Would a workman ever alter the fittings of a machine without the assistance of the fitter?—No; the only thing a foreman would do would be to put a plunger right when it got compressed. He has some iron in his hands, and he would put one under it, and that would set the thing right at once.

482. What tool would he use for that purpose?—A spanner.

483. Would any other spanner do instead of a steel spanner?—The Chief Engineer says not; he says the points of other metal spanners would not stand the strain.

484. *Sir F. Abel.* Would there be any temptation to a man to do anything in the way of repairing a machine?—No.

485. *Colonel Lloyd.* In the case of the barrels that have to be moved, full of powder, from one place to another, would there be any objection to providing them with a tighter fitting cover than the canvas cover which is now used?—I think it would be difficult to do that. Originally we had wooden tops to the barrels, but we found that in moving the barrels out of the boats the men sometimes caught hold of the tops of the barrels, and when the tops slipped off, the barrels fell.

486. Are the canvas cloths you now use for putting on the heads of the barrels impregnated with powder dust?—No, they might be if they got wet, but they are constantly changed.

487. *The Chairman.* If anything in the way of an explosion had happened, would not the machines have been destroyed?—I think not, because there are here and there openings in the buildings.

488. *Colonel Majendie.* Is grain quicker than prism?—Yes, it is quicker, but even then it is slow on account of the density.

489. *The Chairman.* Have you, in your own mind, any idea as to the probable cause of the accident?—I think something must have happened to the powder barrel, but what it was I could not say. I got from the injured men all the information I could, and if the Committee would like to hear their statements, I will read them.

490. If you please?—James Bailey, foreman of the cam house, said: "I had only just left the south end, where Nos. 2 and 3 machines are, and which were working all right. Everything appeared correct, and had been so all night. I passed the boatman Watts in front of the water-wheel, trundling a barrel of grain powder, going into the south end; and when I had arrived against No. 5 machine in north end, a rumbling noise was heard, and all the men in this end looked up and exclaimed, 'What's that!' And after a little while another noise was heard, and a flash of fire seen, when we all started to run out of the house. I had got clear of the house before it exploded, but appeared to have been blown in the water while running away. I kept swimming about until rescued. I cannot account for the accident." Bailey was in the water nearly an hour; he died on 19th December, 1893, at 12.45 a.m. James Clayden, one of the men working No. 2 cam press, said: "I was working in front of machine, and saw pressed prisms pushed off all right, and turned to pack prisms on the rack, when a flash came behind me from my machine." Asked if he knew what caused the fire, he said, "No; machine had been working all right." He died, 14th December, 1893, at 2.15 p.m. William Rudkin, the other man working No. 2 cam press, was so severely burned that he died at 2.30 a.m., 14th December, 1893, having been unconscious the whole time. Edward Larman, one of the men working No. 3 cam press, said: "I was working in front of machine, and had just turned to pack the prisms on rack, when a flash of fire came from the direction of Clayden's machine (No. 2)." Asked if anything had happened to Clayden's machine, he said: "Not as far as he knew. When explosion took place, myself and Clayden ran out of house and got into the river where we were found. I cannot account for the explosion." He died 18th December, 1893, at 7.35 a.m. George Rudd, the other man, working No. 3 cam press, was so severely burned that he died 14th December, 1893, at 1.45 p.m. I tried to talk to this man on several occasions, but he was not in a condition to talk to me. Benjamin Hare, one of the boatmen, stated that "they (himself and Watts) had cleared the north end of pressed prisms and taken two barrels of grain in. Watts the deceased boatman.



who was the only one killed on the spot, was taking a barrel of grain to the south end when the first flash was seen coming from that end. I went to the door of the boat and took off my clean slippers, when I was knocked in the river. I swam about and helped Jennings and Rudd out of the river; we all then walked up to the shifting room."

491. *Colonel Majendie.* With reference to the precautions for the future, I understand you consider it desirable to separate the machines?—I think, if it is intended to work the cam machines again, they should each have a room, the rooms to be separated by brick traverses, and instead of having a boat there should be a tramway line. For small quantities of powder which are being pressed at one time, it is very difficult to get boats up and down.

492. Do you see any reason for the suggestion that other machines should be substituted for the cam machines?—No, I do not.

493. Do you think that the character of the machines is at all affected by this explosion?—No.

494. Have you anything to say in regard to the construction of the building, would you advocate for the future a like construction to this?—Yes, only a little more room in it.

495. *Colonel Lloyd.* With separate machines in separate houses, what would be the maximum quantity of powder that would blow up in any one house?—Seeing that the hopper must hold 40 lbs. of powder, I think you could not do with less than 100 lbs. in each house.

496. *Colonel Majendie.* With such a quantity as that it would be rather in the nature of a mill accident

than of an explosion, would it not?—Yes, certainly. After what has just happened, I think such buildings as these will not be put up again. We naturally thought the place was safe, because we have done this work so long; I think the old building is quite 100 years old.

497. *The Chairman.* Is there anything else which you wish to say in reference to this accident?—I should like to be allowed, if I may, to say a word in reference to the evidence given at the inquest by Mumford and Wraight. What they said was simply perjury and falsehood, and, in my opinion, they are very dangerous men to have in a powder factory; I do not think they ought to stay there, because if they are bad enough to do one thing, they are bad enough to do another.

498. *Sir F. Abel.* To what particular portion of their evidence do you refer?—Mumford said the pins were so hot that he could not put his hands upon them; I have never heard of such a thing in all my life. The whole of their evidence was merely a pot-house arrangement, and it is not safe to have such men about the place.

499. *Colonel Majendie.* Is not that rather a matter for the Superintendent?—I have told him that those men ought not to be in a powder factory. One of them said he had been reduced in wages on account of the evidence he had previously given, but that was not true; he also said that he had been punished by having to eat his dinner half frozen, but the dining room was within 60 yards of his working place, where he could have gone with the other men.

(The Witness withdrew.)

SATURDAY, 27TH JANUARY, 1894.

Present.

Lord SANDHURST, *Chairman.*

Members.

Sir F. A. ABEL, Bart., F.R.S.  
Colonel V. D. MAJENDIE, C.B., Her Majesty's  
Chief Inspector of Explosives.  
Colonel F. T. LLOYD, C.B., R.A.

Mr. R. H. BRADE, *Secretary.*

Colonel M. T. SALE, C.M.G., Superintendent, Building Works Department, and Captain H. HULEATT, R.E.,  
Second Assistant, Building Works Department, *examined.*

500. *The Chairman.* You are Officers serving under the Director-General of the Ordnance Factories, I believe?—Yes.

501. (To Colonel Sale.) Has your department to do with Waltham Abbey as well as with Woolwich?—Yes, we have to do with the structural works at Woolwich, Waltham Abbey, Enfield, Birmingham, and part of Weedon.

502. *Colonel Majendie.* Do you know the building at Waltham Abbey where the late accident happened?—Yes.

503. Was that building erected before you were

appointed to your present position?—Judging from the plans and documents in our possession, it appears to have been erected in 1846 or 1847.

504. From what you know of the place, has it been in any way modified?—Originally it was an incorporating mill; it was blown up in 1861, and reconstructed in the same year as an incorporating mill; in 1887–88 it was converted into a cam house.

505. Was the structure modified in 1887–88?—It was lined throughout with match-boarding, and all the necessary precautions were taken as customary.

506. Will you state in detail the structure of the

house?—Here are the original plans, up to the time of its being made into a cam house [handing in and explaining the same]. The walls were all of wood, with the exception of the cross walls; but the brick wall now standing *there* (i.e., at the south end of the house) was built afterwards, i.e., in 1861.

507. What was the roof?—It was a boarded roof, over timber rafters, covered with tarred felt.

508. Was the interior of match-boarding throughout at the time of the accident?—Yes, with copper fastenings.

509. Was there any exposed iron in the structure?—No. There was a wooden floor, with the usual leather covering, the hides being fastened with copper nails.

510. Was the electric light entirely outside?—Yes; formerly they had wooden insulators, but afterwards earthenware insulators were put in.

511. Was the house, so far as you know, a satisfactory house?—Yes, it was perfectly sound.

512. Have you seen a screw which was found in one of the machines after the explosion?—I have heard of it, but I have not seen it.

513. (To Captain Huleatt.) Have you seen that screw?—Yes.

514. Are you able to identify it?—Yes, it came from the outside part somewhere.

515. Then it could not have fallen into the press until the roof had been destroyed?—That is so. When the building was put up, in 1847, they used iron fastenings, but that is not the practice now.

516. Is it the case that there were other screws of the same character found after the accident?—Yes.

517. All of which came, I presume, from the same source, the roof?—Yes, we found one on the upper side of one of the tie beams, but that would be outside the match lining.

518. Would you say that there was nothing in the roof which could reasonably have been able to fall into the press?—No.

519. How are the roof boards inside fastened?—By copper nails.

520. (To Colonel Sale.) Are those copper nails at all liable to loosen and fall?—No, I have never heard of such a thing.

521. Have you considered the structure of the house since the accident, is there anything which should have been modified in order to prevent an accident of this kind?—The only thing that I can conceive possible, in the case of a wooden structure, is that owing to the chinks in the walls the dust from the outside may have effected a lodgment during the tempest that prevailed on the night of the explosion; but that is only a bare possibility.

522. When you have taken these houses to pieces from time to time, have you found that sort of thing between the lining and the wall?—Not to my knowledge.

523. (To Captain Huleatt.) Has such a thing come before you?—I have heard of powder dust working under the hides, but I cannot say in what house that happened.

524. Have you heard of any grit working into a house between the wall and the lining?—Yes, but probably that came from the wall.

525. But taking a wooden wall, that has not been actually found?—No, not to my knowledge.

(The Witness withdrew.)

Captain F. L. NATHAN, R.A., *examined.*

546. *The Chairman.* You are the Officer in charge of the danger buildings in the Royal Gunpowder Factory at Waltham Abbey, I believe?—Yes.

547. What are your duties?—I assist generally the Superintendent in the management and working of the factory.

526. A match-boarded house interposes two barriers to the grit in the wall?—Yes, match boarding inside, and weather boarding outside.

527. With regard to the house itself, I understand the wall at the south end is standing?—Yes.

528. Will it have to be reconstructed?—No.

529. In all other respects I understand the house was destroyed?—It was burned, and we had to pull it down afterwards.

530. Was there any explosive effect produced upon the foundations of the house?—I believe it was thought that there was a slight depression somewhere *here* [indicating the spot on the plan, about where Watts's body was found, see Appendix I.], but I could not see anything: the walls appear to be quite sound.

531. (To Colonel Sale.) Do you concur in that opinion?—Yes, the walls appear to me to be quite sound.

532. (To Captain Huleatt.) Are any of the other houses in the factory affected at all?—No.

533. Even to the extent of broken windows?—No, it was a very slight explosion, and even the trees near have not been much affected.

534. What was this passage covered with?—Felt.

535. Was that felt blown about at all while the fire was burning?—I was not there myself at that time, but I was told that it was blown about while the fire was burning.

536. (To Colonel Sale.) Are you favourable to this use of felt?—I should not put felt on a new construction.

537. If an explosion occurs, is there a reasonable fear of the felt becoming ignited, and being blown about, and injuring other buildings?—It would require a combination of all three effects, explosion of a very special sort, fire and wind, to do that. I think an ordinary explosion would not set fire to felt in the way it was set fire to in this accident.

538. What construction would you recommend?—Sheet zinc over boarding; it is better and more satisfactory from a structural point of view.

539. *Sir F. Abel.* (To Captain Huleatt.) Was there not one peculiar feature about this house, namely, that there was a considerable step up from the platform to the floor?—There was a small step from one platform to the other, but I cannot say about a step into the building itself.

540. *Colonel Majendie.* (To Colonel Sale.) Can you supply us with a plan of the house as it existed at the time of the explosion?—Yes, here is one [handing in the same, see Appendix I.].

541. *Colonel Lloyd.* (To Captain Huleatt.) The corridor passage outside this house is a closed one, I believe?—Yes.

542. What was it composed of?—Generally speaking, it was the same structure as the rest of the house; it certainly was copper-nailed, because I have just lately repaired it.

543. Was it covered with hides?—No, I think not.

544. There were no hides on the corridor?—No, I think not; I think the whole thing was clean to the boat.

545. (To Colonel Sale.) Was it match boarded as well as weather boarded?—It was not match boarded.

548. Are you intimate with all these buildings?—Yes.

549. How long have you held your present appointment?—Since October, 1892.

550. *Colonel Majendie.* Were you in your house at the time of the accident?—Yes.



551. How soon afterwards were you on the spot where the accident happened?—I got there about 5 minutes to 3, the accident having occurred about 20 minutes before.

552. Was there anything in the nature of an explosion after you arrived there?—There was one little pop, but nothing much.

553. When you got there, was this house fully alight and blazing?—Yes.

554. Had the injured men been recovered at that time?—Most of them had.

555. Did you see the man Watts at all?—Not until I saw him at the mortuary.

556. You do not know of your own knowledge where he was found?—No.

557. There was a little passage leading from the house, and then there was a little platform. Was this close boarded, or was it battened?—The boards ran lengthways with very small intervals. It was laid like all platforms—9-inch boards, with little openings of perhaps  $\frac{1}{2}$  inch between them.

558. Were the boards placed longitudinally?—I think they were crossways.

559. Was the floor of this house higher than the platform?—Yes.

560. How much higher?—About 6 inches.

561. Therefore, a man conveying a barrel along here to the house would have to raise it?—Yes, he would have to lift the barrel from the well to the floor of the house.

562. Have you seen the men bringing barrels along here?—Yes.

563. How do they do it?—They trundle them along until they get there (see Appendix I.), and then they lift the barrels to that part (see spot marked B<sup>1</sup> on the plan in Appendix I.) and then they trundle them along to the machines.

564. Was there any evidence as to an explosion of powder, or evidence of any action of powder at that part (i.e., the spot where Watts's body was found, see Appendix I.)?—When I examined the house it had suffered very much from fire, and all the flooring had gone completely from there. There is a gap between the wall and the brick pier on which the joists laid; I had not looked for any explosive effects there, but when you came down and suggested that the burnt debris that was there should be removed in order to see what was underneath, I had your suggestion carried out, but there was nothing at that spot which I could say had been caused by an explosion of powder.

565. *Sir F. Abel.* Have you ever seen any considerable quantity of E.X.E. powder exploded?—No.

566. *Colonel Majendie.* Were any portions of the barrel found?—I do not know.

567. Having regard to what you saw after the accident, would you say there had been a formidable explosion, or would you say that it was chiefly in the nature of a fire?—A very intense fire; the whole house was burnt.

568. Have you, from a mechanical point of view, made a special study of the machines?—No, but I have seen them working constantly.

569. Who is your engineer at Waltham Abbey?—Mr. Hodgson. He is called the chief engineer, a position corresponding to that of foreman millwright in the Arsenal.

570. Is he very familiar with the machines?—Yes.

571. Has he taken them to pieces?—They have been taken to pieces by the mechanic who had charge of them while running.

572. With regard to the general working of the place, how far do your duties require you to have a knowledge of that; did you go often to this building?—Yes, very frequently.

573. Is it part of your duty to go round the buildings from time to time, to see that the work is being properly carried on?—Yes.

574. Is it part of your duty to see that the men have proper clothing on?—Yes.

575. As a matter of fact, do you yourself ever search

the men, or require them to open their outer clothing, in order to see that there are no pockets in the inner clothing?—I have done so once or twice.

576. Did you, on any occasion, ever find them improperly dressed?—No.

577. Did you find any iron fastenings on their clothes?—No. The foreman of each house examines them, and reports to the chief foreman of gunpowder or to his assistant, who goes round every day.

578. Are they required to visit every house?—Yes.

579. Do they make a written report?—Yes, but anything incorrect would be reported at once.

580. Are those reports filed?—Yes, and they come to me.

581. Have you seen these particular men who were injured at work?—Yes.

582. How about the night work? Would there be the same amount of observation and supervision at night as there is in the day time?—Hardly that, because there are not so many people about, but there is a foreman in charge of the house.

583. Do you sometimes go round at night?—Yes, I was round at that house within a month of the accident, but I never found anything wrong there.

584. Were those same men always on at night?—No, they had one week night work and one week day work.

585. Have any complaints ever been made to you about the imperfect working of the machines, or of anything hazardous in the working of them?—No.

586. Do you think that anything about the machines was dangerous?—No.

587. *Sir F. Abel.* Have you been led to suppose that there was anything in this particular accident which had to do with the breaking of the plungers?—They often broke, I think.

588. *Colonel Majendie.* Is there any chance of the bearings becoming heated, or is there a good lubricating arrangement?—Yes, so far as I know, they were always working properly when I saw them.

589. *Sir F. Abel.* Whose duty was it to see that they were properly working?—The duty of the engineer.

590. *Colonel Majendie.* What orders were there with regard to repairing the machinery; supposing you found one of the men engaged in repairing the machines would you have at once understood that he was doing what he ought to do?—He should not certainly repair a machine; the only thing a man should do, with the foreman assisting, would be to pack up the plungers; plungers are liable to set up slightly and make big prisms; the men would then pack up the plunger by putting in a small piece of packing.

591. *Sir F. Abel.* Would they leave the mechanic to do that?—I am not quite certain about that, but they would, if necessary, pack up a plunger at night certainly; in the day time they might or might not do it. I do not think anything of that sort was going on at the time of the accident because all the machines were running, and they could not do anything of the kind while they were so running.

592. *Colonel Majendie.* I understood there were two electric hand lamps in the building?—Yes.

593. What lamps were they?—The Pitkin lamp.

594. Has the suggested alteration in regard to them been carried out?—Yes.

595. Were those lamps in use at the time of the accident?—I think it is most improbable; they would be used only by the foreman, and he told Mr. Findlay, before he died, that the machines were all working.

596. We understand those lamps were not used for illuminating the building, but only to enable them to light up some part of the machinery?—That is so.

597. Here are some rules which have been handed in as applicable to cam houses, can you throw any light upon them? For instance, Rule 2 says, "Great care must be taken to prevent any undue straining of the machine, as a neglect of proper precautions has led to serious accident"?—That means breaking plungers.

598. Would they call that a "serious accident" if a plunger breaks every day?—I cannot say.

599. Who drew up these rules?—General Noble, I think, but I am not responsible for them.

600. What does this mean: "It is most important that no grain beyond the proper quantity is in the 'bouches' when a pressing is commenced"; why is that, to prevent any increased density?—That probably refers to the charger, as it might mean putting in too large a charge.

601. Does it relate to any possible danger?—No, only to an undue strain that might be put upon the machine.

602. Are we to take it that the quantity in the cam house for each machine must never exceed 200 lbs., and that that relates to powder in any form, prisms or grains?—Yes.

603. And that "no gunpowder is to be kept in the house when not at work"?—Yes.

604. *Sir F. Abel.* "If there be any suspicion of undue straining due to any cause, the machine should be stopped," what does that mean; is it not possible that a man employed there might not know what "undue straining" was?—I think that refers merely to the machines getting dirty.

605. It is a regular practice, not merely an occasional practice, to wash out the machines at a particular period, is it not?—Yes, it depends upon how the machine is working, and the state of the pins.

606. Was the system of washing introduced since these regulations were drawn up?—It has always been the practice; I do not see how they can possibly work the machines unless they are washed out.

607. *Colonel Majendie.* Here is another thing which is rather uncertain, "No person, except those who are properly instructed and duly authorised, is at any time to meddle or interfere with the machinery," does that mean taking the machinery to pieces, or does it only refer to repairs?—I think it covers anything dealing with the machines.

608. *Sir F. Abel.* "Duly authorised"—would the ordinary workman consider himself "duly authorised"?—No, not unless he was working under the foreman, the ordinary man would not be allowed to touch the machines except under the foreman's orders.

609. *Colonel Majendie.* Was the mechanic here when these orders were drawn up?—I could not say.

610. I presume, as Danger Officer, your duty is to enforce these rules?—Yes.

611. Have you had any cases since you have been there of men being reported for smoking?—No.

612. Have you any reason to believe that anything of the sort goes on either night or day?—No.

613. There has been no case of men smoking in the shifting house, for instance?—No.

614. In the General Rules, it says: "Trousers of working dress are not to be turned up, as small stones and particles of grit are likely to be carried into the houses thereby," is that strictly enforced?—Yes.

615. Does that rule apply to the under trousers, as well as to the "lasting" trousers?—Yes.

616. It would be equally dangerous?—Yes.

617. I understand from you that pockets are prohibited in any part of the clothing whatever?—Yes.

618. *Sir F. Abel.* In No. 7 of the General Rules, it says: "The police have orders to search and examine from time to time persons taking anything in or out of the gates"—there is nothing said there about searching men personally?—They have orders to do it; the police do search a percentage.

619. *Colonel Majendie.* What is the percentage?—I think during the week they search about half the men of the factory, and they report having

620. Do you rely upon that searching for the exclusion of matches?—Mostly upon the exclusion of matches, and upon the knowledge that if they have matches they will be discharged. If a man tells a foreman he has no matches, and then the policeman comes on him, the man is reported and discharged

621. *Sir F. Abel.* With reference to the men who have been discharged since the accident, were any of them discharged not by the searching of the police, but by the foreman?—No.

622. The police examine only a percentage?—Yes, as the men come in in their ordinary clothes, whereas the foremen have to examine every man in his working clothes.

623. Then the matches might be in a man's clothes in the shifting room?—That is so.

624. *Colonel Majendie.* When they leave the shifting room, is there any barrier for the men to pass through?—No.

625. *The Chairman.* Do the men assist you in keeping this rule; do they ever report their colleagues for carelessness?—No; but I think if one man caught another smoking, he would report him for it. It might be possible in a small house, where there were, say, only two of them, to make some arrangement between themselves as to smoking, but in a house like that, where there were eight of them, under an old foreman, I do not think such a thing would have been done, eight men would not wink at another one smoking.

626. *Colonel Majendie.* No. 15 of the General Rules says: "Open powder barrels and charge tubs are always to be rolled on their chimes, and never dragged along the platforms, or the floors of houses or boats." You have seen men frequently bringing in the barrels, is that the way they work them in?—Yes, in all the houses.

627. Have you ever seen them drag them in?—No.

628. Would there be risk, in your judgment, if they dragged the powder?—Yes, if there were particles of grit on the platform.

629. With an open platform I suppose it is impossible to avoid grit in dry weather?—I think so, there is always a liability to that; but the platforms are always kept wet, and they were very wet that night.

630. Would it be wet inside the house?—No, but frequently it was very damp, because of the water wheels.

631. Were you satisfied with the construction of the house, or was there anything in it which you thought dangerous?—I think the house was satisfactory, it was match lined inside.

632. Was the match lining in good order?—Yes, there was an exit door behind every man, and I am surprised they did not all get out.

633. *The Chairman.* Which way do those doors open?—Outwards.

634. How are they fastened in case of wind?—By a rope and counterweight.

635. Were they ever locked at all?—No.

636. *Colonel Majendie.* Could you say whether these doors were secured in any way on that night?—I think not.

637. *Colonel Lloyd.* Have you any special personal knowledge of the effect of drawing a very heavy weight, like a barrel of gunpowder, over a surface where there is a certain amount of powder dust?—I have never seen that.

638. Would the effect of such a heavy weight being drawn over powder strewn upon the surface be sufficient to fire it?—I think decidedly not.

639. I am speaking of powder in a very fine state?—I think that would make no difference.

640. Then can you explain why this rule about dragging along the floors was introduced?—Because if there were grit present then it would be dangerous.

641. It would be more dangerous to break this rule if you had a mixture of powder and grit?—Yes, I think so.

642. Have you any knowledge of the effect of a blow upon very fine powder dust?—No.

643. Could you say whether it would be liable to be ignited?—It would depend upon what the circumstances were.

644. Say wood upon wood?—No, I think not.

645. Was the step going up into the cam house covered with hide?—Yes, the hide was lapped over,



646. Was the leather covering of the floor entirely destroyed by the fire?—Yes.

647. With reference to searching men at the gate, are pipes and tobacco allowed to be brought into the factory?—No, pipes would be the same as matches, but the men are allowed to have tobacco to chew.

648. Pipes are not mentioned in the rules?—No, those rules were drawn up by our predecessors and we have not altered them, but after our experience I think they are not quite what they should be.

649. *The Chairman.* I suppose it would be easier to roll a barrel than to pull it?—Yes.

650. So that it would be only the natural instinct of a man to roll it?—Yes.

651. *Colonel Lloyd.* It is quite possible in hoisting a barrel from the well to the floor of the house that there should be a blow or a certain amount of friction?—Yes.

652. *Colonel Majendie.* It would not be rolled up?—No, they had to get both hands and make a clean lift of it.

653. *Colonel Lloyd.* And in doing so a man might drop it on to the edge of the step?—Yes, but even then it would only be wood on leather.

654. *The Chairman.* Do you take men into the works without a character of some kind?—No, we always know something about them; of course the men are shifted about from one job to another.

655. But you are particular about putting certain men to certain jobs, are you not?—Yes, as a rule they are employed first of all as boatmen and afterwards they are shifted. Only reliable men are employed in the granulating house for instance.

656. *Sir F. Abel.* Have you formed any opinion in your own mind as to a possible cause of the accident?—No, I see no evidence upon which to arrive at a probably distinct cause; of course the lifting of a barrel of powder is a possible cause, but one cannot say for certain.

657. *Colonel Majendie.* Have you been able to form any confident opinion as to where the accident originated?—No, except that it originated in this house.

658. You cannot go any nearer than saying it was in the south part of the building?—No, that is according to the statements of the men about at the time.

659. Have you been able to form an opinion as to what portion of that house it was likely to have originated in?—No, but Clayden's statement that a flash came from his machine and from behind him, would, I think, tend to indicate that it came from his part of the house.

660. When men come in first what steps are taken to inform them as to the rules?—The rules are read over to them when they are engaged, and the rules of their particular house are read over to them by the foreman, I think, once a week. Of course the rules are posted up in the houses.

661. We understand that the men in the cam house would be required to observe two sets of rules?—Yes.

662. Are the general rules posted up in that house?—No.

663. Have the men a book of them in any form in their possession?—I think not, I think the book of rules was discontinued about the time the Ordnance Factory rules were introduced.

664. What are the Ordnance Factory rules?—They are rules which are generally applicable to all factories.

665. Not general danger rules?—No.

666. Did those general rules relate principally to accidents?—Yes.

667. How are the men kept informed about these Waltham rules; do you suppose the men occupy much of their time in reading them?—No.

668. Can they all read?—I cannot say.

669. You have paid some attention to the electric light in danger buildings, have you not?—That I have nothing to say to.

670. But if in your judgment it was dangerous, you

would have something to say to it, would you not?—We can only make suggestions as to altering it.

671. Is there, in your own knowledge, anything with regard to the electric light which was suspicious or dangerous?—No, because that house was re-wired on an improved system; I considered the installations satisfactory.

672. Then you would hardly include the electric light as one of the probable causes of the accident?—No; anything going wrong with the light would put the whole house in darkness, and I understand from what the men said before they died that there was plenty of light in the house.

673. Were there any utensils in the house made of glazed earthenware?—No.

674. Do you remember where the vessel was in which they deposited their oiled sponge clothes?—It was outside, and well clear of the building.

675. You were fully alive to that risk, and any departure from the regulations upon that point would be treated accordingly?—Yes.

676. I observe there is nothing in the rules about that?—No, but I have known of so many accidents in regard to them that I am particularly alive to the danger.

677. *Sir F. Abel.* The steel spanner of which we have heard a good deal was always lying about, was it not?—It was supposed to be kept in a cupboard in the shoe room.

678. As a matter of fact, we saw it lying on a bench or table in the house?—That was there for your inspection.

679. It was not supposed to be kept there so as to be available for the men?—No, it was only to be used by the foreman or under his direction, and not generally.

680. *Colonel Majendie.* Are you aware that any representations have been made with regard to this particular house, which have not been acted upon?—No.

681. Did you see Watts after his death?—Yes.

682. Was he injured by explosion as well as by fire?—As far as I could see I think his head showed some signs of being partly blown, but he was so very much charred.

683. None of the others were injured in that way, I believe?—No, the worst burns were probably caused by the prisms sticking on and burning.

684. With regard to the future, would you desire to see this arrangement reproduced, or some modification of it?—I think it would be desirable to isolate each machine, and to limit the number of persons.

685. What sort of number would you propose for each compartment; would two persons be enough?—Yes, plus the foreman.

686. There is always the man who serves the house coming and going?—Yes.

687. That would make four as the maximum in a compartment in any one time?—Yes.

688. Do you think you could work with that arrangement?—Yes, decidedly.

689. Do you think it would be easy, having regard to the character of this accident, and the non-explosive nature of the prisms and the stuff generally, to so isolate them that an accident, if it happened, would be reasonably confined to one compartment?—Yes.

690. Would you treat the building to some extent like an incorporating mill?—Yes.

691. *Sir F. Abel.* Would there be much accumulation of dust during this process?—No.

692. Was there any dust outside?—No.

693. Would you propose that there should be a similar free communication between the houses, that is with reference to the covered way?—No, I should bring a tram alongside and have a platform to each house, the brick wall projecting beyond the side walls of the houses.

694. *Colonel Majendie.* What are your particular reasons for a tram?—I like it, as I think for this particular class of house you can get the work better done. I do not think we could work a granulating, or a

dusting house with a tram because the quantities are so large, but I think you could work a cam house by that means, and also a moulding house. If you deal with small quantities, as in this case, then I think a tram is a good communication.

695. Is 200 lbs. the lowest limit for each machine?—I think you could work with less for a tram, it might be reduced to even a barrel.

696. The night of the accident was a stormy night, was there any lightning?—I did not observe any.

(*The Witness withdrew.*)

Mr. SKINNER, examined.

699. *The Chairman.* You are engaged in the powder factory, at Waltham Abbey, I believe?—Yes.

700. You were one of the gang at work in this cam house at the time of the explosion, were you not?—Yes.

701. And the only one of them uninjured?—Yes.

702. How long have you been working in the factory?—Between six and seven years.

703. *Colonel Majendie.* Have you been working for the whole of that time in the cam house?—No, only for 18 months in the cam house.

704. At the time of the accident where were you?—Here [pointing to the plan, see Appendix I.; the witness also showed where Bailey, Jennings, and Massey were].

705. Had you been in the other compartment at all?—Not since supper.

706. What time was that?—11 o'clock.

707. Where do you take your supper?—Sometimes in the shoe hole there, or in the dining room.

708. Where did you have your supper that night?—In the shoe hole.

709. Who else had it there?—Almost all of us.

710. *The Chairman.* How does the supper get there, is it brought from the dining room?—No, we bring it from our own homes.

711. *Colonel Majendie.* Is the supper heated in any way?—Not unless you take it from the dining room.

712. Is there any cooking required?—No.

713. Do you have any hot tea?—Yes.

714. Where do you make that?—In the dining room.

715. Was it cold or hot at the time of your supper?—Cold.

716. You did not bring any kettle from the dining room and make the tea there?—No.

717. Is that ever done?—No.

718. Did you all knock off work for a definite time?—Yes, when the light goes out, when they oil the engines.

719. At the time of the accident you were where you are shown on the plan?—Yes.

720. What did you first hear or see?—I heard a report in the other end.

721. You are sure it was from here [pointing to the south end of the house as shown on the plan, see Appendix I.]?—Yes.

722. Was it loud?—Yes, something like a 7-pr. when fired.

723. Did you guess what it was?—Yes, we guessed there was something up by the flash.

724. What did you do?—I went straight for this door, and got out as soon as I could. I heard a second explosion before I got out.

725. Did you hear any more reports?—Yes, when I got by the trees the whole thing seemed to go at once; I heard, however, no more than a rattling noise, because I was so near to it.

697. Was there a conductor on the house?—Yes. When I got down there on the morning of the accident I saw the Superintendent, and he told me to go at once and look after the injured men, and so I saw very little of what was going on.

698. *The Chairman.* Do you agree with others that the operation in which those men were engaged is not a very dangerous one?—We never regard it as dangerous; it is not to be compared with the granulating and the breaking-down work.

726. Did any of the other men get out at the same time as yourself?—I never saw anyone.

727. When did you next see any of your mates?—I came up as far as the water warder's house and told him our house was gone, that was about 30 yards from the building. As I was turning round I saw Carr coming along as best he could with his clothes on fire, I got some water and put him out. Afterwards I saw Massey.

728. Did you see Jennings?—No, I did not.

729. Did you see Bailey?—No.

730. Did you see the other men who had been there?—Only after they had been removed.

731. Did you see Watts?—No, I never saw him at all.

732. When they bring the barrels they bring them up here [pointing to the clean platform as shown on the plan, see Appendix I.], do they not?—Yes.

733. How do they bring them?—They roll them on the chine.

734. Is the floor of the house a little higher than the platform?—Yes, there is a step.

735. How did they get the barrel up the step?—They lift it up.

736. Is it hard work for a man to do that?—Not very, it is only a little lift.

737. Having got it in the house what do they do then?—Place it behind a machine, one to each machine.

738. Do they roll it there?—Yes.

739. Did you ever see them drag it?—No, never, it would be harder work.

740. Is it hard to move a barrel on to its side before they begin to roll it?—No, you can tilt it very easily.

741. Have you ever worked in this other part?—Yes.

742. Is the process just the same as in this part?—Yes, only they have to roll it on the chine past the water-wheel.

743. In working in this house did you always wear clean shoes?—Yes.

744. Where did you put on those clean shoes?—In the house here [pointing to shoe-room marked in the plan].

745. Were all the men, so far as you know, dressed in the proper clothing that night?—Yes.

746. Had you been working in this house before supper?—No, I only went to get my supper and I had to pass through that house to do so.

747. Did you see these men at work that night?—Yes, I believe I did once.

748. Did you talk to them while they were having their supper?—Yes.

749. Were they, so far as you could judge, sober, and right in all respects?—Yes.

750. Had you got your proper clothes, the lasting clothes, over your other clothes that night?—Yes.

751. So far as you saw, were the other men dressed in the same way?—Yes



752. When you go into the factory, you are first of all searched, or liable to be searched, by the police, are you not?—Yes.

753. Then you pass through the gates into the shifting house?—Yes.

754. What happens there?—We strip everything off, and put on our other clothes.

755. Are those other clothes, clothes with pockets sewn up or cut out?—Yes.

756. Who sees that you change in the shifting room?—Nobody; but the foreman has his rules to look at any man if he thinks proper.

757. Are you prepared to say that he looks at every man every day?—No, he does not.

758. You say that when men come to work the rules are read over to them?—Yes, a man is told everything before he comes, and they see him afterwards.

759. Have you ever been introduced to these rules at all [the witness was shown a copy of the cam-house rules]?—Yes.

760. Had you ever seen the general rules, have you a book with them in?—Yes.

761. When did you get that book?—About 12 or 18 months ago.

762. Has every man, so far as you know, a book?—Yes.

763. Have you ever had these rules read over to you?—I do not say that I have; they are posted up at the gates as you enter the works.

764. What do the books contain, do they contain these rules, and the rules of all the houses?—No, every man knows his own rules, and the general rules are posted up all over the factory.

765. Have you ever stopped to read them?—Yes, there are some posted up near the gate, and as we are waiting to go in we read them.

766. Are there any men who cannot read?—Yes.

767. Do they have the rules read to them from time to time?—Yes.

768. I presume all men know it is against the rules to smoke?—Yes.

769. Have you ever seen that done?—No, and if I had ever seen anybody doing such a thing, I should have reported him at once.

770. Even in the shifting house?—Yes.

771. Do you think the rule with regard to pockets is strictly observed?—Yes.

772. The rule is to have the pockets either sewn up or cut out?—Yes, you must do one or the other, we do not want pockets as we have nothing to carry about with us.

773. Have you ever seen men with matches in their possession in the factory?—No.

774. Have you known the machines do anything which you considered dangerous?—I have known the charges to become very troublesome when they got worn; that is caused by the plungers meeting, and when it happens the machines get damaged.

775. When a machine behaves in that way, what happens, what do you do?—I pull a lever out and stop the machine, the foreman comes and sees to it, and sees that all is right again before the lever is put in.

776. When that happens do they remove all the powder that is in the house?—Yes, if they are going to do anything in the way of screwing up bolts and things of that sort.

777. What does a man use for doing that?—A spanner.

778. Where is that kept, in the house?—No, in the shoe hole.

779. Is that spanner ever used by anybody except the mechanic?—Yes, if the bolts were working loose during the night we should screw them up, or the foreman would.

780. *Sir F. Abel.* Would you do it of your own accord?—No, not unless the foreman told me.

781. *Colonel Majendie.* Have you ever done it yourself?—Yes.

782. In that case the machine is not cleared of powder?—No, because it may be only the nut working loose.

783. Were the machines all working at the time of the explosion?—Yes, all four.

784. You can speak of these two, but how can you tell about the other two?—Because there is a tell-tale, so that we should not put in with the other machines.

785. What is the object of that?—So that there should not be too much strain on the wheel at any one time, and so that as near as possible we should all be pressing differently.

786. Then you know absolutely whether the machines are all working or not?—Yes.

787. And they were all working at the time of the explosion?—That is so.

788. Are the machines ever repaired while still moving?—No, you cannot do that.

789. Bailey was in the habit of using a little hand electric lamp, was he not?—Yes.

790. Was he using it at that time?—No; he was gauging the prisms at the table by me and talking to me.

791. Would that require a lamp?—No, because there were windows there with the electric light.

792. Was the house dusty with powder?—It would be dusty.

793. But, I presume, not so dusty as a granulating house?—No; we sweep up when we stop for supper, and again before leaving.

794. You did not require your respirator as in the granulating house?—No.

795. Then the dust was not floating in the air?—No, but there was dust about the machines, and we swept that up with a hand-brush.

796. When did you have the powder brought in last?—About ten minutes before the accident.

797. Who brought it in?—Watts and the other man.

798. Where they in their proper dress?—Yes, I think so.

799. Would they take their shoes off?—No.

800. The platform was clean?—Yes, they left their shoes in the front part of the boat.

801. Do you know at all where the spanner was that night?—I cannot say, I did not see it.

802. *Sir F. Abel.* Was there only one spanner for the four machines?—I think there are two in each end, a small one and a big one.

803. *Colonel Majendie.* Were there any tools connected with the working of the machines?—No, only one spanner for each machine in case it ran hot.

804. *Sir F. Abel.* Would they be steel spanners?—Yes, I should say they were.

805. And they were often there?—Yes.

806. Did the pins often run hot?—Yes, they always ran warm.

807. How warm; could you bear your hand upon them?—Yes.

808. Did they often break?—I never saw them break, but the plungers did.

809. Often?—We have had two break in one night, and perhaps two in one day, and then we might go a long time without any breaking.

810. What caused them to break?—The pressure on them.

811. Do you consider there was any risk in that?—No.

812. When they broke, did you stop the machine?—Yes, and it was reported to the foreman in the morning.

813. Would the powder be removed before the plunger was removed?—Yes. Sometimes the pins got warm, and then they bent.

814. *Colonel Majendie.* Have you ever known a pin so hot that you could not touch it?—No.

815. Are there any other defects about the machines besides those you have spoken of?—Yes, I have heard that the nuts which screw the bed of the machine have broken in two, but I have not seen it done. [The witness described the position of the nuts.]

816. One of the cam house rules is, "Great care must be taken to prevent any undue straining of the machine, as a neglect of proper precautions has led to serious accident." What do you understand that to mean?—That is to always look after a machine.

817. What part would be liable to strain?—I think if the pins were not properly cleared when you started a machine that would cause a strain.

818. What serious accidents have you known?—I have known a machine to be broken up and taken a week to repair.

819. Then do you think the rule means that sort of an accident and not an accident such as an explosion?—That is so, but even that might lead to a serious accident.

820. Here is another rule from the cam house rules, "It is most important that no grain beyond the proper quantity is in the bouches when a pressing is commenced," how do you know what the "proper quantity" is?—The charge shows that.

821. Can you prevent it?—Yes, we stop the machines.

822. Does that often happen?—No, not very often.

823. It says 200 lbs. for each machine, was that regulation observed?—Always, we had a very strict foreman.

824. That 200 lbs. includes prisms, as well, does it not?—Yes.

825. Another rule says, "No persons except those who are properly instructed and duly authorised are at any time to meddle or interfere with the machinery," but if the foreman tells you to do it, you do it?—Yes.

826. And under those circumstances you would be a "duly authorised" person?—Yes.

827. But you would not meddle with a machine unless the foreman told you?—That is so.

828. But if the foreman were in the other part of the house, what would happen?—We should go round and fetch him.

829. Would you stop the machine before calling the foreman?—Yes.

830. Had anything gone wrong that night with your machine?—Nothing that I know of.

831. Had anything gone wrong in the south end?—I think they had packed a plunger on No. 2 machine by putting in a little disc.

832. When did they do that?—Some time after supper, I think.

833. What makes you think that happened?—Because I saw the foreman come and fetch one of the washers.

834. Where did he keep them?—They were hung up beside each machine, and if he had not one at one end he went to the other for it.

835. What are they made of?—Copper.

836. Is that often done?—Yes. When the plungers are put on new they are bound to press the washers down.

837. Had those plungers been put on new?—Yes.

838. When you were in the place the last time before supper, was No. 2 machine working?—They were washing it out, and Bailey was with them.

839. In the general rules, it says: "Trousers of working dress are not to be turned up, as small stones and particles of grit are likely to be carried into the houses thereby." I presume you are familiar with that?—Yes.

840. Does that apply to the trousers you wear under the lasting trousers?—It applies to all trousers, if you have them too long, you must cut the bottoms off.

841. But you would not turn up the bottoms of the trousers you wore under the regulation trousers, would you?—No, because they would fit you before you put them on.

842. As a matter of practice, do the men, to any extent, look after one another; I mean, if you saw a man doing something which you thought was dangerous, would you report him?—Yes, because he would be endangering my life.

843. Has that been done from time to time?—Yes.

844. The other men would not try to screen a man, they would tell the foreman, would they not?—Yes, certainly.

845. Did you notice any lightning on the night of the accident?—I did not see any. When I came out

on to the platform there was no wind at all; it got up after the explosion took place.

846. Do you know whether any man had gone from here to the cook-house and back again at supper time?—I do not; I do not think they had. Some one has always to bring hot water to this house in order to wash the machines.

847. Who does that?—The boatman.

848. Where does he get the hot water?—From the hot-water tank at Group B mills.

849. There were no kettles there, I presume?—No.

850. How do you bring your tea?—In the ordinary quart can.

851. Is that a can that has been on the fire?—No; we always keep our cans clean.

852. What do you do with the cotton waste for the machines?—That lies on the machines, three pieces at each end.

853. When they are dirty, what do you do with them?—We do not have them all dirty at once, but they are taken away and we get a fresh supply at the end of every week.

854. Was there no box for them outside the house?—Yes.

855. When did you put them into the box?—Every Saturday.

856. *Sir F. Abel.* Where did you keep the dirty pieces?—On the machines. There was always a dirty piece, a half-dry piece, and a dry piece, at each end.

857. With regard to the machines, how often was the washing out done?—Every four racks.

858. Was that a regular rule?—Yes.

859. Were there any instances where you had to do that more frequently?—If we found the pins working badly when new, we should wash them more frequently.

860. Were you always careful to see that the water ran through?—Yes.

861. *Colonel Lloyd.* Have you ever seen a file used in this house, either by a fitter, or by anybody else?—No, I have never seen a file used. If a file were wanted, they would take the thing down to the shop.

862. They would not use a file in the house for the smallest thing?—No.

863. You have never seen one used?—No.

864. Who is responsible for the cleanliness of the floors, and for seeing that the platforms are kept wet?—The boatmen look after the platforms.

865. Does the same boatman attend to everything outdoors for one house?—Yes.

866. Who would be responsible for the cleanliness of this corridor?—The boatmen before they started to roll their powder in should have cleaned it.

867. Can you say whether they did that on the night in question?—I cannot say, because I did not go out.

868. But it should have been done?—Yes.

869. *The Chairman.* Was it raining that night?—No, not until after the explosion.

870. *Colonel Lloyd.* Is that corridor match-boarded as well as weather-boarded?—No, because there are doors here to enable them to see the wheels if they want to.

871. Would it be possible for grit to get into the corridor in any way by means of the wind?—Not unless it was blown from the top of the house.

872. But from the path?—There is a weatherboard on the side *here* about a foot high, and the same *here*; *this* is fastened in except when the boatmen are doing their work.

873. But in a high wind there would be nothing to prevent the dust from blowing in through the openings in the weatherboards?—It could get in in that way.

874. And grit could get in in that way?—Yes.

875. You are quite sure that passage was not match-boarded?—No, it was weather-boarded.

876. Was the floor leather-lined or was it an open floor?—It was boarded.

877. Were the boards set close together?—Yes, they fitted close like an ordinary wooden floor.

878. Was it fastened with copper nails?—Yes.

879. Do you know if that was a close wooden floor



whether it was not covered with hide, because men were in the habit of rolling barrels over it and it was an inside floor?—I cannot say.

880. Would it be the custom of the factory to leave a boarded floor like that?—Yes, all the houses are left like that.

881. Is it not the custom to cover over closed floors?—Yes, in all the houses, but in places like this they leave the bare boards.

882. Do you know of any regulation forbidding the bringing of tobacco pipes into the factory?—There is a regulation hanging up just as you enter the factory saying that smoking is strictly forbidden.

883. Is there any regulation against a man having a pipe in his possession; when a policeman asks you whether you have any matches, does that include pipes?—Yes.

884. Suppose a man had no matches but a pipe in his possession, would he be dismissed at once if he were found out?—Yes.

885. But there is nothing said about pipes in that regulation?—No.

886. A man may have tobacco?—Yes, for chewing.

887. *The Chairman.* I understand you got out of the door just immediately behind where you stood?—Yes.

888. Carr was opposite to you, was he not?—Yes.

889. Could he have got out as quickly as you did?—Yes, I think so, if it had flashed into his mind what had taken place at the other end. There were two reports at the other end.

890. *Colonel Lloyd.* What was the interval between them?—I cannot say.

891. *Sir F. Abel.* You had no doubt at once what had happened?—I saw the flash, because as I stood at my machine I could see into the passage.

892. Did you say anything to the other men as you went out?—I cannot say.

893. *Colonel Majendie.* Did you see the flash from the first explosion?—Yes, it shot into the passage here. [The witness explained the position of his machine, and his own position with regard to the passage, see Appendix I.]

(The Witness withdrew.)

TUESDAY, 30TH JANUARY, 1894.

Present.

Lord SANDHURST, *Chairman.*

Members.

Colonel V. D. MAJENDIE, C.B., Her Majesty's Chief Inspector of Explosives.  
Colonel F. T. LLOYD, C.B., R.A.

Mr. R. H. BRADE, *Secretary.*

Mr. HENRY CRAGGS, *examined.*

907. *The Chairman.* You are the Chief Inspector of the Metropolitan Police at Waltham Abbey, I believe?—Yes, and I have charge also of the police at the Royal Gunpowder Factory, and also at the Royal Small-Arms Factory, Enfield Lock.

908. Have you charge of the arrangements for searching the men at the gate?—Yes; I attend at the gate occasionally, and direct them to be searched.

894. Do you think you can tell us at all in what portion of the other house the explosion occurred; that is to say, in which corner, or side, or part of it?—I can only repeat what Clayden said when they took him out of the river. He said it was his machine that went.

895. Did he say that to you?—No.

896. If an explosion were to occur in this room you would probably be able to say whether it occurred in this corner, or that corner, but I understand that you cannot say in what part of that house it occurred?—That is so.

897. But you saw the flash immediately after the first explosion?—Yes, through this door here (see door marked H on plan, Appendix I.)

898. *The Chairman.* Do you think night-work is more dangerous than day-work?—I do not see that it is if you get a proper light.

899. *Sir F. Abel.* Are you satisfied with the light you get?—Yes, we get a very good light at night.

900. *Colonel Majendie.* Have any complaints been made by the men about their machines?—No, nothing more than the pins working badly when they are first put in.

901. Was there any uneasiness in your mind about the machines?—No.

902. Did you think them safe?—We have talked a little in the night, and what would be the consequences if anything happened, and we have talked about how things stood.

903. But you have never shaped your ideas into complaints?—No.

904. Did you ever think the work was especially dangerous; did you consider it as dangerous as the work in a granulating house or in a breaking-down house?—I think a breaking-down house is more dangerous because you might get something in the powder.

905. Have you known of anything being found in the powder in your house?—Only bits of wood that would chip off a barrel.

906. But no pieces of iron or anything of that sort?—No.

909. *Colonel Majendie.* How long have you held your present appointment?—Since May, 1892.

910. What are the gates leading into the factory?—The Main gate, the Refinery gate, and the Quinton Hill gate.

911. Is the practice, with regard to the searching, the same at each gate?—Yes.

912. Is there any way by which men can get into

the works other than by coming in at one of these gates?—No, the place is surrounded by water, except portions of Quinton Hill.

913. At what hours do they come in?—Various times, from 4 in the morning up to 8, and from 5 up to 9 at night.

914. And, may we take it, at whatever hour they come in, the practice with regard to searching is always the same?—Yes.

915. What is the practice?—The men are searched indiscriminately, but not every man. There is a sergeant at the main gate, and a constable at each of the other gates.

916. *The Chairman.* And are some members of your force continuously on duty?—Yes, changing every eight hours.

917. *Colonel Majendie.* Have they written orders?—They have printed instructions.

918. Can you give us a copy of them?—They are printed in the General Instruction Book of the police.

919. Can you say what they are?—The police have to patrol the factory to see that there are no trespassers, to see that proper precautions are taken against fire, to lock the gates, to ring the bell for the men to come in and go out, to see that there are no fires on the barges that come in, and if a constable has reason to suspect that any man has matches in his possession he is to search him.

920. "If he has reason to suspect," how would that arise?—Such a case has never arisen in the factory, but those are the instructions.

921. With regard to the constable at the gate, what are his instructions as to searching men?—It is left to the discretion of the police as to what men they should search.

922. But are there always some men searched at every entry?—Yes.

923. And at each gate?—Yes.

924. What proportion of the men are searched?—Here are two returns dealing with the number of men searched, and the articles found in the possession of some of them. (See Appendix No. IV.)

925. *The Chairman.* How many men are there employed altogether in these works?—About 800, I think.

926. *Colonel Majendie.* What does the searching consist of?—A man who is about to be searched would be asked whether he had any matches or pipes, and then the constable would feel his pockets, and also round the bottom of his waistcoat, to see that nothing had dropped out of the pockets in between the lining.

927. Supposing matches are found on a man?—He would not be allowed to enter the works. In such a case we generally send for the foreman, and then the man is directed to call again at 9 o'clock to see the superintendent, to whom I should make a report.

928. Have you ever found a man with matches in his possession coming out of the factory?—No, only going in.

929. Do men frequently admit they have matches before they are searched?—No, in almost every instance in which matches have been found upon a man he was in ignorance of the fact; he has probably been out the night before, and forgotten all about the matches being in his pocket. All those men appeared very much surprised when the matches were found on them.

930. Could you say, roughly, what proportion of the men are searched every day?—About one-tenth, I think.

931. Are there any occasions on which you find it necessary to institute a stricter search than the one you have referred to?—No.

932. Has the searching been conducted in exactly the same way since the accident of December last as it was previous to that time?—Yes, but there have been some men searched during the last few weeks. After the first match found after the accident the Superintendent requested us to search as many as we could.

933. Since the 1st January, 1894, five men appear to have been found with matches, but in the whole of the previous year only two men were found with

matches?—Yes, but those five all joined since the explosion, and we make it a practice to search new men more particularly than the older ones. One of those five was a boy about 15, who had a match and a cigarette in his pocket. It is almost second nature with an old man not to put a match in his pocket.

934. Have the men, before they come to the factory, received any instructions about not bringing matches with them?—Yes; when men apply at the main gate to see some of the officers in order to get taken on for work, the police tell them that they must be very careful not to take any matches in.

935. Do the police tell them that individually?—Yes.

936. Supposing a man has a pipe in his pocket, do you take that away?—Yes.

937. Do you consider that interrogations about matches include pipes?—"Have you any matches or pipes?" that is the question.

938. Do you ask that question of every person entering the works, whoever he may be?—Yes.

939. *The Chairman.* A man would not be dismissed for having a pipe, would he?—No, but he would be suspended for some days.

940. You say that one of the duties of the police is to look after the barges. What barges are those?—The coal barges.

941. Where do they come in?—Some at Quinton Hill, and some at the Refinery gate.

942. Are the men on those barges in the employ of the War Office?—No; they are contractors' men.

943. What sort of regulations are they under?—Precisely the same as other people.

944. Are they searched?—No, but they are asked.

945. Are they allowed to leave their barges at all when in the works?—Yes.

946. Do they?—Yes.

947. Then they are not really under the same control as the regular gunpowder hands?—No, not exactly.

948. But, taking the men employed on the barges, what is there to induce them to give up their matches if there are no consequences?—There is the notice outside.

949. It is an instruction, but it does not go beyond that?—That is so.

950. When they leave their barges they may wander about the works?—No. Perhaps they bring a barge in on a Saturday night and moor it alongside the wharf, and then go away till Monday.

951. May they wander into any of the powder buildings?—No; they are not allowed to wander about the factory at all.

952. Then, as we understand it, this practice of searching is applied to non-powder hands as well as to others?—Yes, to all men in the works department.

953. How high up in the scale does that go?—Are foremen subjected to anything of that sort?—Yes. The working foreman, the assistant master worker, is exempt. It does not follow that because a man is searched to-day that he will not be searched to-morrow; one of those men, Poulton, was searched the night previous to the night on which matches were found upon him, but in the first instance he had no matches. The police do not actually put their hands into the men's pockets.

954. Do you make them turn out their pockets?—No, a man is liable to be searched by his foreman after entering the factory.

955. *Colonel Majendie.* As we understand it, what you do is to prevent matches coming on to the factory area rather than preventing them going into powder buildings?—Yes.

956. *Colonel Lloyd.* While you have been at Waltham have you ever known of any case of smoking in the works?—No.

957. Have you known any cases of matches being picked up in the works?—I believe there have been two or three such cases, but I do not know that of my own knowledge.

958. *The Chairman.* Were they found near the barges?—Not very far from the barges, and some few weeks back one was found at Quinton Hill, near the gun-



cotton department, that is about 20 yards from where the barges come in.

959. *Colonel Lloyd.* Would there be any penalty on the contractors' men smoking in the works?—No.

960. Could such a man be had up in the police court?—The case would be reported to the Colonel Superintendent.

(*The Witness withdrew.*)

Mr. ALFRED BEALES, examined.

962. *The Chairman.* You are the master millman at Waltham Abbey, I believe?—Yes, I have to superintend all the incorporating mills under the master worker. I have to see that the work is properly carried out, that the charges run the proper time, to see that a proper moisture is maintained, and to keep an account of what each mill turns out. That is my work in the daytime. At night I have also to visit all the houses, to see that the work is being carried on properly. I visited No. 2 cam house, and after going to the north end to see that all was right, I passed on to the south end, and there I saw Bailey, the foreman. I asked him if everything was all right, and he said yes.

963. *Colonel Majendie.* As I understand it, you have not the control of the houses, but you have a duty of supervising them, by having to visit them at night?—Yes, to see that everything is all correct.

964. What do you mean by "all correct"?—I go to them and ask if everything is all right; if anything is wrong the foreman reports it to me, and I make out a detailed report for the master worker next morning.

965. If there were any deficiency in the supply of powder, or anything wrong with the machinery, would that be brought to your notice?—Yes.

966. Are you there every night?—I take weeks about, and I have done so for the last 30 years.

967. Did you know all the men employed in that cam house?—I have seen them there.

968. Were they a steady lot of men?—Yes; I have heard no complaints about them. The foreman I knew from boyhood; he was very steady, and he took a very great interest in his work.

969. When you went to this building, what was going on?—I went to the north end first, and all the machines were at work, and the men too. As I did not see Bailey there I went to the south end along the outside path.

970. What was going on in the south end?—The men were all at their work, and Bailey was standing with his back to the door. I asked him if all was correct, and he replied that everything was correct.

971. Were the men working in there in their proper clothing?—Yes, they all had their lasting suits on.

972. You did not look at their underclothing?—No, I did not.

973. Does that form part of your duty?—No; that would be the foreman's duty.

974. Did he carry out that duty always?—That I cannot say.

975. Have you ever seen him do it?—No, because his men changed in the shifting room, and he would do it there.

976. Were the men steady that night; was there any skylarking going on?—I have never seen any skylarking going on, and I believe Bailey would be the last man to allow anything of that kind.

977. Have you ever known any cases of smoking?—No, not in the factory.

978. Do you think it would be at all likely for any of the men to do that?—No.

961. But you cannot say that there is any punishment attaching to it?—No, I think the Colonel would write to the contractor and say that that man was not to come there again; but as a matter of fact those men are very careful, and they are so accustomed to come there that they hand over their pipes and matches before going in.

979. From your experience of the men, would you say that if any man attempted to do that sort of thing the other men would be likely to interfere with him, or do you think they would wink at it?—I do not think they would allow such a thing to be carried on.

980. Nor in the shifting room or dining room?—No, not in any part of the works whatever.

981. Do many of the men chew tobacco?—I think it is the practice with a great many of them.

982. You have been round this house very often at night, but have you ever been there when the men have been taking their meals?—I have been there when the machines were stopped for meals.

983. Where have you seen them taking their meals?—In the dining room, which is close by.

984. Have you ever seen them taking their meals in the shoe room?—No.

985. Do you know, as a matter of fact, whether they are in the habit of having their meals in the shoe room?—I believe in some houses they do that.

986. But take this particular house?—There is no place for them to sit down such as there is in the granulating house and the press house.

987. But taking such a place as the press house where they have a shoe room, would they bring their plates and kettles, and such like things there?—They would bring their tea made from the dining room.

988. How would they heat it?—They would make it hot in the dining room, and bring it up with them, and, perhaps, stand it on the steam pipe to keep warm.

989. Would they bring up the tea in the same vessel they had heated it in the dining room?—No.

990. So that there would be no chance in that way of fire being introduced in the house?—No.

991. When you have been going round, have any of the men made any complaints to you about anything being wrong with the machinery?—No, nothing further than the breaking down of a plunger. When I have asked Bailey, he has sometimes said that No. 1, 2, or 3 has stopped on account of a plunger breaking, and he has gone on with the next machine, if there has been a spare machine standing. In all these instances I have reported the case next morning.

992. Have any complaints been made to you about the pins or other parts of the machinery getting heated?—No.

993. Did Bailey keep you from conversing with the men?—No, never. I have asked Bailey before the men, and they could have said at once whether Bailey was correct or not.

994. Would Bailey have any interest in saying a thing was right when the thing was wrong?—No.

995. The condition of the machinery did not rest upon Bailey, I presume?—No.

996. Supposing the machinery broke down, who was responsible for that?—The chief engineer.

997. Have you ever seen any person repairing the machinery in that house?—No, nothing further than seeing Bailey altering the plungers.

998. What did he use to alter them with?—A spanner.

999. A steel spanner?—I cannot say whether it was steel or not. In those circumstances the machine would be stopped and washed out.

1000. Would all the powder be moved from the house, or from the other machines?—I think not.

1001. Were you on the scene of the explosion soon after it occurred?—Yes, I was near the mill head at the time, and in going round to where I thought the explosion was, I met a man who said that the cam house had exploded.

1002. Was he one of the injured men?—No. I said to him, "Go and call Jackson, the fireman, and then go and call Captain Nathan."

1003. Did you see any of the injured men at the house, or near the house?—When I got down there I went into the wash-up house, and most of them were there.

1004. Did you see Watts?—No, I saw the water-warder, and I understood from him that he had them all there except Bailey, who was in the river; and so I went to search for him.

1005. Did you see Watts at all?—No.

1006. When you were in the house, before the explosion, did you notice whether Bailey or any of the others were using the small hand electric lamps?—I did not see any of them.

1007. You have seen those lamps in use, I suppose?—Yes, I have one of them myself.

1008. When you saw the men in the house, after the explosion, were they in their regulation clothing, so far as they had any clothing at all?—Yes.

1009. I suppose you have often seen the powder brought into the house from the boat by the boatmen?—Yes, I have seen it rolled in.

1010. How?—On the chine.

1011. Have you ever seen them do anything else than roll it on the chine?—No, I have never seen it dragged along.

1012. Do you know the two boatmen, Hare and Watts?—I have seen them.

1013. Were they new hands, or were they men who had been there for some time?—I think they had been there only a short time, probably about 12 months.

1014. Had they full knowledge of the duties of boatmen?—Yes.

1015. Have you ever seen Watts take a barrel into the house?—Yes, I have been in the house when they have been rolling the barrels in.

1016. This particular man, Watts?—I cannot say for certain.

1017. But one or other of the two men?—Yes.

1018. And they were men who rolled the barrels across on their chines?—Yes.

1019. How long does it take you to get round the house at night?—About one and a-half or two hours.

1020. Do you go near to Quinton Hill?—No, I have nothing to do with the powder branch.

1021. Do you visit all the danger buildings?—Yes, I make it a point to always see the workmen there.

1022. Do you go into many of the other houses?—Yes, the press house, the granulating house, and the shifting house, besides the mills.

1023. And the glazing house?—Not very often.

1024. In looking over these houses have you seen anything which you consider will in any way throw light upon the cause of the accident?—No, I have looked over it, but I cannot throw any light upon it.

1025. Have you seen any explosion before?—Yes, I have seen several, but we are not so unfortunate in our works as we were. I think we have now a better system, and we run heavier charges, which are, I think, better than the old 60-lb. charge; we now run 75-lb. charges, and with a charge of that description the mill is very much better covered.

1026. *The Chairman.* What are the beds of those things?—Stang and chilled iron.

1027. *The Chairman.* How are they started from the outside, and self-

acting?—Yes, but the millman has to look after them, because we have to study the weather, which has a very great effect upon incorporating gunpowder. Sometimes we take as much as 18 to 20 pints of liquor away, and at another time, when the atmosphere is very dense, we should not take more than one-third of that quantity. So you see we have to study the thing pretty closely, so as to bring the powder off at a certain moisture.

1028. *Colonel Majendie.* Do your men go into the mills while they are working?—Yes.

1029. Then at that time they are exposed to a great risk?—Yes, but they are protected as much as possible.

1030. When did you last have a mill accident?—11th March, 1892; it exploded on a 60-lb. charge, after running about 7½ hours. I had never known a charge to explode after running so long before.

1031. *The Chairman.* When you are on night duty, are your visits to the various mills made at all sorts of hours?—Yes, the men never know when I am coming.

1032. Do you make any formal reports to say that you have been round and that all is right?—No, I do not make any report except in the case of something going wrong.

1033. *Colonel Lloyd.* Is it your custom to go round early in the morning, say between 2 and 5?—Yes, I occasionally go round the last thing before I shift my clothes, to see that everything is correct.

1034. It is a common thing for an incorporating mill to blow up, is it not?—Yes, but we have not had so many accidents lately.

1035. Has it ever, to your knowledge, been suggested that some other material than iron should be substituted for the beds of the incorporating mills, such, for instance, as phosphor-bronze?—Some years ago the engineer we had spoke to me about having rings put on the runners, but I think it was said they would not be hard enough, they would wear out too soon. The runners are faced up every now and again, so as to get smooth surfaces on them.

1036. *Colonel Majendie.* Are any of the new runners stone runners?—No, they have not been put in in my time.

1037. *Colonel Lloyd.* Have you known of any experiments being made to ascertain whether any other material could be used that would not be liable to strike sparks?—Not in our factory.

1038. Have you been a foreman?—Yes.

1039. When you were a foreman was it ever your habit to search the men?—Yes.

1040. When you searched them, did you anticipate finding anything, or did you merely do it as a matter of routine?—I hardly did that.

1041. Do you believe the searching is still done?—Yes.

1042. Are men allowed to bring pocket-knives into the factory?—To the wash-up house; but they have no other means of taking them except in their baskets.

1043. Do they require them for eating their dinners?—Yes, I think they would.

1044. Have you known of men eating their dinners in any other place than the dining room?—I have seen them in the shoe room.

1045. Did you ever see them use their knives there?—I cannot say that I have.

1046. Would it be against the rules to do so?—There is no rule to that effect. The rules state that men are cautioned against carrying knives when employed about the mills or powder houses.

1047. If a man put his knife into the front of his shirt, having no pockets, after his dinner, would any other workman see him do that?—The foreman would report him, no doubt.

1048. Have you ever known any such case?—No.

1049. Is any examination ever made of the shoes that the men wear, to ascertain whether they are serviceable and clean?—The master worker examines them, and passes them when they come in.

1050. Is there any periodical examination of them?



—I think not. Repaired shoes are not allowed in the powder vessels, but they are allowed for the mill men.

1051. Are the shoes ever cleaned, or brushed in any way?—We have mats laid down at every door.

1052. Is it anybody's duty to see that they are clean and free from grit?—Only the men themselves and the foremen in the house.

1053. Would there be any examination of the shoes; has it ever been suggested to you that the shoes might have grit on them?—No, I do not see how they could get grit on them, because they never go out of the house.

1054. The surfaces of the platforms are liable to have grit on them?—Yes, but they are constantly being washed down.

1055. Occasionally grit may get on?—Yes.

1056. And sharp grit may get into the soles of the shoes?—Yes.

(The Witness withdrew.)

Mr. WALTER J. CHITTENDEN, examined.

1062. *The Chairman.* You are a foreman in the Royal Gunpowder Factory, I believe?—Yes.

1063. How long have you held that appointment?—About seven years.

1064. What are your duties?—I am employed in the master worker's office. I see the men in, I keep the time and work books, I check the work done, and I occasionally visit the men at the powder houses.

1065. Have you a gang of men under you?—No, I am doing only general work.

1066. In what part of the factory are your particular duties; were you engaged in this cam house?—No, but I visited there occasionally to see if they were at their duties, and I also asked the foreman if everything was working all right.

1067. To whom are you responsible?—To the chief foreman, and through him to Mr. Findlay.

1068. *Colonel Majendie.* Does the chief foreman, Turnham, still go round?—Occasionally.

1069. Do you go round every day?—No, not every day.

1070. When do you go round?—When there is no one else to go. Mr. Findlay's son goes round when Turnham cannot go, and when Findlay does not go, then I go.

1071. Do you go round at night as well as in the day?—No, I have not been on night duty.

1072. What is the object of your going round?—To see that everything is working all right.

1073. Does that apply to the machinery?—To everything.

1074. Supposing there was too much powder in any house?—I should report that.

1075. Would you report men for not being properly dressed?—Yes.

1076. Do you have to do directly with the machinery?—The foreman would report such things to me.

1077. You do not examine the machinery yourself, do you?—Only just cursorily; I examine the prisms, and gauge them.

1078. Supposing a machine was broken, or was working badly, would it be the duty of the foreman to call your attention to that?—Yes.

1079. Has Bailey ever called your attention to anything wrong with the machines?—No, I had not gone down there since the Friday before the explosion, and then they were repairing the machines.

1080. What were they doing then?—The fitter was in the house putting a pin into No. 3 machine, and Nos. 4 and 5 were waiting for him to deal with; they had washed them out, and cleared the powder out of the house.

1057. Have you ever known men work without their shoes; has a man ever said that his feet are tender, and that he would work in his bare feet?—No.

1058. Would that be forbidden?—Yes, I think so; I think the foreman would not allow men to walk about the place in their bare feet. I would not allow such a thing. I should consider it against the regulations.

1059. *The Chairman.* When you go into the houses, do you yourself put on these slippers?—Yes.

1060. Would it not be a wise precaution to have the soles of these shoes inspected, to see whether they are free from grit?—Yes, I think if a foreman examined those shoes every morning it would be a good thing.

1061. Do you also wear lasting-cloth clothes when you go round the houses?—Yes.

1081. Had the pins worn, or were they broken?—A set of pins will last about three weeks, and then they begin to wear.

1082. Are they phosphor-bronze pins?—Yes, and when they are worn they make untrue prisms.

1083. Is it the practice to remove powder before any work is done in the way of repairing the machines?—Yes.

1084. Would you consider removing a pin as a repairing operation?—Yes, when they have the fitter in.

1085. Is there any work that Bailey might do without calling in the fitter?—He would put liners under the plungers when they are worn.

1086. In order to do that, what would he have to do, would he have to unscrew some portions of the machines?—Yes.

1087. Would he do that without calling in the fitter?—Yes; that is what we call adjusting the plungers.

1088. Would he clear the house of powder for that purpose?—I think not; he would wash the machine and the plunger, and he would clear the machine out.

1089. Were the machines liable at any time to have powder encrusted upon them at any part?—Not if they washed them out.

1090. Supposing they did not wash them out, where would there be any incrustation of powder?—In the pin-hole.

1091. Have you ever seen that happen?—No.

1092. Then it is merely your belief that it would happen?—I know it does happen; that is why they have to clear out the holes.

1093. What else would a foreman do to the machines?—He would alter the cross-heads, that would be for the purpose of increasing or decreasing the density.

1094. Would he require to use a spanner for that purpose?—Yes, a small spanner.

1095. Would he remove the powder?—No, I think not.

1096. Were the plungers and the pins often broken?—Yes, that was of frequent occurrence.

1097. Ought a fitter to do those repairs?—Yes.

1098. Have you known the foreman to do them without the fitter?—I believe he has occasionally to put in a pin, but not a plunger.

1099. Would he have to replace a broken pin?—Yes.

1100. Would he clear the house of powder for that purpose?—I cannot say, but I think not.

1101. Have you ever seen him do it?—No.

1102. I do not see any cam-house rule which says that the house is to be cleared of powder before any of the repairs are done?—I do not know of any printed rules about that.

1103. Do you not think it is desirable that there should be a regulation to that effect?—Perhaps it would be well, after the experience we have had.

1104. Are you aware that there have been accidents elsewhere due to repairing the machines while there was powder still in the house?—I believe that at Hay & Merrick's they had such a thing happen.

1105. Did you hear of one that happened at Kame's factory?—Yes.

1106. At any rate, we may take it that you think it is desirable that such a rule should be observed?—Yes; when a machine is under repair, the powder should be removed.

1107. Have you ever seen any of the men repairing the machines?—No.

1108. Whereabouts in the house were the spanners generally kept?—In a cupboard in the shoe-room.

1109. Do you know where the spanners were found after the accident?—No.

1110. Have they been found?—I think the screw-wrench has been found, but I do not where it was picked up.

1111. How soon after the accident were you on the spot?—In about half an hour.

1112. Did you see Watts?—Yes, I was there when he was found; in fact, I was searching for him.

1113. Had his body been moved at all when you saw it?—No. In the old mill there was a brick trench underneath the floor, and he was in there under a charred beam, with his head turned that way. [The witness explained the position of the trench, and pointed out that Watts was lying close by the machine, with his head towards the north, and his legs under the debris.] It seemed as though Watts had dropped into the trench.

1114. Was Watts dead when you found him?—Yes.

1115. Was he injured by explosion at all, or only by burning?—As far as I could see, his head was burned, you could see his brains; his arm and part of his trunk were burned away.

1116. Which arm?—The left, I think.

1117. Were the arm and the missing portion of the head on the same part of the body?—Both on that side.

1118. And you say you think it was the left side? Yes; I believe he was lying on his face when the fireman picked him out.

1119. Were his limbs otherwise uninjured?—No, he was burnt all over.

1120. Were his limbs all there?—I could not say, I did not assist to get him out.

1121. Did you then, or at any other time, see any portion of a barrel which might have contained powder?—There was some out here [pointing to a spot on the plan between the south end of the building and the head-stream. See Appendix I.]

1122. Did you find anything here [pointing to the spot where Watts's body was found. See Appendix I.]?—No, everything was burned there.

1123. With the exception of Watts, all the other men were out of the house when you got there, were they not?—Yes, I saw them in the shifting room.

1124. About how far was Watts from these two machines, would you say half way between the walls and the machines?—I think the trench was about 2 or 3 feet away from the machines.

1125. Can you say what the total distance is from the wall to the machine?—I cannot say for certain, but I think it is about 8 feet, and the trench would be rather more than half-way towards the machines.

1126. Did you see the trench before the explosion?—No.

1127. Did you know of its existence before that?—No.

1128. Did you ever see Watts, or anybody else, bringing powder into the house?—I cannot remember any particular man.

1129. Have you ever seen a man lift it up here [pointing to the spot marked B' on the plan. See Appendix I.]?—No.

1130. Had you anything to do with regard to the men's clothing?—No, the foreman would be responsible for that; Bailey would examine his men.

1131. He should examine them?—Yes, when they came to the house.

1132. And not in the shifting room?—No, we have a special man there.

1133. In going your rounds, did you ever say to any of the men: "Let me look at your underclothing, and see if you have any pockets"?—No.

1134. Have you ever seen anybody do that except Bailey?—No.

1135. Have you ever seen the men searched?—Yes; I have been searched by the foremen myself.

1136. In what house?—The mixing house.

1137. Who was the foreman?—King.

1138. How often did he search you, every day?—Yes, I think so.

1139. Does any man go out of the factory between the time of coming in in the morning and going out in the evening?—No, not the workmen.

1140. Would there be any opportunity for a man to change his clothes in the course of the day?—Of course there is an opportunity, but the foreman would not allow the man to go away. The policeman would not let a man out without a pass from his foreman.

1141. Would a man be able to go back to the shifting room and change his clothes?—Not without the foreman knowing, because the work would be delayed.

1142. But would he be able to do so during the meal time?—Yes, he could go then.

1143. And would a man have access to his clothes at that time?—Yes.

1144. If he felt cold, and had not got a waistcoat on, he could put one on there?—Yes, he could do so.

1145. And the foreman would not know of that, would he?—Not unless he missed the man.

1146. But a man must, in the course of the day from time to time, leave his work for a certain purpose?—Yes.

1147. Might it not be supposed that he was away for that purpose?—Yes.

1148. At any rate the door of the shifting room would be open to him?—Yes.

1149. Have you ever known of any smoking on the works at all?—No.

1150. Would the men stand one of their number smoking?—No.

1151. *The Chairman.* Are the men suspicious of one another in bringing things in?—No, of course they all go together to the shifting room, and they watch one another.

1152. *Colonel Majendie.* Have you ever known of any man attempting to smoke?—No.

1153. Not even in the shifting room, or in the meal room?—No.

1154. Has the question of allowing the men to smoke in the shifting room and some other parts of the works ever been considered or suggested at all?—No, not by the men, or by anyone else.

1155. Are you aware that the practice of private factories differs in that respect from yours?—I was not aware of that.

1156. Did you know all the men in that house, more or less?—Yes.

1157. Were they generally a steady and experienced lot of men?—Yes.

1158. There were none of them young hands, were there?—Rudd was the youngest; he had been there only about a month.

1159. Had Watts been employed there for some time?—Yes, he was an experienced boatman.

1160. Had he ever been punished, or found fault with?—No, he was discharged on reduction in April, but he was taken on again.

1161. Did you know Bailey well?—Yes, he was an apprentice with me.

1162. Was he steady?—Yes.

1163. What was his age?—About 32 when he died.

1164. How long had he been foreman?—For about five or six years; he was in charge of the cam machines



when they were first started in 1887, and he had had charge of that house since.

1165. Did you personally find Watts's body, or did somebody else find him and call your attention to him?—Jackson, the fireman, found him. I was walking towards the place when they found him.

(The Witness withdrew.)

Mr. EDWARD JACKSON, examined.

1168. *The Chairman.* You are the chief fireman at Waltham Abbey, I believe?—Yes.

1169. For how long have you held that appointment?—Seven years come July.

1170. What are your duties?—To see to all the fire appliances, and to see that the engines are in proper working order in case of fire.

1171. What staff have you?—Only two men in uniform, but I drill about 50 or 60 of the other men every month.

1172. *Colonel Majendie.* What are your duties in the daytime?—To see to the fire appliances, and to be ready to drill the men at all times.

1173. Then I understand you have nothing to do with the buildings, or the making of powder, or the boats, or the barges?—No.

1174. How soon after the accident were you on the scene?—In about ten minutes; I was at home when it happened.

1175. How far is your house from the works?—I live just by the Refinery gates, that is about five minutes' walk.

1176. What first directed your attention to the accident?—The ringing of my bell. When I got there the men had already got the engine out, but it was not actually working.

1177. Was the house fully alight at that time?—Yes, and burning with great violence.

1178. Did you hear anything in the nature of an explosion?—No, not till about 20 minutes after the fire had been burning, and then I heard a slight explosion.

1179. How soon afterwards were you able to make search for the bodies?—As soon as I possibly could; of course we do not wait for every spark to be out. The first intimation I had about Watts was from Bailey, when I pulled him out of the water in the tail stream. When I pulled him out I asked him if he were burned, and he said no, but I got him on to my back and carried him in the usual way to the dining room; he was quite numbed with the water. As we were taking him to the hospital I asked him if he had any idea of where Watts was last seen.

1180. Why did you ask him for Watts?—Because he was the only man missing at the time. Bailey told me that he last saw Watts rolling a barrel of powder close to the machines. I then went back from the hospital and made a search, and I found Watts here. [The witness pointed out the exact position on the plan.]

1181. Which way was his head lying?—Towards the north end.

1182. Did you notice what his injuries were?—Yes, part of his head was blown off and his brains were lying underneath.

1183. Were his limbs injured?—Yes, both arms were off, and both his feet, his side was burned away and his entrails looked as though they were roasted.

1184. Were the arms blown off?—I think they were burned off, and I should say the same with regard to his feet. He was lying in the trench and the beam was resting on the brick wall. I put my hands underneath the body and it dropped a little as I pulled the debris away.

1166. Do you think you can say positively that he had not been moved at all when you saw him?—Yes, I think so.

1167. Were they able to move him without taking the beam away?—Yes, I think the fireman said he got a piece of wood and moved him on that.

1185. Was he on his face?—Yes.

1186. As far as you can recollect which side of his head was injured?—It was the left side. [The witness then explained how, by means of a piece of wood, he was able to get the body out of the trench.]

1187. Did the man's head appear to you injured by the explosion?—Yes, I think so, because part of it was blown right off. I do not think it was a burn, because, if it had been, the brains would not have been mixed with the debris.

1188. Was there any other evidence of an explosion about the body?—Only in the case of the hand, I think, which was afterwards found.

1189. Where was it found?—Somewhere here [pointing to a spot marked L on the plan to the north end, between the house and the water, Appendix I.], but how it got there I cannot say.

1190. It might have been blown there?—Yes, the hand was almost as clean as mine is now.

1191. Were any other portions of the poor fellow found?—No, although I made a minute search.

1192. I understand that none of the other men who died had any portion of their bodies blown about?—No, they were burned.

1193. Had they all their regulation clothing on as far as they had any clothing at all?—I could not say, because I did not have much dealing with them until they were stripped.

1194. Did you find or see the remains of a barrel here [pointing to the spot where Watt's body was found, Appendix I.], any staves or anything of that sort?—Nothing at all.

1195. Had it all disappeared?—Everything was burned in the south end.

1196. Was the fire more violent in one place than in another?—No.

1197. How about the boat?—That was pretty well sunk, and the hood was blown off it.

1198. You say you heard nothing of the explosion?—No, I did not; I am a very light sleeper, and very easily awakened, but I did not hear any noise. The west wall is intact, but if there had been a very violent explosion that would not have been there, and the same with regard to the mills on the other side of the stream which have tanks over them. If there had been a very violent explosion it would have capsized those tanks.

1199. *The Chairman.* With regard to your not hearing, is your house in the same direction as the wind was blowing from?—Not exactly on that night.

1200. We understand there was a gale of wind?—It was not so severe at the time of the explosion as it was three hours before.

1201. *Colonel Majendie.* Was it raining at the time of the explosion?—Yes.

1202. Was there lightning?—I did not notice.

1203. Did you know Watts?—Yes.

1204. Was he a steady man?—Yes.

1205. Had you ever seen him doing his work?—No.

1206. Where did you get your water from?—From the river between the cam house and the magazines.

1207. Where was the engine kept?—Just by the dining-room.

1208. How long did it take you to extinguish the

fire?—It took me rather a long time, that is, comparing it with a good many fires I have been to. I had only a 5-inch pumping-engine.

1209. Is this the most powerful engine you have?—No, I have another near the cordite factory, and in various places I have hydrants with 145 lbs. pressure to the inch.

1210. What other manual engines have you besides this one in the factory?—I have 12 altogether; this one is for the Lower Island alone.

1211. Do you think you want a more powerful engine?—Yes.

1212. Have you made any application with regard to that?—Yes, before the accident. I have also applied that hydrants might be laid down to the Lower Island, but the authorities would not allow them, after the Superintendent using his best endeavours to get them.

1213. Would you rather have hydrants than an engine?—Yes, because two men can get a hydrant to work, whereas it takes 16 to work an engine.

1214. Could you get a good pressure for the hydrants here?—Yes, 145 lbs. to the inch.

1215. Is that the only part of the factory where you have asked for hydrants?—Yes.

1216. Have you had occasion to use your engines for any other accident since you have been at Waltham Abbey?—Yes, on the 22nd August, 1890, there was an explosion at No. 1 breaking-down house, and two men were blown to pieces.

1217. Have you used them for a mill accident?—Yes, at group E, which fired one Monday morning. We used the hydrants on the gun-cotton store at Quinton Hill, and it did not take us so long to deal with that as it did with these small buildings.

1218. *The Chairman.* Did you see any of the felt flying about from this blazing roof?—Yes, there was very little wind, but I told the men to go about the platforms with buckets of water.

1219. Is there any danger to be expected from these felt roofs in cases of fire when the wind is high?—Yes. Felt is very light, in a case of fire it is as light as cork.

1220. Would you like to see all this roof made of zinc?—Yes, I think that would be an improvement; a felt roof is not a proper thing in a place like this, especially as it perishes after 12 months' wear, and then requires a coat of tar.

1221. Supposing you had had these hydrants, and supposing the firemen had been on the spot, I suppose nothing could have saved the life of this poor man, Watts?—I think not; I think he went as soon as the first explosion happened, and I do not think he was far away from the explosion.

1222. Then you think the explosion took place in his own barrel, as far as you can form an opinion?—Yes, but of course it is only my idea. All these machines were working as perfect as anything could work, until the main beam fell across the waterwheel and that stopped them.

1223. I understand that some of the men were picked up from the water?—Yes.

1224. How did they keep themselves up; is the

(The Witness withdrew.)

Mr. A. W. BRACE, examined.

1246. *The Chairman.* You have been employed as a boatman at Waltham Abbey, I believe?—Yes, from April until August, and since then I have been employed in the cam house, on No. 2 machine.

1247. How long have you been in the factory altogether?—About 3½ years.

1248. *Colonel Majendie.* Did you work with Watts in the boat?—No.

water deep?—In some places it is 10 feet deep, but in places there is a bank; which has been caused by the constant washing of the water from the wheel, and they could stand on that. Bailey, I think, was washed across from the wheel on to the bank, and when he regained his consciousness he struck out for where he could see the fire and hear the noise of the engine. When I heard Bailey calling for help I called to my man named Brown to come and help me, and when I pulled Bailey out he was as sensible as I am.

1225. Was he very much burned?—Not very much.

1226. *Colonel Majendie.* What was it that killed him?—The water, I think, because mortification set in with him.

1227. Did Bailey say anything about Watts?—No. I spoke to Bailey several times after the accident.

1228. Did he say anything that would throw any light upon the question?—No.

1229. Did he make any suggestion with reference to it?—No, I asked him where he last saw Watts, and he told me.

1230. *Colonel Lloyd.* Did you see Rudd and Rudkin after the accident?—Yes, in the hospital.

1231. Were they burned more on one side than on other?—I could not say, they were burned about the face.

1232. Did they bear any signs of a violent explosion?—No.

1233. Did the fire absolutely burn itself out?—No, it was extinguished by me.

1234. Did you make any search for signs of fire all round the house?—Yes, and to see if I could find any more remains of Watts.

1235. Did you find the hand then?—No, it was found by some of the workmen.

1236. There was no doubt it was his hand?—That is so.

1237. When you were searching, did you find anything about which would give you any reason to believe that they had occasioned the explosion?—No.

1238. Were any tools found?—Yes, a spanner.

1239. Where was that found?—In the shoe house.

1240. Was the door of the shoe house burned down?—Not when I first arrived there, but parts of it got pretty well burned down by the end.

1241. Were any other tools found in the shoe house?—Not that I know of.

1242. Were any other tools or implements found in the building that was burned?—Nothing beyond the ordinary tools.

1243. Were they found where you would expect to find them?—Yes.

1244. Did you find the spanner?—No. They could not possibly use a spanner on those machines when they were working, and as a matter of fact, they were all working after the explosion.

1245. *Colonel Majendie.* Is there any work that could be done with a spanner on any of the standing parts of a machine?—No.

1249. Have you ever seen Watts during his work?—No.

1250. When you first became a boatman, who told you to act as such?—I had my orders from the master worker's office.

1251. But when you first became a boatman, did you get any instructions from anybody?—One boatman instructed another. The man I was working with was an older hand than myself.



1252. Was Bailey at the cam house when you first became a boatman there?—Yes, I had one week with him.

1253. During that time, I suppose you frequently delivered powder into both parts of the house?—Yes.

1254. I understand you lifted the powder out *here* [pointing to the end of the platform marked B on the plan, Appendix I.], and rolled the barrel along on its chine?—Yes.

1255. And then *here* [pointing to the spot marked B<sup>1</sup> on the plan, Appendix I.] there was a little step?—Yes, about 9 inches high.

1256. How did you get the barrel up?—I lifted it up, by putting one hand at the top and one hand at the bottom.

1257. Was there any difficulty in doing that?—No, it was the easiest way to do it.

1258. Which side did you trundle the barrel, did you trundle it to your right?—The left hand went first.

1259. When you got it *here* [pointing to the spot marked B<sup>1</sup> on the plan, Appendix I.], you deposited it on the bottom, and then lifted it up?—Yes.

1260. Did you then roll it on, or leave it there?—We rolled it on to the machine.

1261. How near?—Until we got directly behind the machine, where the man feeding the hopper stood.

1262. Were those barrels inconveniently heavy to move?—Not when you were used to them, though they were a little awkward to begin with.

1263. Who told you to roll the barrel on its chine when you first went to work?—It is in the rules.

1264. And you knew that rule about the open powder barrels and charge tubs, and observed it?—Yes.

1265. Have you ever seen a barrel dragged along?—No, it is easier to roll them.

1266. Is there any special difficulty in getting a barrel up this step?—No, none whatever.

1267. Is there any way by which a man could make it easier for himself?—No, the easiest way would be to lift it.

1268. When you were at that house and had rolled the barrel in, how would you stand with regard to the barrel?—I should lift it with the right hand at the bottom and the left hand at the top.

1269. With your left side towards the barrel?—Yes.

1270. Do you know whether other men rolled it on their right side?—I think they all rolled it as I rolled it.

1271. Trundling it with the right hand and guiding it with the left?—That is so.

1272. Have you ever seen a left-handed man work it?—No.

1273. You never saw Watts doing it?—No, he was in the opposite shift to me.

(The Witness withdrew.)

Mr. S. MUMFORD, examined.

1274. *The Chairman.* You are a workman in one of the powder houses in Waltham, I believe?—Yes.

1275. How long have you been there?—About two years.

1276. What house are you working in now?—No. 5 moulding house.

1277. *Colonel Majendie.* Where were you working at the time of the explosion?—In the cam house, on the day shift.

1278. When were you last in the house?—I came out at 6 o'clock on the Tuesday night as the accident occurred on the Wednesday morning.

1279. Whom did you work under?—Mr. Ephgrave.

1280. I suppose none of the men who were in the house at the time of the explosion were working with you?—No.

1281. Where did you work?—On No. 4 machine, in the north end.

1282. How long had you been working there?—Between seven and eight weeks.

1283. Had you worked all the time at this particular No. 4 machine?—I once went down to No. 1 machine, which is a spare machine in a separate place.

1284. Who was your mate on this No. 4 machine?—Up to Friday night a man named Argent, and then I had three different mates between the Friday night and the Tuesday night.

1285. With regard to this particular machine, had it been subjected to any repairs during the time you had been in the house?—New pins were put in on the Friday before the explosion.

1286. Who put them in?—I could not say, perhaps the fitter; they were put in in the daytime as we came in at night.

1287. Who usually put in the pins?—Johnson, the fitter.

1288. Have you see him do it?—No.

1289. Have you seen anybody else do it?—No.

1290. Have you seen the foreman do it?—No.

1291. Have you not done it yourself?—No, not put a pin in.

1292. Have you seen the fitter at work on the machines?—Yes.

1293. What work have you seen him doing?—Putting in new plungers and new bands for the cross-heads.

1294. When he did that were the machines cleared of powder?—Yes, they were always cleared out when that was done.

1295. Have you ever seen your foreman do any repairs to the machines?—Nothing except tightening the plungers and altering the top cross-heads if the powder was light or heavy.

1296. What did he use for tightening up the plungers?—A steel thing like a key; it is not like a spanner.

1297. Was there a spanner for each compartment?—There were three laid about in the house, a pair of pin pliers, and a shifting spanner for altering the nuts of the top cross-heads.

1298. But speaking for the men generally, did they use any tools other than the spanner, can you remember?—No, nothing except a little prober which is used for cleaning out the plunger. There was a piece of wood used for tapping the pins known as a tap-stick.

1299. What was the prober made of?—Metal.

1300. Any other tools?—No.

1301. Was there any work which you could do on the machines in regard to tightening them up or anything of that sort while they were running or working?—No.

1302. You always stop the machine?—Yes.

1303. Could it be done without stopping the machine?—Yes.

1304. Can you follow up the thing as it runs on full?—Yes, you can do the outside screw, but not the inside one.

1305. But you have never seen it done?—No.

1306. When the plungers were tightened were the machines cleared of powder?—No, there was very often powder in the bushes.

1307. When they were doing it and when you have done it?—Yes, I have done it when there was powder in the bushes.

1308. Did you consider you were acting in accordance with the regulations in doing that?—There was no regulation against it.

1309. Are you familiar with these regulations for the cam house, Lower Island, they were stuck up in the house, were they not?—Yes.

1310. Have they been read to you or by you?—They have never been read to me but I have read them.

1311. Have you ever read this one, "No persons, except those who are properly instructed and duly authorized, are at any time to meddle or interfere with the machinery," do you know that rule?—Yes.

1312. What does it mean?—That you are put there to work the machine, and if anything goes wrong you have to alter it, if a plunger goes wrong you have to put it right.

1313. I suppose the loosening of the plunger was a defect?—It was a strain upon it, I think.

1314. Would you get defective working in the machine if the plunger was loose?—Yes.

1315. And to rectify that you would tighten the plunger up?—Yes.

1316. Would that be consistent with rule 7 which says, "Any defect in the machinery, or any repairs required, should be at once reported to the master worker and to the foreman of machinery, Lower Island." In the cases where you have done such work have you made a report to the master worker?—We used to speak to the foreman.

1317. When you wanted to tighten up a plunger did you go to Ephgrave and say, "May I tighten up my plunger"?—No, but we almost always told him there was one loose.

1318. Have you had any experience with Nos. 2 and 3 machines?—I have worked with No. 3.

1319. Have you had the same difficulty with that in regard to tightening up the plungers?—Yes, you would tighten them up just the same.

1320. Have you ever had broken pins?—Yes, on No. 3 that happened; I think it was caused by packing up a double interval of prisms, and one flew back and got between the bush and the plunger and broke the pin.

1321. In that case who repaired the machine?—I cannot say, it was more than 12 months ago.

1322. Did you say anything to anybody about that?—No, I was only a fresh hand down there, and I left it to the older hands.

1323. Do you know anything about the No. 2 machine?—I have seen a great deal of trouble with it.

1324. What sort of trouble?—With the pins; we could not get the water down. After every four racks water is supposed to go down through the plunger, and down through the bottom crosshead, but it would not go down.

1325. Why?—Either the pins were too large, or the holes in the plunger were too small.

1326. Was there the same difficulty with the other machines?—When there were new pins put in all the machines worked very badly in that way.

1327. Had there been any alteration in the pins down to the day before the accident?—On that particular day in No. 4 they ran better; they had just begun to work right on that afternoon; it was on Friday night that they began to work bad.

1328. Can you tell us anything about the practice of the other machines, No. 5, for instance?—That same day the pins worked so badly that one of them pulled clean out of the block in which it was screwed; it pulled right out of the thread.

1329. Was that reported?—Yes, and the man went down to No. 1 machine, that was in the night, if I remember; the next day the machine had new pins put in.

1330. With regard to Nos. 2 and 3 machines, were you aware of anything going wrong with them?—Only the pins working bad.

1331. In what way; did they work hot?—They worked hot, and they will work hot if you cannot get water down.

1332. Have you known them to work hot?—Yes, on No. 2 machine.

1333. How hot?—So hot that the man had to have a wiper to handle them with.

1334. Have you at any time made any report about that?—No, it was not my place; I was not at work at that place.

1335. Did you think the heat of the pins was attended with danger?—I did not think they would get hot enough to cause an explosion.

1336. Did you see anything in this house to lead you to believe the machines were dangerous?—I never thought anything about it except on the Friday before, when it was spoken about.

1337. Who spoke about it?—Myself and Carr, who was working at the same end of the house on No. 5 machine, he said he should not be surprised if there was an accident with the pins.

1338. Did he convince you that there was any risk about them?—No, we were both talking about them.

1339. Did you say anything to the foreman about your fears?—We did not take much notice of it.

1340. But if you thought your life was imperilled would you not speak about it?—(The witness gave no answer.)

1341. Who had been working on the No. 2 machine up to the time of the explosion?—They had been chopped about, and then Brace was on it a little while.

1342. Did you hear him say anything about his machine?—He complained about the pins running bad.

1343. When did this conversation take place; did you talk about it in the shoe hole when you were changing?—I cannot exactly say where it was, but it has been spoken about.

1344. Was the foreman present when you were speaking about it?—He had heard the complaints, and I know he has worked hours by himself in trying to get the pins to go.

1345. By himself or with the fitter?—With us. If you could not get them to go there was a pair of pin pliers for unscrewing the nuts.

1346. That he did with you and other men?—Yes, on No. 4 machine.

1347. Was the fitter present when he was doing that?—No.

1348. Was the house cleared of powder?—No.

1349. Was the machine cleared of powder?—Yes, the hopper.

1350. Were the bushes clear?—Yes.

1351. But there might be some powder in No. 5 machine?—Yes.

1352. Was some force used to remedy those defects?—Yes, you must force them.

1353. Where did you take your meals?—Some in the shoe-hole and some in the dining room.

1354. Where did you heat your tea?—In the dining room.

1355. Did you bring the heated vessels down into the shoe-hole?—We had an ordinary quart can and the boiling water is kept up there.

1356. You did not put the can on the fire to boil the tea?—No.

1357. Did the men bring plates and things of that sort for their dinner?—Yes, they brought the plates and knives in their baskets.

1358. Did they do that in the shoe-hole?—They very rarely used a knife in the shoe-hole.

1359. Did you ever see a knife used there?—Yes.

1360. Have you ever seen them take their meals in the cam house itself?—Never.

1361. You are quite sure about that?—Yes.

1362. Have you ever seen any of the meal things taken into the house?—No.

1363. You had, I suppose, to wear lasting cloth clothes over your other clothes?—Yes, over our old clothes.

1364. Where did you keep your old clothes?—In a cupboard in the wash-up house.

1365. Has each man a cupboard?—No, there is one between two men.

1366. Who keeps the keys?—Some of them have neither locks nor keys.

1367. You were not allowed to have pockets in those clothes?—No, no pockets and no metal buttons.



1368. How did you keep your trousers up?—Some wore belts and some wore bone buttons.

1369. Who saw that you changed your things there?—There is a special man in charge of the wash-up house.

1370. How many men were there in the wash-up house at one time?—Sometimes as many as 200, in the large wash-up house.

1371. Would it be possible for the man in charge of the wash-up house to see that every man changed his clothes there?—He would walk up and down, but he could not see every man.

1372. Was there any arrangement by which the men had to pass him to show that they had changed; for instance, had they to pass through a turnstile or anything of that sort?—No.

1373. Whose place was it to inspect the men's clothes?—According to the rules, I think it is the foreman's place to read the rules and search the men once a-week.

1374. Have you been searched by the foreman?—Yes.

1375. Where did he search you, in the shifting house or in the powder house?—I have been searched in the shifting house, but not in the powder house.

1376. By Ephgrave, I suppose?—No, I have never been searched by him.

1377. How long had you been with him?—Eight weeks.

1378. And he never searched you during that time?—No.

1379. Nor anybody else?—No.

1380. If you had had a pocket in your clothes no one would have known it?—That is so.

1381. Do you say you think they ought to search men once a-week?—That is one of the old rules, I believe.

1382. Where would that be?—In the old rule book.

1383. Does every man get a copy of that book?—No, but I have seen them about in the different houses.

1384. Have you ever known men to have pockets in their underclothing?—No, but I believe one or two have been caught lately with pockets.

1385. In the danger buildings?—I cannot say that.

1386. Have you ever had pockets in your clothes?—No; I have had them either cut out or sewn up.

1387. Have you been searched by the other foremen you have been under?—Yes; if they do not actually search, they ask whether you have certain things.

1388. Do any of them do it every day?—No, I think that is not required.

1389. Or every week?—I have not been searched half-a-dozen times since I have been in the place.

1390. Who read the rules over to you when you first

came in?—Mr. Findlay only said that we were to have no pockets and no buttons.

1391. Have the general rules ever been read over to you?—I had the main ones read to me out of a book.

1392. You are not familiar with this particular set [showing witness a copy of the general rules]?—Only by seeing them posted up about the factory.

1393. Do the men study them carefully?—I cannot say.

1394. Do you study them yourself?—I have read them, but I cannot say that I have studied them.

1395. Have you ever known a case of smoking in the factory?—No.

1396. If you saw a man smoking what would you do?—Clear out of it pretty quick.

1397. Would you report it to anybody?—Yes.

1398. Then you did not think the danger in the machines was sufficiently great to induce you to "clear out"?—No.

1399. You did not make any representation that you thought your life was imperilled by the defective character of the machines, did you?—No.

1400. Did you think it was?—They were certainly working very bad, but we did not know what heat they would run to before exploding. In fact, when you are working with the machines in that house, it would not do to think about those things.

1401. *The Chairman.* You had three mates with you between the Friday and the Tuesday?—Yes, one was not with me for more than two hours. I think that was because one of the others lost two or three hours in the morning.

1402. *Colonel Lloyd.* When you say you have been searched only six times, does that include the searching by the police at the gate?—No, they very often search you; you do not go a week before being searched two or three times. Every morning they search so many.

1403. Did you ever know of a file being used in the house?—I saw one used out on the edge of the platform, that is the only place.

1404. What was that being used for?—I think the fitter was filing a charger which cut into the bed of the machine.

1405. You saw that done yourself, I presume?—Yes, the fitter was on one platform and I was on the other.

1406. Were any precautions taken to remove the filings afterwards?—The platforms were washed down.

1407. Are they continually being washed down?—Yes, several times a day.

1408. Have you ever known of a file being used inside the house, either by the foreman or the fitter?—No.

1409. Have you ever seen the fitter making any alterations in the machines when there was powder in the house?—No.

(The Witness withdrew.)

Mr. CYRIL WRAIGHTE, examined.

1410. *The Chairman.* You are employed as a workman in the Royal Gunpowder Factory at Waltham Abbey, I believe?—Yes, I am employed as a skilled workman, and I have been there since 1879. I have worked in almost every danger house in the place. About four years ago, I was working at No. 2 cam house on the Lower Island. I have also worked in No. 1 house.

1411. *Colonel Majendie.* Have you had any experience of these machines since you left No. 2 house?—No personal experience.

1412. You cannot, therefore, tell us anything about the recent condition and working of the machines?—I believe they were working in the same condition as when I left.

1413. How do you arrive at that conclusion?—By looking at the machines when I have been passing by.

1414. Was there anything in the working of the machines at the time you were there, which was other than satisfactory?—Yes, when the pins were put in new they fitted so tight in the plunger that you could not get any water down them; we then had to press the water by a squirt can under the bush block. Sometimes, too, the plungers and pins could not be washed out.

1415. Would there be powder there?—Yes, encrusted in them.

1416. How would those incrustations be got away in the long run?—Only by the wear.

1417. Was any attempt made to get them away; did you or anybody ever try to get them off?—Only by washing them, as the pins became worn the water would pass down between the plunger and the pins.

1418. You never saw any mechanical means employed to remove those incrustations, did you?—No, sometimes we would unscrew the pin fastened at the bottom and work it up and down in the plunger, but still we could not get the water to pass down these pins.

1419. You say "we," who would that be?—The workmen employed.

1420. And the foreman?—No, only the workmen.

1421. Did they do that because the foreman told them?—They did it as a practical thing.

1422. Was it according to regulations?—According to the master worker's orders.

1423. Written orders?—No, only verbal orders.

1424. Was that consistent with the written orders?—We have no written orders in regard to cleaning the machines.

1425. Have you any orders relating to the treatment of a machine when it becomes defective?—No.

1426. Are you sure of that?—Yes. As regards a broken plunger or the bearings getting scored, as the machine is unable to proceed, the matter is reported to the engineer, and the machine is stopped. Sometimes a plunger gets compressed, and sometimes the top plunger gets plugged with part of the film which gathers on the pins.

1427. Who would attend to those matters?—The workmen.

1428. I presume those would be defects?—Yes.

1429. Do you mean to say you have never seen any orders forbidding workmen to interfere?—None.

1430. Are you familiar with the orders posted up in the house?—Yes, but the only order posted up in the house says, "Visitors are forbidden to touch the machines."

1431. Are not these orders posted up in the house [handing witness a copy of the cam-house rules]? Have you ever seen those before?—No, I have not.

1432. You are quite sure of that?—Yes.

1433. Have they ever been read to you without your seeing them?—No.

1434. When you first entered the factory were any rules read to you?—I was supplied with a copy of what was called the old rule book, but those books have since been abolished; we had to give them up. In Mr. William Adams's time the rules had to be read to the men every week, at least, but that was discontinued when Mr. Findlay became master worker.

1435. Where are you working now?—In No. 1 press house.

1436. How long have you been working there?—Since 4th December.

1437. Are there any rules posted up there?—Yes, as to the quantity of powder in the house; they have been posted there since the time of Colonel Hay.

1438. Are these rules posted in the press-house [handing witness a copy of the press-house rules]?—Yes, I think those are the exact rules.

1439. Have you had an opportunity of visiting No. 2 cam-house lately?—No, I have been kept away from visiting the lower part of the works since the accident.

1440. But before the accident?—It is six months ago since I was there.

1441. Did you look into the house then?—Yes, I walked into both houses.

1442. And did not notice these cam-house rules?—No.

1443. You cannot say they were not there?—I could not swear they were not, but if they had been there I should probably have seen them. When I was in the cam-house the last time I passed a remark to the man who was there upon the dirty mats in the shoe place.

1444. Whereabouts was that?—There were four doors on the west side of No. 2 cam-house, and under those doors were four recesses, about 4 feet square each, and in those recesses there were dirty cocoanut mats.

[The witness, by means of the plan, pointed out the positions of these recesses and mats which were used by the visitors and Officers, and also the position of the step and mats used by the boatmen. See Appendix I.]

1445. Was that mat there when you were there?—Yes, and it was there right up to the time of the explosion.

1446. I thought you were not in this house?—No, but I asked the question.

1447. When, and of whom?—After the explosion, and of Mumford and some of the relieving gang.

1448. Where there any other steps?—Yes. [The witness pointed out where the other steps were, and said there were no mats there. See Appendix I.] Here there are some wooden platforms, which, I believe, should be covered with leather because of the rule that no gunpowder should be rolled wood to wood, but there was never any leather issued out for covering them.

1449. There would be no object in having cocoanut matting there, I suppose?—No, because that part was supposed to be clean.

1450. You say "supposed to be clean," have you any reason to suppose it was not clean?—Yes, the place was not covered, and a duck, or a fowl, or a cat, or anything might go over it.

1451. Where there any ducks, or cattle, or sheep, about the factory?—No.

1452. With regard to this platform [pointing to the outside platform shown on the plan, see Appendix I.], was it not kept clean and swept?—Yes, but the only light afforded to that platform was from here [see spot marked M on plan, Appendix I.].

1453. Therefore in the night time you could not see whether it was clean or not?—No.

1454. You are working in a danger building now, are you not?—Yes.

1455. What clothing are you working in?—We provide our own underclothing, and we have what they call a fire-proof smock and overalls.

1456. Do you change in the shifting house?—Yes.

1457. Who sees that you have not got any pockets in your underclothing?—That has been a neglected thing for some time past, but since this explosion the foremen have asked the men to let them search them, to undo their smocks and overalls, and to let them see what they have underneath.

1458. Do you say that was not generally done before this explosion?—That was not generally done before the explosion. The foreman would merely say, "I suppose your clothes are all right."

1459. How often?—They would sometimes run for two or three months without asking at all.

1460. Where would he say that?—In the shoe place, not in the shifting house.

1461. When you were working in this house, under whom did you work?—Adams.

1462. Did you ever work under Bailey?—Yes.

1463. What was Bailey's practice about searching?—He always seemed a very careful young man, and took a great interest in the work, though he was rather fidgety at times.

1464. Did he search you?—Yes, I have been searched by Bailey.

1465. It is four years ago since you worked in the house, and you have spoken of some defects in the machines at that time, but were there any defects which caused you to be apprehensive of accidents?—Yes, on one occasion I was working in No. 1 cam house, and one of the bottom plungers became compressed. It was our duty to loosen that plunger with a steel plunger spanner, and put what we term half-liners in. The pin was still in the plunger, and we put the half-liners in, one on each side, and while in the act of unscrewing the plunger the spanner slipped and struck the iron cylinder of the machine, and sparks flew from it.

1466. Was there any powder in the machine?—In the hopper, but none in the machine. Powder in the hopper, powder on the table, and powder in the barrel at the back.

1467. Did you report that?—Yes, to Samuel Adams,



the man in charge, and he turned round and told me he did not believe it. I then asked Mr. Turnham, chief foreman, to bring it before Mr. Findlay, so that Mr. Findlay could bring it before the Superintendent. I heard no more about it, but the next time I met Mr. Findlay I asked him if, when these steel spanners were used, he would make an order that all powder should be removed from the house. To that Mr. Findlay said it would involve too much time.

1468. Did you remain working there?—When the tools were going to be used, I took my dirty boots, put them on and walked away from the house. On another occasion I was in the south end, working at No. 3, when a man at No. 2 asked for the steel spanner to be passed to him, and just then Mr. Turnham entered the house. I said "Are you going to use the spanner," and he said, "Yes." I said, "I am going out," and I walked to the north end. Mr. Turnham followed me, and said, "What do you mean by going out of the cam house; if I were timid, like you, I would go out of the factory altogether." I asked him if he would give me an order, and he said "No." I then turned to No. 4 machine, and picked up two iron spanners, and asked him if they were proper things to be used in a powder house. He said I was there to do work, and not to dictate. Those spanners were lying about. If anyone had gone into No. 1 cam house they would have noticed some copper nails which I drove into the wood work on purpose to hang the spanners on.

1469. Could those spanners have been used while the machines were in motion?—Yes. One kind of spanner is for the plungers, but the other kind is made to fit the nuts of the studs which hold the bed to the cylinder. I have known those studs to break off short. Owing to the vibration of the machines the nuts get loose, and as the bottom plungers were descending I have known the spanners to be used to tighten the nuts.

1470. Were those steel spanners?—Yes, they were when I was there.

1471. Where did you take your meals?—When I was at the cam house we went to the dining-room.

1472. Did you ever take your meals in the cam house itself?—No.

1473. Or in the shoe room?—No.

1474. Do you ever see people having their meals in the cam house?—No.

1475. Why did you ultimately leave the cam house?—I think it was for complaining about the manner in which those steel tools were used. I was shifted to the breaking-down house, and while there I complained of the dangerous manner in which they carried on their work. Maynard was then shifted to the breaking-down house, and I took Maynard's place in the press house.

We had not in that house sufficient time to do the work properly, but we did six pressings instead of seven for a week, and then we went to Mr. Findlay, and while trying to explain the matter to him he said, "Wraighte, you are the ring-leader in this," and I was then suspended from the powder. Mr. Findlay then gave me an order to go to No. 3 breaking-down house, and when I got there I asked the foreman how he was working. I said, "Are you working with flaps up or down?" he said, "Up, by Mr. Findlay's orders." I said, "Are you working with the governors in the clutch?" and he said, "Out." I then said, "You must put the flaps down and the wheel in clutch, or I shall not start work." A man then came in and said he had orders to stay there and do double duty; I said, "Very well, I am going down to the office," and when I got there, I asked why I was picked out for the breaking-down house, as there was another man willing to work there, and Mr. Findlay knew I had a dislike to work there, on account of the conditions under which they were working. Mr. Turnham said Mr. Findlay was determined I should go there. I said, "I am willing to go there or to any other house if you will work according to regulations, but if not, then I said I am right to refuse." I afterwards went before Colonel Barker, who suspended me for what he called intimidation, and I was suspended from the black powder for six weeks, and until the arrival of General Noble. During the time I was suspended I was put to all the dirty work that could be found for me. I was even put to digging holes in the mud. With regard to the machines, I should like to say that when I was employed with the Nos. 1 and 2 cam machines, the pins became very much worn, and so affected the prisms [the witness described the inter-working of the pins and plungers and bush-blocks].

1475a. Did you call attention to that?—Yes, and if it were daytime the engineer would come and put another pin in.

1476. And at night?—If we could not find an old pin ourselves the machine would stop.

1477. Then the pins were sometimes put in in the night time by the men themselves, irrespective of the fitter?—Yes.

1478. You have seen them so put in?—Yes.

1479. And put them in yourself?—Yes.

NOTE.—The Witness subsequently, i.e., on 8th February, 1894, wrote to the Secretary, "I beg to state that H. Skinner, the only uninjured man, stated in the presence of J. Cole, S. Mumford, and myself that the steel spanner was fetched from the north end by one of the deceased workmen to the south end, to be used on No. 2 machine on the night of the explosion."

(The Witness withdrew.)

SATURDAY, 3RD FEBRUARY, 1894.

Present.

Lord SANDHURST, Chairman.

Members.

Sir F. A. ABEL, Bart., F.R.S.  
Colonel V. D. MAJENDIE, C.B., Her Majesty's  
Chief Inspector of Explosives.  
Colonel F. T. LLOYD, C.B., R.A.

Mr. R. H. BRADE, Secretary.

Mr. GEORGE EPHGRAVE, examined.

1480. The Chairman. You are a foreman in the factory at Waltham Abbey, I believe?—Yes, in the cam-house.

1481. For how long have you been a foreman?—I have been a foreman in the prism powder houses for about 12 years, but only the last 9 months in the cam-house.

1482. How long have you served in the factory altogether?—About 20 years.

1483. Have you worked on the day and night shifts?—Yes, my duties were opposite to those of Bailey.

1484. Colonel Majendie. When were you last on night duty, the week before the accident?—Yes.

1485. Was there any difference in the mode of carrying on the night duty as distinct from the day duty?—Not the slightest difference.

1486. In your opinion, can the work be regarded as being as satisfactory in the night as in the day?—Yes, if we get a good enough light.

1487. Was your light good?—Yes, especially since the last dynamo was put in.

1488. At the time of the accident, was it a good light?—Yes.

1489. Was it all external lighting?—Yes, from outside the windows; we also had two little hand-lamps.

1490. Were they much used?—No, except when we had to adjust a machine, and then I had one of the men to hold the lamp.

1491. You did not use the electric lamp for illuminating the buildings, but only for a definite purpose?—That is so.

1492. And you put it out directly the work was done?—Yes.

1493. Was there one of those lamps for each compartment?—Yes, and there was a third one for the boatman for fetching the water with.

1494. It was your duty, was it not, to search the men under your charge?—Yes, occasionally, and to read the rules to them.

1495. What did the searching consist of?—Turning their smocks up and seeing what sort of belts they had on, and also seeing that they had no iron buttons.

1496. Were there any reports made by you about that to anyone?—No, I made no reports. We all stripped together in the wash-up house, most of the men had been working for some years and they well knew what the penalty would be if anything was found on them.

1497. In the old clothing the pockets had to be either cut out or sewn up?—Yes.

1498. In the course of time that old clothing wore out, did it not?—Yes, and we had to get fresh.

1499. As a matter of safety, was the fresh clothing inspected and marked?—No, it was left to ourselves.

1500. And would you see that the substituted clothing had no pockets, or that the pockets had been sewn up?—Yes.

1501. Who looks to the sewing when it comes undone?—The men themselves; there are needles and cottons served out in the wash-up house and there are plenty of bone buttons from the lasting clothes. No iron buckles or buttons are allowed.

1502. Was the system of searching the same at night as in the day-time?—Yes, but we did not trouble much about it on night duty, we generally did the searching in the daytime, every Monday morning, and as we took turn and turn about for day and night duty that made the searching only once a fortnight. We used to strip, about 20 in one compartment, and we should round on a man who did not take his clothes off.

1503. Have you ever known them do that?—Yes; the men have complained to me and to others.

1504. During your 12 years' service as a foreman, I presume you have searched a good many men?—Yes.

1505. And in that time have you ever found men in the danger buildings with pockets in their clothing?—No.

1506. Have you ever found them with their pockets unsewn?—No, but I have found them with their pockets cut out.

1507. That you do not object to?—No.

1508. Were the machines working satisfactorily when you left on the evening before the accident?—Yes, I left them in good order.

1509. Have you found the pins sometimes break?—No, not break, but they would sometimes pull out from the bottom when the powder got clogged, and when they were new we had great difficulty in clearing them. We used hot water to try and clear them, but when they were new they fitted so perfectly in the bushes that the water would not go down. We had new pins on the Friday previous to the accident, but we had had two days and two nights with them, and so they were in good working order on the Tuesday night.

1510. Do the plungers go wrong sometimes?—Yes, they compress slightly, and go down. Sometimes, if the powder stands long in the magazine, it will get a little lumpy, and if you get lumps in the machine they will compress the bottom plunger. A plunger was broken on the Tuesday morning.

1511. Was that replaced?—Yes, and we started working about half-past 10.

1512. Who replaced it?—Johnson, the fitter.

1513. Were the repairs to the machine always done by Johnson?—Yes, but we packed the plungers ourselves, and tightened up the nuts.

1514. I understand you have spanners for the pur-



1515. Where were they kept?—In a drawer or in a cupboard.

1516. Would you tighten up the nuts?—If I was about I should do it. Every time we washed the machines it was the duty of the men to feel the top plunger and see if it was all right, because the action of the machines sometimes worked the screws loose. The screws generally wanted only half a turn, and if I happened to be down with No. 1 machine the man working in front of the machine being washed would give the screw half a turn.

1517. Could any work of that sort be done while the machine was actually in motion?—No, a man would be liable to get his arm smashed if he tried to do that.

1518. Is there any work about the machine which could be done with the spanner while the machine is actually running?—We might use the little spanner in adjusting the machine for the densities; we could do that, but we do not do it.

1519. Have the chargers, as a rule, worked satisfactorily?—They work with difficulty at times. The grain of the brown powder is harder than the E.X.E.; it is so hard that sometimes it cuts into the metal of the charger, and if it gets under it we have to take it away and clear it out.

1520. Have any complaints been made to you by the men with regard to the working of the machines?—Only about the pins; we talk about them amongst ourselves.

1521. Have they ever expressed any opinion about the machines being dangerous?—No.

1522. Have you had any such idea yourself?—No.

1523. Have you ever seen anything in the way of an accident with the machines?—Only when a machine has smashed up; that is, when a man has neglected to watch it.

1524. How would that happen?—If water gets on to the charger, the powder gets clogged, and stops it. The man's duty is to see that the charger comes over, and if the charger gets clogged on a damp day, and the prisms are not pushed off and the men are not watching, then the top plunger comes over and pigtailed the pins, and smashes up the whole thing.

1525. Does that often happen?—No; and since they have given men a week's holiday (that is, suspended them) we have had nothing of that sort. If anything happened, it would happen when they have pigtailed the pins, and when they are so hot that they cannot hold them.

1526. In order to ensure the satisfactory working of the machine, a man must keep his attention on the machine?—Yes; there is really no work about it, a child could do the work.

1527. *The Chairman.* You say the pins do run hot?—Yes; that is when they neglect to watch the machine, and when the pins get pigtailed.

1528. *Colonel Majendie.* Do any of the bearings at any time work hot?—No; a grain of powder sometimes gets into the bearing and (what we call) "mucks" it, and we have to get it out.

1529. Is there any place for putting the cotton waste into?—Yes, we have a cupboard for that.

1530. Where, in the shoe-hole?—We put the clean ones in the shoe-hole, but the dirty ones we put on the tables at the side. A man has six cloths for each machine.

1531. Is there any place outside in which to deposit the dirty ones?—Yes, it is a kind of a square tank outside the door.

1532. When is that used?—Every Saturday; we clear out the dirty wipers on Saturday.

1533. Where do the men have their meals in the night time?—Sometimes in the dining room, and sometimes in the shoe-hole. The lights go out sometimes at half past 10 and sometimes at 11, according to the work.

1534. Which was the commonest thing at night?—Half to the dining room and half to the shoe-hole.

1535. Is the shoe-hole clean?—Dirty, with big

boards about. [The witness then pointed out, on the plan, the position of the shoe-hole, which, he said, was not large enough to accommodate more than about five men at a time. In the shoe-hole were several movable boards, which the men used for standing on, in order to keep their shoes clean when coming out of the cam house. The witness also pointed out that on the shoe-hole side of the house there were clean mats, whereas on the other side of the house there were dirty mats.]

1536. A man coming in at *this* door (*i.e.*, one of those marked C, D, E, or F, on the plan, Appendix I.) would come with his dirty boots?—Yes; but those doors are only for the officers who would look in to see how we were going on, without changing their boots.

1537. What is the object of the clean mat for the shoe-hole?—I cannot say.

1538. When a man brought powder in *there*, (*i.e.*, at the spot marked B' on the plan, Appendix I.), was there any difficulty in lifting it up?—Yes.

1539. Did you ever see it slip and go back again?—I cannot say; I dare say it has happened, but those men were well up to their work, and they could easily hold the barrels.

1540. They were a good weight?—Yes, but there are others that are heavier; when the barrels go out they weigh 120 lb.

1541. Do you think it is a good arrangement to have this step *here*?—No, but I suppose that was there owing to the construction of the house.

1542. Have you, in the course of your experience, known of a case in which matches were found on a man in the factory?—Not with black clothes on. About 15 or 16 years ago some matches were found on a stoker named Powell; that was in Mr. Adams's time. Those matches were found in the man's coat pocket hanging in the stoke-hole, and the man was discharged. I have never known of anything explosive being found on any one in the powder house.

1543. Do you think men would "round" on one another if they caught a man with those things in his possession?—Yes, the men working with us know what is right.

1544. But even experienced men sometimes do imprudent things?—Yes.

1545. At any rate your point is that the other men would at once call attention to any such thing?—Yes. Bailey was a wonderfully cautious man about those things, and that was why some of the men did not like him.

1546. Had you known Bailey for some time?—Yes.

1547. And could you give him a good character?—Yes, he was a good steady chap.

1548. Have you ever known a case of smoking on the works?—No.

1549. Not in the dining room?—No, if such a thing happened it would be reported in a moment.

1550. We understand that someone comes round to these houses at night?—Yes, Collop comes round when my gang is on, and Beales comes round when Bailey's gang is on.

1551. How often do they come round at night?—Collop comes round about 9 o'clock at night, he looks in at the door and asks if it is all right, and we say "Yes," and then he goes away. He does not understand about the work; if a machine goes wrong we send for the engineer.

1552. Was anybody in the habit of coming round in the small hours of the morning, say, about 2 o'clock?—No, not often, except perhaps Beales would come down when he wanted to take a sample.

1553. Would Collop sometimes go round one way and sometimes another?—Yes, but he generally came about 9 o'clock.

1554. Has he ever come twice?—Yes, about 4 o'clock in the morning.

1555. Did Beales do the same?—Yes.

1556. You could not be sure when he had come once that he would not come again?—No.

1557. Would he come twice generally?—No, more often once.

1558. Would anybody else come round?—No, no one, except perhaps Captain Nathan.

1559. Did anybody ever, whilst they were at work, come and look at the men's clothes, that is, anybody other than yourself?—I believe Captain Nathan has done so. I heard that he once found a man with an iron hook on his clothes.

1560. Did you know the men who were killed?—Yes.

1561. Were they a good lot of men?—Yes, they had worked with me.

1562. Have you ever heard of a case in which sparks struck from the machinery in the house?—No, nothing beyond what I heard Wraighte said at the inquest.

1563. Did you hear of it at the time?—No.

1564. Would anything of that sort be talked about in the factory?—Yes; we have all laughed at the thing in the factory, you cannot get power enough on the spanners for that.

1565. But still, I presume, you would not dispute the fact that if you struck the two substances together you would get a spark?—Yes, if it were rough stuff, but not with a malleable iron thing like that.

1566. Have you in your own mind arrived at any conclusion as to the probable cause of the accident?—No, excepting that a match, or something combustible, got into the powder.

1567. How could that happen?—I do not know; there have been cases in which they have found matches in the powder. I believe they have a prism in the laboratory in which is shown a match cut in two.

1568. Have you formed any opinion as to where the accident originated?—According to the men who died, it originated at No. 2 machine, either in front or at the back; Clayden told me it was his machine, and he was in front of it at the time, and he was just in the act of taking the six prisms off to put on the rack. Directly he has packed them, he turns his head round for six more, so, if he was in the act of packing them, that machine was actually pressing; he said he saw the flash sideways.

1569. Was he turning to the left?—Yes. [The witness then showed, on the plan, the position of Clayden's table, and how Clayden was placed in reference to the machine and the lever. See Appendix I.]

1570. Did Clayden say the flash came from the machine?—No, he said he believed it was his machine.

1571. Did you ask him at all whether you saw anything occur *here* [pointing to the spot where Watts's body was found, see plan, Appendix I.]?—No, he said he got out of the door as soon as he could, and jumped into the water.

1572. He was looking to the north, and the flash came from the east?—Yes. *This* (*i.e.*, No. 2 machine) was the machine where a plunger was found broken, but we do not know where the thing fell from that was there, or whether it caused the breaking of the plunger.

1573. Was that house lined?—Yes. There was a band carried up to the ceiling for the purpose of bringing up the top blocks of the top plungers; that band ran on a pulley fixed in the lining of the ceiling, and over the pulley there were pieces of wood fastened so as to prevent anything falling down from the roof into the machine.

1574. Was that screw sufficient to cause the breaking of the plunger?—Yes, but I do not know how it came there.

1575. Did you visit the house after the accident?—Yes, about 6 in the morning, but I was not allowed to go in.

1576. You are not aware that other screws were found there?—No.

1577. The wood lining was all burned, was it not?—Yes.

1578. Under those circumstances, it would be easy enough for things to fall?—Yes.

1579. Have you ever known anything to fall under ordinary circumstances?—No, never.

1580. From your recollection of the arrangement of the roof, do you think it would be possible for anything to get through, would not the wood lining prevent anything from getting down at all?—I think so. There is no evidence to show where the screw or nail came from, it might have been in the powder, and when the man shot it into the hopper, it fell over the top.

1581. But if the screw were of the same nature as a number of others that were found in the house, the presumption would be, would it not, that it came from the roof?—Yes.

1582. Do you think it is more likely that the accident happened *there* than *here* [pointing to the plan, firstly, to the spot where Watts's body was found; and secondly, to the front of No. 2 machine where Clayden was. See Appendix I.]?—There was nothing *there*.

1583. Was not Watts rolling in a barrel?—Yes, but he could not get pace enough on the barrel, there was hardly room to move. [The witness then explained the positions of the different machines, and other articles in the house.] Watts could not get up even a snail's pace at *that* point.

1584. Do you know where Watts's body was found?—Yes.

1585. The other men came out at this door (marked J on plan, Appendix I.), did they not?—Yes, and so got the benefit of the boat. [The witness then explained how the explosions affected the different men, and showed that in rolling his barrel along Watts would be practically over the powder.]

1586. The presumption is that Rudd and Rudkin were at their machines?—Yes, they probably sat down and watched the chargers.

1587. Close to the door?—In front of the weights and near the door.

1588. Were they nearer the door than the weights?—Yes.

1589. That hardly agrees with their positions as marked on the plan?—That represents where they should be, but directly they fill the hopper they sit down *there* (see spots marked P<sub>2</sub> and P<sub>3</sub> on the plan, Appendix I.) and watch it.

1590. How long would the hoppers last?—About a quarter of an hour or 20 minutes.

1591. During that time they have nothing to do?—They have no laborious work to do, only to watch the machines. It is just as likely that those two men were sitting on the seats *here* [pointing to the spots marked P<sub>2</sub> and P<sub>3</sub> on the plan where the seats, or barrels, would be. See Appendix I.]

1592. And if a man were rolling in a barrel he would pass between them and the machine?—Yes.

1593. *The Chairman.* You say that when the pins are put in first they work very stiffly?—Yes.

1594. Have you ever seen any accident in consequence of that?—No, only by pulling out the block.

1595. How often are the cleaning cloths served out?—When a foreman wants any, he sends up to the stores for them; we can always get them when we want them.

1596. You say that the accident may have been caused by something in the powder?—Yes.

1597. Do you mean in the barrel or in the machine?—It got into the powder, and then into the machine.

1598. You mean in the powder in the machine, and not in the powder in the barrel?—I do not think it was caused by rolling the barrel along. It was a wet night; the platform is exposed to the weather, and a man rolling a barrel along there would get the bottom of it all wet. The reason why we do not have leather along there (*i.e.*, the platforms) is because leather would soak up the water, and keep the barrels always wet.

1599. Are the boats allowed to go alongside other



houses, the press house, for instance?—No, not while the men are working, nor at the granulating house.

1600. *Colonel Lloyd.* When you have been examining men in regard to their clothes, have you ever found such things as pocket-knives on them?—No.

1601. Would a man carry such a thing as a knife in his shirt-front?—Anything of that sort a man would carry in his basket.

1602. Would a man have a dinner-knife in the shoe room?—Yes.

1603. Would there be any objection to that?—No, so long as he kept it in his basket.

1604. Have you ever known of a knife being brought into the house?—No, only by the fitter.

1605. Do you see any objection to having the steel spanners cased in leather?—You could not case the working part, and when the plungers have been a week at work the action of the powder and the water makes the screws fit in so tight that no metal but steel would be of any use to move them.

1606. Could not you have a smaller spanner?—No, you could not get them in. There is a little slot of only about  $\frac{1}{2}$  inch to put the spanners in.

1607. And no addition of leverage would be of any use to you?—No.

1608. Do you see that any danger can arise from using steel spanners?—No, not unless you use them roughly. Wraighte says he used a spanner, but he had no business to do so. It is a foreman's work to pack a plunger; all a man has to do is to give a screw a half-turn, and he can do that with his thumb if he likes.

1609. Do you see any way in which the machines could be modified, so that a metal spanner could take the place of the present steel spanner?—No, I do not see how that can be done, because the powder and the water together will corrode anything.

1610. Did you see Rudd and Rudkin before they died?—Yes.

1611. Could they give you any account of what happened?—No, neither of them; they simply said they saw a flash, and nothing more. Clayden was the only man who could give a clear idea of it. It was such a low ceiling that it was like an oven when the fire went.

1612. *Colonel Majendie.* Did Rudd and Rudkin say where they were when they saw the flash?—No, but they talked of being in the house and Jennings, too. He might have escaped a lot, if he had had presence of mind, but instead of going to the door where Skinner went, he went round to the other side and fell over the shafting, and he got the benefit of the boat.

1613. *Colonel Lloyd.* When Watts brought his barrel of powder into the house, were there any other barrels of powder already there?—No, because we do not call for any more barrels until we want them; sometimes we let the hoppers go three parts empty. We blow a whistle when we want them to bring us up some powder.

1614. How many barrels of powder would a powder boat have in it when full?—About eight. On Monday mornings they bring up nine barrels, that is allowing one for the hoppers, but after that they bring up only eight.

1615. Do you say there has been no accumulation of dirty cloths?—Yes, because if Captain Nathan finds any dirty cloths in the house on a Saturday, we get into a bother.

1616. How many would you use in a week?—Three dozen.

1617. Then there might be three dozen about on Saturday?—Yes.

1618. *Colonel Majendie.* They would not be all oily ones, would they?—No, only eight of them. They are put outside in an open tank, and rain and water and anything can come upon them; the tanks are half full of water sometimes.

1619. How is the powder put into the hoppers?—By means of a bowl, they empty about three parts of

the barrel till there is only about 20 lb. left in it, and then they take the barrel in their hands and tip the rest into the hopper.

1620. There is no searcher above the hopper, is there?—No, but the chargers are made so sensitive that if a bit of wood, only half an inch, gets in there it stops the charger, and so will a bunch of hairs from a hand brush.

1621. Then could a screw get through?—No.

1622. A little particle of a grit might?—Yes, or even a piece of a screw.

1623. With reference to these cam-house rules, are they the only ones posted up in the cam-house?—Yes, but every man has a book of general rules, and every house has its own rules. In the old thick rule books I think you will now find the general rules.

1624. You read the rules to the men?—Yes, once a fortnight, on Monday mornings.

1625. One of the cam-house rules says, "When starting afresh the machine should first be run several times with the hopper empty, and stopped, so that the chargers are over the dead plate," is that to see that the machine is working all right?—That means after a machine has been repaired. When we go away we leave the hoppers empty and the machines thoroughly clean; the men who come next set the machines running and they oil up; then they stop and fill up the hopper and then they carry out this rule: "After any stoppage of the press from whatever cause, the grain in the charging rings should be partly taken out before the machine is again started." We put a spud in and clear the thing out, so that the first prisms are wasters.

1626. No. 2 of the cam-house rules says, "Great care must be taken to prevent any undue straining of the machine, as a neglect of proper precautions has led to a serious accident." Do you know of any such accident?—No. If we find any undue straining, we at once send for the fitter; and we can tell in a moment if there is anything wrong with the machines. There are only four bearings, and if we hear any groans we can tell at once that something is wrong.

1627. In another part of the same rule it says this: "It is most important that no grain beyond the proper quantity is in the bouches when a pressing is commenced." Why is that, to prevent the prisms turning out badly?—When starting a machine, a man shooting powder in is likely to put more powder in the bushes than is needed. If you shoot it in, the powder will settle down, and in that way we get prisms that are too heavy.

1628. *Colonel Lloyd.* I presume you are perfectly familiar with the general rules?—Yes.

1629. Would you wish to see any additions made to those rules with a view to greater safety or to taking additional precautions?—No, except with regard to the machines; I should like to see some improvements made in them.

1630. Do you think improvements could be made?—Yes.

1631. *The Chairman.* Do you mean in the rules, or in the machines?—In the machines. I do not know anything about the rules, except that they should be more strictly enforced, and the men better looked after, and so on. We make no reports. I think the machines might be improved so that we could work easier with them; the pins are all the trouble. I think if the hole through the bottom block to which the plunger is fastened were made bigger there would be more likelihood of our being able to get at that part. We can clear a plunger, because there is a hole at the side; but the bottom block is more in a half-moon fashion where the pin runs through, and we cannot get at that part.

1632. Do you think there might be an accumulation of powder there that would not be cleared out?—That is where it does accumulate.

1633. Was a copy of these rules posted up in the cam-house when you were last on duty?—Yes, a copy at each end, and a copy in No. 1 house.

1634. *Colonel Majendie.* I understand from you that a man must carefully watch a machine, as the charger may not work?—That is so.

1635. Would there be any possibility of so arranging it that it would go all right even if a man were not looking at it at all; that is to say, is it possible to arrange for something to do what a man now

does?—No, I think not; I think you must have one man in front and one behind the machine, so that if anything goes wrong, one of them can stop the machine. The men now do it all right; though, sometimes, perhaps, one may not watch it, and the machines themselves sometimes work beautifully, and then perhaps a charger will hang up just once.

(The Witness withdrew.)

Mr. JOHNSON, examined.

1636. *The Chairman.* You are employed as a mechanic at Waltham, I believe?—Yes.

1637. How long have you been there?—I am now in my tenth year.

1638. *Colonel Majendie.* Are you on at night?—No, only in the daytime.

1639. Are you often called by the foreman to repair the machines?—Yes.

1640. Had you attended frequently to the machines in the house that exploded?—Usually every day for one or the other of them.

1641. Had you been called there the day before the accident?—Yes, to put new plungers into No. 2 machine.

1642. What had happened to the plungers?—They had broken; that did not happen more on one machine than on the other, it was much the same all the way through.

1643. Were the plungers of the same character as they had always been?—Yes.

1644. Had you put new pins into that machine repeatedly?—Yes; that machine had been working with its pins about eight days, the other machines had had theirs in only six days.

1645. Do the pins work badly at first?—Yes, always at first.

1646. Supposing a plunger broke in a machine at night, what would happen?—They would stop the machine till the morning.

1647. Have you ever known a plunger replaced by the workpeople?—Never.

1648. You are quite sure of that?—Yes, because I have no plungers in the house.

1649. Have you ever known a machine work with a broken plunger?—No.

1650. Can they replace the pins?—No, I never leave any in the house.

1651. Where do you keep the pins?—In my workshop.

1652. Is that locked up at night?—Yes, as I go away.

1653. Is there anybody else in your position?—Only my foreman.

1654. Where was the key on the night of the explosion?—In Mr. Barker's office.

1655. Do you know that?—Yes, I found it there the next morning.

1656. Was there any work of the nature of repairs which could be done by the workpeople without calling you?—Yes, a plunger might compress, and then they would pack a liner underneath.

1657. Would they have to use a spanner to do that?—Some call it a spanner, but I call it a screw-driver, it is like an ordinary wood screw, in the trade we always call it a screw-driver.

1658. Is it not of steel?—Yes, because metal will not stand the strain.

1659. The spanners were kept in the house, were they not?—They were supposed to be kept in a cupboard in the shoe-hole.

1660. Were they to be used by the men?—Yes, because possibly a screw might get a little bit loose in the working; they would do that themselves so as to save the time and trouble of coming for me.

1661. Was there any other work which they could, or did, do on the machine?—There was just the alteration of the top cross-heads.

1662. What implements would they use for that purpose?—A spanner and a short piece of gun-metal, and a gun-metal hammer.

1663. Would they stop the machine for that?—Yes.

1664. Was there any work they could do on the machine without stopping it?—No.

1665. Have you had any complaints made to you as to the working of these machines?—No, no more one day than another.

1666. Speaking generally, were they machines people were suspicious about?—No.

1667. Were you?—No, I thought them safe. On the morning after the explosion if those machines had been cleaned out with water, I would not have minded putting powder into them.

1668. Was there not a screw found in one of the bushes?—Yes, on No. 2 machine, I saw it after it was taken out of the machine.

1669. Was it at all distorted by pressure?—Very little indeed.

1670. What sort of screw was it?—I saw it only in Captain Nathan's hands; it looked like a copper screw.

1671. Are you able to say it was not a screw from some part of the machine?—Yes; it came from somewhere out of the roof.

1672. Could the screw get from the roof while the wood lining was in the house?—No; the machines were working after the explosion occurred.

1673. Then the screw must have followed the explosion, and could not have caused the explosion?—That is so.

1674. With regard to the machines generally, you appear to consider them safe machines when they are working all right?—Yes.

1675. Do you think they are dangerously liable not to work all right?—No.

1676. Have you seen any reasons for recommending any alterations in the machines?—I have seen no cause for anything of that sort.

1677. Could anything be done to prevent the plungers getting broken, and the pins working unsatisfactorily?—No, because these are due to the pressure.

1678. You do not think they are owing to constructive defects in the machines?—No.

1679. What happens is inevitable from the nature of the work?—Yes.

1680. Could any alteration be made so as to render them less frequent?—No, we have tried all ways, but it is an impossibility.

1681. We have been told that if the man who works the machine does not attend carefully to it a charger



may not work properly, and not push the prisms forward enough?—If the charger should happen to hang up then they must stop the machine.

1682. Supposing a man's attention is called to something else, and the charger hung up, would that cause an accident?—I do not see how it can that way; a charger cannot come over a second time, because the cam that works the charger would stop it.

1683. Is there any liability to the plungers coming down and cutting the prisms which have not been pushed away, or not removed?—If a charger should not come over, and if the man did not notice it, the plungers would probably cut the prism in two.

1684. That has been done?—Yes, but it has not caused an explosion.

1685. You would not think that a nice thing to happen to a prism, would you?—It has happened three or four times without an accident; I put that down to the men's own fault.

1686. That is all productive of defective working in the machine?—Those machines would stop at once.

1687. Yes, when they discovered it; but the mischief might be done in producing this defective working?—We have had that happen many times.

1688. Bent pins are of course objectionable, and bad working?—Yes, and if they become pig-tailed, or if a charger happens to hang up, they send for me at once. I say, "What is the matter?" and they say, "The charger will not work." They empty the hopper, and take the charger off, and then if there is any fault in it I detect it. If a charger does not shove off the prisms properly that might be because the bottom plunger is rough on the face, then I have the house cleared of powder, and I replace the plunger, and they start work again.

1689. The cases of pig-tailing of the pins have been due to the non-attention of the men, have they not?—Yes.

1690. Is there means of so modifying the machine that you could be independent of the attention of the men; that is, could you make the machines do automatically what the men now do?—That was being done at the time this happened. A man may fill his hopper and walk away; the machines have now been altered to meet that.

1691. A man's attention is not constantly necessary?—Since last May, two of those machines have been repaired, and so a man could fill up his hopper and walk right away till more powder was required.

1692. *Colonel Lloyd.* That was not the case with No. 2, was it?—Yes, those two machines were repaired since No. 2.

1693. *Colonel Majendie.* Then those defects have not occurred since those particular alterations were carried out?—No, the machines were taken right out of the house when they were altered.

1694. *Colonel Lloyd.* Then those defects could not occur again as the machines are?—That is so.

1695. That is the case with all the machines now?—Yes, but No. 1 has not been under thorough repair yet; that has not been taken off its foundations, and is not right like those four were. The bearings in No. 1 are not so tight as in the others; it works automatically, and is a little out of adjustment, but nothing to make any complaints of.

1696. *Colonel Majendie.* When you carried out any repairs or alterations in the machines, was the whole house cleared of powder?—Yes, whichever end I was in.

1697. And all the other machines were cleared of powder?—Yes, washed down.

1698. And the prisms taken away?—Yes.

1699. When the men were putting liners in or making the slight alterations you have mentioned, would they clear the house?—Not for putting in a metal liner, I think; when they take the screws out the place is all swimming with water where the screws are.

1700. But there would be powder about in other parts of the house?—Yes.

1701. In the cam-house rules it says, "Great care

must be taken to prevent any undue straining of the machine, as a neglect of proper precautions has led to serious accident." Can you tell us what that means, what accident?—I think that is only like a caution. I do not think there have been accidents with the machines.

1702. Do you think it would be right if it said, "Might lead to serious accident"?—It would look better that way.

1703. How long have you been familiar with those machines?—Ever since they have been there—seven years.

1704. "When starting afresh, the machine should first be run several times with the hopper empty, and stopped so that the chargers are over the dead plate," that is to see that the machine works correctly?—Yes.

1705. "It is most important that no grain beyond the proper quantity is in the bouches when a pressing is commenced"?—That is to see that they get no extra charges in.

1706. "Any defect in the machinery, or any repairs required, should be at once reported to the master worker, and to the foreman of machinery, Lower Island." Is it reported to two persons?—Yes.

1707. What is your relationship to Mr. Barker?—I am his charge hand.

1708. Suppose a pin becomes bent, or a plunger becomes broken, who would be told of it first?—I should be.

1709. And would you tell the foreman of machinery?—They would send for me; I should repair the machine, and then tell Mr. Barker.

1710. Were there any written reports of such matters?—No, I reported verbally only.

1711. "No persons, except those who are properly instructed and duly authorized, are at any time to meddle with or interfere with the machinery." What would that mean; that the workpeople are not to do anything with the machines?—I think that refers to visitors. Visitors might accidentally start a machine when it was not in working order.

1712. You do not think that forbids a man to put a new liner under a plunger?—I do not read it in that way.

1713. What does "undue straining" mean?—I think that is alluding to the chargers.

1714. What would you call an "undue strain," if you heard a machine making a noise is it to be stopped at once?—When the chargers get a little bit dirty at the bottom it takes a little more to shove them back and that might strain; they are supposed then to stop a machine and report. I think that refers only to the chargers.

1715. "Before work is commenced the foreman on duty will examine all the machinery and see that everything is clear before starting the machine." Is that the foreman of the house?—Yes, before any powder is put into the machine the foreman is to see that it is all right.

1716. Have you, since the accident, and, in consequence of any enquiries made, seen anything which would lead you to believe that the accident was due to the machine?—No.

1717. Do you believe it was due to the machines?—No, I believe they were quite clear. I have taken those machines to pieces, and found them the same as if they were in working order, bar that plunger being broken where the screw came down.

1718. And that you believe happened after the accident?—Yes.

1719. *Colonel Lloyd.* What makes you think that this screw fell in after the accident?—Because the roof fell in.

1720. But, apart from that, are there any mechanical reasons which lead you to believe the plunger broke afterwards?—Yes, from the way in which it was compressed, it seems as though it was pretty hot at the time it was compressed.

1721. Where was the screw found?—On the top of the bush block, the machine was working at the

time. [The witness then showed, by means of a diagram, where the screw was found.]

1722. Was the screw bent or sheared?—Sheared, it was in two parts and one part seemed as though it had been in the bush.

1723. You think it was the screw getting in that broke the plunger?—Yes.

(The Witness withdrew.)

Mr. FINDLAY, re-examined.

1725. *Colonel Majendie.* I want, in the first place, to ask you some questions with regard to the cam-house rules. No. 2 says, "Great care must be taken to prevent any undue straining of the machine, as a neglect of proper precautions has led to serious accident," what accident does that refer to?—I do not know.

1726. Who prepared these rules?—General Noble.

1727. If there had been any serious accident, you would have known of it, would you not?—Yes, but I am not aware of any serious accident.

1728. "Care must be taken to prevent any undue straining of the machine," what does that mean?—That there must not be a greater quantity of powder put into the bouche than the charger will allow, if the chargers are allowed to stand under the hoppers for any length of time we get a little more powder than we require.

1729. *Sir F. Abel.* Do you think that conveys to the men sufficient information as to what the term "strain" might mean?—Yes, I think so.

1730. *Colonel Majendie.* "If there be any suspicion of undue straining due to any cause, the machine should be stopped, and the circumstances reported to the master worker or the foreman of machinery at the Lower Island," would it be the duty of the foreman at the house to make that report?—Yes.

1731. To one or the other?—He would go to the engineer, and not wait for me.

1732. That is to effect a repair, but apart from the circumstance of repairs, he has to make a report, has he not, under this rule, that there has been a necessity for calling in the engineer?—Yes.

1733. Is that in writing?—No, only a verbal report.

1734. There is no written record kept of repairs and alterations?—No.

1735. "No persons except those who are properly instructed and duly authorized, are at any time to meddle or interfere with the machinery," what does that mean?—That no one is to interfere with the machinery except the foreman or the engineer.

1736. "Any defect in the machinery, or any repairs required, should be at once reported to the master worker and to the foreman of machinery, Lower Island," would it be in accordance with that rule for the workpeople to do any alterations or repairs to the machinery?—The workpeople do none, only the foreman.

1737. Are you quite sure of that?—Yes, I am quite sure, and they had no right to do so.

1738. If we have been informed that they do it, do you say that the information is incorrect?—I say that they should not, except, perhaps, in the case of packing a plunger when the foreman might stand by, and a man might turn the screw.

1739. That would be the only thing which you think should be done by the men?—Yes.

1740. *Sir F. Abel.* Packing a plunger is a frequent operation, is it not?—Yes.

1724. *The Chairman.* I understand you were on duty in the day time, but suppose anything went wrong with the machines at night, what was done then?—They would stop the machine, for repairs the next morning; there is always a spare machine in No. 1 house.

1741. Suppose the foreman were away taking the density, is it not likely that the men would do it?—I do not believe they would do it.

1742. *Colonel Lloyd.* Supposing the foreman told them to do it?—If that was so, I think, a man might, but I doubt a foreman telling him, if he did it is unbeknown to me, and I have never heard of it. I should say it would be improper for a workman to do that.

1743. *Colonel Majendie.* With regard to the removal of powder, would a machine be cleared for packing a plunger?—No, not for that; you only want to turn a screw, not take it out.

1744. In the case of alterations, such as replacing plungers and putting in new pins, and carrying out repairs of that sort, would you remove the powder either from the house or part of the house where the work was carried on?—Yes.

1745. With regard to searching the men to see that they have no pockets in their clothing, and no iron fastenings, do you think that the regulations would be satisfied with the foreman looking at the men, say, once a week?—I think it should be every day, there are instructions for it.

1746. Written instructions?—No, verbal, they are asked every day if they have done it, I have asked them myself.

1747. Then if a foreman went for a week, or a fortnight, he would not be observing what you understand to be the regulations upon the point?—That is so.

1748. We understand that there is some sort of recess in the floor, near the doors, for dirty mats, but that near the shoe room was a clean mat?—That would be a dirty mat too.

1749. Do you consider the shoe room is clean or dirty?—Dirty.

1750. Is it the case that there are certain boards the men walk upon in order to keep their shoes clean?—Yes, in every shoe room.

1751. Are those boards fixed or removeable?—All removeable.

1752. Where would they generally be?—Here [the witness explained where the boards would be, and also pointed out the mats where the Officers of the factory would go into the cam house].

1753. With regard to the implements that were habitually present in the house, can you tell us exactly what they were; we have heard of a steel spanner more than once?—That is almost a screw-driver, it is hardly a spanner. [The witness explained by means of a diagram, see Appendix III., the shape of the implement.]

1754. Is it the only steel tool used in connection with the machines?—There is another spanner, a metal one, for altering the cross-heads.

1755. The alteration of the cross-heads would have to be effected by the workpeople, I presume?—No, by the foreman.

1756. Would it be contrary to what you under-



stand by the rules if they did?—Yes; no one should interfere with the cross-heads except the foreman.

1757. Then those two tools were intended to be used by the foreman without calling in the mechanic?—Yes.

1758. Do you think that is sufficiently clear from these cam-house rules; do you consider, under Rule 6, that the foreman is the only "duly authorised" person to carry out those repairs?—Yes.

1759. With regard to the searching, and the observance of the other regulations, it has been stated more than once that there is no written report, no signed certificate, that a foreman has done this or that?—No.

1760. Is it not in your judgment desirable that some more strict measures should be taken to ensure that that is done? In the first place, to whom does the foreman report?—To the other foreman who visits the house.

1761. He says "it is all right," and that ends it?—Yes.

1762. Do you think that is sufficient? Should not the foreman make a written report, or sign a certificate, or in some way commit himself to what he says?—I do not see any objection to that.

1763. Do not you think it would be an advantage to do that?—No.

1764. If you became acquainted with the fact that the men were only searched once a week or fortnight, would your opinion upon the desirability or otherwise of a written report be modified?—You would only get the foreman's bare word for it then as you do now; you would get it in black and white, but it would only be his bare word. I would just as soon take a foreman's word as his written statement.

1765. Would not that apply to all reports?—There is no objection to a written report if the Superintendent says it is necessary.

1766. *Sir F. Abel.* Do not you think a man is more likely to think twice about a thing if he has to write it down?—I think not; a man's word is his bond in any case.

1767. *Colonel Majendie.* If a man says "all right" on Tuesday and Wednesday, when he has inspected those men only on Monday, he is making a false statement, is he not?—He is doing the same if he puts it in writing.

1768. Then do you think that something more than a written or verbal report is necessary to secure that the thing would be properly carried out?—Yes.

1769. What would you suggest?—That the foreman should have a form to fill up that he had done such and such a thing.

1770. That is what I am suggesting, do you think that would secure it?—He would be bound to say that he had done it.

1771. Would not that be an advantage?—Yes, as far as that goes.

1772. In your collection of curiosities at Waltham are there not some prisms that have been found with foreign substances in them?—Yes, pieces of wood and part of a pin.

1773. Any pieces of flint or iron?—No.

1774. At present they pour the powder into the hopper so that whatever there might be in the powder would pass, of course, into the hopper, and then ultimately into the machine?—Yes, of a certain size, but not a large thing.

1775. Would it not be possible to have over the top of the hopper a sort of searcher so as to prevent anything of a dangerous character going into the machine?—It would have to be so large that I do not think it would be of much use; the mesh would have to be very large to allow the powder to go through because there is no shaking arrangement on this machine as there is with a granulating machine.

1776. Then you think it would not detect every foreign body that might be dangerous?—No.

1777. Have you seen men sitting down in the house?—I do not remember seeing any man doing that.

1778. *Sir F. Abel.* Was there any provision there for sitting down?—No.

1779. *Colonel Majendie.* Are you sure there was no barrel?—Yes, if there was it was one they had turned upside down.

1780. Then you think that any evidence we may have that there was that sort of thing is incorrect?—I do, I never saw it.

1781. *Sir F. Abel.* Is there any reason why there should be empty barrels there?—None whatever.

1782. *Colonel Majendie.* Have you seen the men generally standing right up to the machine?—Yes.

1783. How long would it take for the hopper to empty itself?—It is not allowed to empty itself, the man would put powder in it about every five minutes to keep the hopper full. A man's orders are, that he should stand at the machine in case the front man wanted him to pull the clutch out, his duty is to stand by in case he is wanted. I never saw a man sitting down.

1784. Have you ever heard anything at any time about some sparks being struck by one of these spanners?—Wraighte said he was unscrewing one of the plungers when the spanner struck some sparks, but I should like to point out that the house was cleared of everything when that was supposed to have been done. Colonel Barker went down to the house and saw Wraighte, and investigated the thing, and he said he did not believe it, nor do I. Wraighte was taken away from the cam house in consequence of that.

1785. Has he ever made any other complaints about danger or risk?—No.

1786. *Sir F. Abel.* How could a man be engaged in such work; because you say under no circumstances should he do those things?—But all the work was stopped.

1787. Then the foreman would be instructing him to do it?—Yes. With reference to what I said the other day about matches, I should like to say that it was only yesterday that I found, in February, 1889, there was a man found with a box of matches in his great-coat pocket, hung up in the shoe-room of one of the houses. When the foreman found those matches he immediately brought the man down, and he was discharged at once. It was a very wet morning, and the man put on his private coat to go to the house. Since then every man has had a great coat given him, so that now they do not have to take their private coats to the houses.

1788. Have you known any cases of single matches being found?—Yes, I know in 1864 matches were found on the magazine floor.

1789. *Sir F. Abel.* What steps are taken by you to make sure that the men are acquainted with the rules?—There is a copy of the general rules at each entrance to the factory; each man had a copy at one time, but those copies have now been taken away.

1790. Are the rules read to them?—No; they used to be, and everything was explained to them, and the foreman signed a book that he had read them over.

1791. *Colonel Majendie.* Why was that rule altered?—They were done away with when the Ordnance Factory rules came in force.

1792. Would it not be desirable for the men to have something in their own possession?—Yes, I think so.

1793. Are you responsible for the general rules?—No, I am not responsible for any rules.

1794. Have you studied these rules at all carefully and methodically?—No, I was not asked about them when they were drawn up.

1795. In those general rules, I believe, there is no rule forbidding repairs to be carried out until the house has been cleared of powder?—No.

1796. And if you took the press-house rules, which would supplement these, I do not think you will find any rule in them as to repairs?—No.

1797. So far as the written rules go, there is no order that the press-house man should not carry out repairs?—That is understood, but there is no formal regulation.

1798. *Sir F. Abel.* Is not the washing out of the cam machines a very important operation?—Yes.

1799. There is no reference to that in the rules?—No.

1800. *Colonel Majendie.* In regard to the articles liable to spontaneous ignition, such as sponge cloths, there is no rule, I believe, upon that subject?—No.

1801. What do you understand to be the practice with regard to sponge cloths?—No oily sponge cloth is to be left in any building, they are to be taken out each night.

1802. Then if they were taken out on'y every Saturday morning, that would not be complying with the regulations?—No.

1803. There is no regulation that they would be disobeying?—No, there is a receptacle outside every house.

1804. Do you suppose, as a matter of fact, that they are removed from this house daily?—I have not the slightest doubt.

1805. Do you think that any evidence to the contrary is incorrect?—Yes.

1806. Even if it were the evidence of a foreman?—Yes.

1807. *Sir F. Abel.* How many are supplied to them?—As many as are required, there is no stint.

1808. *Colonel Majendie.* With regard to the night inspection of these houses, do you know what time the head millman generally makes his round?—He can go which way he likes, to the upper works first or to the lower works first.

1809. Did he often go to the cam-house at 2 o'clock in the morning?—I cannot say.

1810. What is your belief, do you think he visited that house in the small hours of the morning, or only early in the evening?—I believe he would visit it at about 10 or 11 o'clock in the night when he went down to the lower works.

1811. And not again?—He would go only once in any case, the house was immediately under the foreman.

1812. *Colonel Lloyd.* What is exactly the object of the footboards?—A man might go out into the shoe-room to get a drink, and in order to get there he would step on to these clean boards so as not to have to take his boots off.

1813. Would the footboards ever be brought into the house?—Never.

1814. There would never be any necessity for that?—Certainly not.

1815. *The Chairman.* A man might step off one of those boards on to the dirty floor?—Yes, he could do that if he liked.

1816. *Colonel Lloyd.* Have you ever known a man to do that?—No.

1817. Do you think they would be so careful as never to do that?—Yes.

1818. Was Wraighte removed from the cam-house as a punishment?—No; he is a man with a peculiar disposition, an off-hand sort of man, and treats me with contempt.

1819. Is he a grumbler?—Yes, and he has always been a grumbler.

1820. You place no reliance upon what he said with reference to the sparks?—I believe it was a falsehood.

1821. Why was he removed?—Colonel Barker took him away because he was not satisfied with him.

1822. Did that entail a loss of wages?—No.

1823. Was not the receptacle for the sponge cloths outside the house a dirty receptacle?—Yes.

1824. Would those sponge cloths be brought in again next day for use?—No, but if they wanted to wipe up a dirty place they might do such a thing.

1825. Then there is a possibility of grit being brought into the house?—No, the tank is about 2 feet deep, but open at the top.

1826. If there were an accumulation of dust it would be at the bottom?—I do not think dust would be there any more than on the clean platform.

1827. As a matter of fact, sponge cloths are put into a dirty receptacle, and might be brought out again next day?—I do not say they are.

1828. But they must be either in the house or out of it?—They are not left in the house. A cam machine is working night and day, and the cloths are not taken out every hour; they stop there till they are dirty, and then they are thrown into the tank outside.

1829. Is it a fact that sponge cloths which are put into a dirty receptacle outside the house are ever brought into the house again for use?—Not to my knowledge.

1830. *The Chairman.* Is Mumford a discontented man?—Since the accident it appears so, though no complaint has ever been made of him. What he said at the inquest was talked over in a pot-house, and it is entirely false. If he ever did what he said he did he ought to have been discharged.

1831. *Colonel Lloyd.* We have had evidence that the men sometimes take their meals in the shoe room, do you see any objection to that?—I do not see any objection to it, because they have only half an hour for their meals, and if they had to go down to the dining room, they would not have sufficient time for meals.

1832. But with regard to the cam-house, is the dining room far away?—About three minutes' walk.

1833. Do you think it would be an improvement in the regulations if, where a dining room was within a reasonable distance, men were compelled to go to a dining room for their meals?—Yes.

1834. The machines are stopped during meal times?—Yes, and the house closed.

1835. Is the house locked up?—Yes, by the foreman.

1836. *Sir F. Abel.* Do they sweep it down before they go away?—It is cleared.

1837. *Colonel Lloyd.* But not washed out?—No.

1838. How often is a house of that sort, with a leather floor, washed out?—When we do the repairs, but it would be swept constantly. The more you wet a leather floor the worse it is, and the more powder sticks to it.

1839. But not if it is dry?—You could not wet a floor and get it dry in half an hour or an hour.

1840. Do you know of any material better than leather which would bear cleaning without serious injury, would kamptulicon do?—I do not think anything could beat leather as to wear.

1841. But as to the possibility of getting ingrained with powder?—Kamptulicon would not last so long.

1842. Do you think it would be a precaution if all the leather floors were washed a little more often than they are?—I think not.

1843. Do you think it would act in a contrary direction?—Yes; as long as the place gets properly swept you get no powder on it, but if you wash the floor the powder would stick on.

1844. If the leather floors were washed on Saturday night would they not be dry enough by Monday?—They would be dry but they would all be like wet saltpetre on the top; I think you should not wash out a house as frequently as that when you can keep the floors clean by constantly sweeping. Our floors are very clean, and they compare well with those of any other factory into which I have been.

(The Witness with rev.)



1845. The Chairman. Have you anything you wish to say with reference to your previous evidence?—Yes, I said that the spanners were only used by the mechanics in the house, but I now find the foremen use the spanners for packing up the plungers.

1846. And, so far as you know, no one but the foreman and the mechanic use those implements?—That is so, the order is that no repair is to be done by the workman.

1847. If a man did anything of that sort he would be doing something which is contrary to the regulations?—Yes, he should have spoken to his foreman.

1848. Colonel Majendie. We understand that the men coming into the factory on the barges are subject to the same sort of inspection by the police as the men coming to work in the factory?—Yes, they search the barges.

1849. They ask the men, but they do not go further than that?—I do not know that they do.

1850. Do you think it is altogether satisfactory that contractor's men should be able to come in with less supervision than the man who, so to speak, carries his life in his hand?—No, I do not, but the contractors are not under me in any way.

1851. But apart from any question of such responsibility, do not you think it desirable that some regulations ought to be made to operate very stringently against the bargemen?—Yes.

1852. I suppose I am right in saying that there is no punishment attached to a bargeman, he may be reported, but he cannot be dismissed, by you at any rate, whereas one of your own men would be dismissed?—That is so.

1853. The bargemen do disembark when they get into the factory, do they not?—A man might come ashore to get a drink of water, or to eat his dinner.

1854. Sir F. Abel. Are the men employed in the Engineer Works Department subject to the general rules?—They are searched by the police.

1855. But only a percentage?—Yes.

1856. Have they to work in the danger buildings?—Yes, but the building is washed down and cleared before they come in, and it is always looked over carefully afterwards.

1857. Colonel Majendie. Are you under the impression that the men are searched by their foreman daily?—Yes.

1858. You would not consider searching men weekly or fortnightly satisfactory, would you?—No, I think they should be searched every day.

1859. And that you understand is what is required to be done?—Yes.

1860. Can you point to any written rule or regulation requiring that?—No, I do not think it is either written or printed.

1861. Do not you think it would tend to ensure a more rigorous carrying out of any rule if a foreman had in some way to certify daily that he had carried out his duty?—I do not think the fact of sending in a written report ensures a man having done his work any more than a verbal report does.

1862. Do you think a verbal report is as good as a written one?—Yes.

1863. But is there not a greater formality in putting your name to a written report?—I think the man who signs a false report would make a false statement.

1864. Sir F. Abel. But if anything comes to your knowledge afterwards, have you not more hold over a man who has signed a written report, because in the case of a mere verbal report he might say you had mistaken him?—Yes.

1865. Colonel Majendie. To whom are those verbal reports made?—To the master worker, or to my assistant, or to myself. We go round very frequently. We ask the foreman "is it all right?" and he says "yes," or "no," as the case may be.

1866. Are you quite sure that the foreman under-

stands that in saying "all right," searching the men under his control is included in his "all right"?—I think so.

1867. If a foreman told us he searched the workmen only weekly or fortnightly, he would be doing one of two things, either he is deceiving the persons to whom he reports, or he is misunderstanding the regulations?—Yes, a foreman ought to search his men every day in the danger buildings; I can easily have a report sent in daily.

1868. Would it not be well to have it formulated, and have a definite rule upon that point?—It could be done on the printed rules in the house.

1869. Has the question of a modification of these rules occupied your attention?—The question is in abeyance, while this Committee is sitting.

1870. With regard to the publication of the rules we have not been able to ascertain quite clearly how the men know what the rules are?—When a man is taken on, the master-worker has all the general rules explained to him, and the rules of the special house are explained to him by the foreman.

1871. We understand that the general rules are only posted up at the gate, and here and there about the works?—Yes.

1872. It appears to have been sometimes the case to give the men a book of rules with those and others in them?—Yes.

1873. That has been discontinued?—Yes, since the time the Ordnance Factory rules were started; here is a copy of the book which is now given to the men [handing in the same, extracts from which are printed in Appendix V.].

1874. But these rules do not touch the question of safety?—No.

1875. Would it not in your opinion be an advantage to adopt a system by which every man would be required to have a copy of the rules in his possession, would not that tend to procure a more general knowledge of the rules?—Yes, I think it would.

1876. Do you approve of the practice of meals being taken in the shoe room occasionally?—I do not see any harm in it, but they have a more comfortable place to get their meals in if they wish.

1877. Then you do not think it tends to irregularities to bring food into a place which is a quasi clean building?—It is a dirty floor.

1878. But the footboards make it a clean building because a man can stand on some parts without changing his boots?—Yes.

1879. Would it not be desirable that the men should be altogether excluded from the shoe room when taking their meals?—It might be a precaution.

1880. Would they not bring knives and earthenware vessels, which are liable to give off sparks?—Yes, but in their baskets.

1881. Is the shoeroom lined?—That particular one was built of wood, except one wall, which was of brick; it has a slate roof.

1882. Was there anything dangerous in the room which could possibly have fallen?—I think not.

1883. We understand that a granulating house is unlined, and therefore objectionable upon that ground, was there anything of the same sort about this house to make it objectionable?—No.

1884. You think if it had a clean floor it would be as safe as a powder house?—Yes.

1885. Who took the evidence of the men which you have handed in (see Appendix VII.)?—Captain Nathan.

1886. Were the men up in the office?—Yes.

1887. Did they give the evidence willingly?—Yes.

1888. One of them, Steele, says this: "Carr told Nurse Jones, and I heard it, that he saw sparks under the hood of the magazine," what does that mean?—I do not know what he means, unless he refers to the expense magazine, which lies about 50 yards to

the north of this house. I have spoken to Carr, but he did not tell me anything about that; he is still in hospital.

1889. Clarkhall: "Do you consider the machines dangerous, and if so, in what way? Yes, when the charger would not come over owing to the powder getting under"?—The dust sometimes gets in and clogs the charger.

1890. Has that ever been brought to your attention as a matter of risk?—No, it requires the constant attention on the part of the men working the machines.

1891. "Larman said it was Clayden's machine that went first"?—Yes, and Clayden said so too.

1892. Wraight said, "Emery ought not to be used in cleaning the machines," is that used?—Yes, I think it was, but I have stopped it now.

1893. Ephgrave suggests that holes should be made in the bottom of the machine for squirting water in, has that been considered at all?—We have not touched that at all yet.

1894. Several of the men seem to have been anxious to work in the cam houses, and one man said it was because they get better pay; do they get better pay?—It depends upon the job they are on.

1895. Was it a highly paid house?—No, they got 28s. or 29s. a-week for 12 hours a-day.

1896. Eve: "The iron roller over the counter-weight made each machine dangerous," what does that mean?—The cross head carrying the upper plungers is pulled in one direction by a heavy weight that goes over pulleys.

1897. Is there the risk indicated here that they might fail on the machine if it broke away?—If its axis broke it might be a danger.

1898. Will the machines receive your attention before they are used again?—Yes.

1899. "Pipes at the bottom of machine to carry water away, and parts to be painted," will those points receive your attention?—Yes.

1900. Sir F. Abel. In your report you say that the only possible suggestion that has occurred to you in reference to the explosion is that a match might have been dropped in the powder barrel, have you any reason for making that suggestion?—No, I cannot imagine anything else; the match might have been in the man's private clothing, underneath his lasting clothing.

1901. Colonel Majendie. If a match could get into a barrel it might get into the machine too?—Yes.

(The Witness withdrew.)

1902. Have you any reason for thinking the explosion originated at the barrel rather than at the machine; let us suppose a match from some source, is it likely it would declare itself at the barrel or at the machine?—If it originated at the barrel it would communicate with the machine and vice versa.

1903. Your report tends to show that it would occur more probably at the barrel than at the machine?—I think a match is more likely to have tumbled out of a man's clothing on to the floor.

1904. You do not think the match got into the powder barrel?—No, I think perhaps it tumbled out of the pocket while stooping.

1905. Colonel Lloyd. Have any experiments been tried with a view to showing the inflammability or explosibility of a leather-covered floor that has been well worked with powder for months; I mean, has a match been thrown down upon such floors?—I do not know.

1906. Would there be a tendency for fire to spread over a leather floor under these circumstances?—Yes, I think it is very likely.

1907. Would you advocate more water being used in this house for cleaning the floors?—It would do them no harm to wash them out occasionally.

1908. We gathered from one witness that if that were done to any extent there would be an efflorescence of saltpetre on the floor after washing over the leather, and that the chines of the barrels would be more or less muddy with powder mud, does that objection occur to you?—There would be something in that, certainly.

1909. Are you yourself satisfied with the present arrangements for sweeping the floors?—I think they are kept very clean.

1910. All the evidence tends to show that a great deal of the trouble connected with these machines arises from the pins becoming bent. Do you see any objection from a danger point of view to prisms being pressed solid, and then bored out with a suitable drill?—I think there would be more danger in boring them out than under the present system. There would be more heat in boring them, because they are very hard.

1911. Do you think that method of manufacture would be so dangerous as to make it impossible?—Yes, I should prefer the present method.

1912. With all its disadvantages?—It has been considered perfectly safe until this accident.



*Present.*Lord SANDHURST, *Chairman.**Members.*Sir F. A. ABEL, Bart., F.R.S.  
Major-General F. T. LLOYD, C.B., R.A.Mr. R. H. BRADE, *Secretary.*Colonel A. FORD, *examined.*

1913. *The Chairman.* You are one of the Inspectors of Explosives under the Home Department, I believe?—Yes.

1914. Under what Act were you appointed?—Under the Explosives Act of 1875; I also served for some time previously under the Gunpowder Act of 1861.

1915. How long have you occupied your present position?—For over 20 years; that is, from 1873.

1916. Have you during that period had much experience in regard to the licencing and inspection of factories for explosives of all sorts?—Yes, I have had very great experience in those matters.

1917. How many factories are there at present which are subject to the inspection of Her Majesty's Inspectors of Explosives?—127 in all; 85 of which have been licensed since the passing of the Act, and 42 were taken over as legally existing at that time; these latter had what is called a "continuing certificate."

1918. What is meant by a "continuing certificate" factory as distinguished from one under a licence?—If a factory was legally existing at the time of the passing of the Act of 1875, the occupier was entitled to a "continuing certificate" if such was claimed within three months of the date of the Act coming into force, viz., before the 31st March, 1876.

1919. In the case of a factory under licence does every application for a licence come before the department of Her Majesty's Inspectors of Explosives?—Yes.

1920. What is the course that is taken in regard to such applications?—The occupier of the proposed factory submits what he considers to be a suitable plan of the site, showing the positions of the different buildings, and states the amount of explosive and the number of workpeople to be allowed in each, and the distances they are to be apart from each other. If we find all those details satisfactory, then we grant a draft licence based on them, but if they are not satisfactory, we point out in what particulars they fail.

1921. Are all those details inclosed in the draft which you receive from the owner of the factory?—What he sends up is often only a very rough draft, and we put it into shape.

1922. Do you, for that purpose, send him down a set of questions to answer?—A great deal of correspondence usually takes place; but if it is a large factory we generally ask the owner or occupier to come up and see us at the Home Office, and then we thresh out details in an hour or two which would probably take us weeks to do by correspondence.

1923. When a licence is granted, can any alteration be made in it without reference to the Secretary of State?—No, none at all.

1924. Suppose some alteration is required, how do you set about effecting that?—The occupier has to apply for an amending licence.

1925. Then it appears that you have practically to go through the same form you have gone through before, and see that everything you require is complied with, the same as when you are dealing with an original licence?—Yes, unless the alteration is of a minor character, in which case the amending licence can be granted without reference to the local authority; and in the case of a factory under "continuing certificate" the occupier can get an amending licence without having to go to the local authority, whatever the nature of the alteration.

1926. *Sir F. Abel.* I understand that an amending licence would apply, not merely to some modifications in the arrangements in the factory, but also to modifications with regard to explosives manufactured?—Yes, any alteration of any kind; any deviation from the original licence would require an amending licence.

1927. Then, at the very outset, the amending licence deals with the most important part of the whole question, namely, the nature of the explosive; and no explosive can be manufactured until the place is considered so far satisfactory that it can be licensed?—That is so. The explosive has to be considered first of all; but, beside that, there are the other details included in the licence.

1928. *The Chairman.* In granting licences, is attention paid to the protection of buildings and works outside the factory?—Danger buildings are all required to be at specified distances from buildings and works outside the factory.

1929. And are the danger buildings required to a certain distance from one another?—Yes; the distances in both cases depend upon the amount of explosive that may be allowed in each separate building.

1930. When you say "explosives in separate buildings," do you include in that what might be in boats or wagons within a certain distance of the danger building?—Yes.

1931. On what principle are these distances, or safety zones, assigned?—They depend entirely upon the amount of explosive in the building, except in cases where the quantities are small, and then the nature of the explosive is also taken into consideration. Where the quantities are as much as 5,000 lb., we require the same distances for all explosives, except fireworks, when the distances are much reduced.

1932. *Sir F. Abel.* Quantities of 5,000 lb. would have reference entirely to magazines, would they not?—It is quite possible that that amount might be in a working building, though I cannot at present call to mind a building where it is so; it might, for example, be in a building required for blending.

1933. *The Chairman.* Can you supply the Committee with any table showing the distances which would be required for the various quantities?—Yes, here is a table showing distances from protected works for magazines and other danger buildings [handing in the same, *vide* Appendix XIV.] This

table has been compiled from the results obtained from explosions that have actually taken place.

1934. Is the distance which is assigned to every factory, or to different buildings in the factory, included as a condition of the licence?—Yes, it is inserted in the form of a schedule.

1935. Is the manufacturer free to alter any of those distances without the permission of the Secretary of State?—No, if a distance is to be altered he must come to us for an amending licence, and if the distance is reduced, then we reduce the amount of explosive allowed in the building.

1936. *Sir F. Abel.* Has a manufacturer to come to you when dwelling houses are erected within the distances specified in your schedule?—Yes.

1937. *The Chairman.* Therefore a person does not build his own house at his own risk?—No, in that case the manufacturer cannot go on using the particular building under the old licence.

1938. Has the drafting of licences in a great number of cases come under your immediate control?—Yes.

1939. When a licence has been drafted, is it required to run the gauntlet of any local criticism?—It is sent in the form of a draft licence to the applicant who, after advertising in the local papers for at least a month, takes it before the local authority. The local authorities do not go into the details at all; they either assent or dissent, and their objections, if they have any, are generally from a residential, or some similar, point of view. If the local authority assents, then on the assent reaching us, we tell the occupier to build the factory in accordance with the draft licence, and when the building is sufficiently completed to enable manufacture to be commenced, the draft licence is confirmed. If the local authority dissents, or imposes conditions, the applicant is asked whether he submits or agrees to the conditions, or whether he wishes to appeal. If he submits there is an end to the matter; but if he does not submit or agree, he has a right of appeal to the Secretary of State, with whom there rests the final decision, and who has power to grant the licence over the head of the local authority. We have had some eight or ten cases of such appeals; some have been granted, and some refused.

1940. Can you show us one or two typical licences to illustrate their scope and nature, and also the detail into which they run?—Yes; here is our copy of the licence which was granted to the E. C. Powder Company [exhibiting the same to the Committee. A copy of a magazine and one of a factory licence will be found in Appendices XII. and XIII.]

1941. Can you also show us an amending licence?—Yes, here are some twelve amending licences which have been successively granted to the same company [exhibiting the same to the Committee]. Very often the whole of the buildings are in some way altered, because as he goes on the manufacturer gains experience, and he finds that he cannot work on the original lines.

1942. Then it follows from what you have said, that the licence itself contains a number of regulations which have to be observed?—Yes, it is practically all regulations.

1943. What is the penalty for a breach of the terms of a licence?—A fine not exceeding 50*l.* plus the forfeiture of the explosive in the building in which the breach took place.

1944. If a manufacturer subsequently conforms to the regular requirements, does he get his licence at once?—His licence is not taken away if he commits a breach.

1945. Are there any rules outside the terms of the licence?—There are the general rules for gunpowder factories contained in Section 10 of the Act, and for factories for explosives other than gunpowder there are the rules in the Order in Council, No. 2.

1946. With regard to the general rules are they

posted up in the factories?—They are required to be posted up, as also are the special rules, in the danger buildings.

1947. Are the general rules posted up at the gate of the factory?—I cannot recall any instance where the rules are at the gate; they are in or about the danger buildings, sometimes outside the houses in glass frames, but mostly inside.

1948. Can you refer the Committee to the general rules applicable to gunpowder factories, and also to those applicable to factories for explosives other than gunpowder?—Yes, the first you will find in Section 10 of the Explosives Act of 1875, at page 153 of the seventh edition of the guide book, and the second you will find in the Order in Council, at page 249 of the same book.

1949. How are the special rules arrived at?—Under Section 11 of the Act the occupier of a factory is entitled to make special rules for the regulation of the persons managing, or employed in or about, his factory with a view to securing the observance of the Act, and for the safety and discipline of such persons and for the safety of the public. If after being required to do so an occupier does not within three months submit some such special rules to the Secretary of State, then the Secretary of State has power to make the special rules, but no special rules can be operative until they are sanctioned by the Secretary of State.

1950. Can you show the Committee a copy of such special rules as have been approved in the case of a gunpowder factory, and in the case of a factory for explosives other than gunpowder?—Yes, here is a copy of the special rules compiled by Messrs. Curtis's & Harvey, and here is also a copy of the special rules used by Nobel's Explosives Company [exhibiting the same to the Committee].

1951. Do these special rules vary in different factories, and under different circumstances?—Yes.

1952. Can they be varied without the sanction of the Secretary of State?—No, all alterations have to be submitted for sanction.

1953. Are there any rules of the nature of extra special rules applicable in factories?—Yes, in certain cases. For instance, it was found that a copper stud used in some mills was liable to cause an explosion, and therefore the manufacturers submitted an extra special rule forbidding the use of it. The principle we adopt in going through these rules for approval is to make as few alterations as possible. If, therefore, a manufacturer submits a special rule for a particular building, we accept it; and if he submits an extra special rule, we take it as such. It is immaterial to us whether he calls it one or the other, as the penalty is the same.

1954. What are the penalties for breaches of the general and special rules?—Not exceeding 10*l.* and forfeiture for the general, and not exceeding 40*s.* in the case of the special rules.

1955. Is a manufacturer at liberty to make any other rules than those which you have mentioned?—No.

1956. I presume, if he did make any such rules, he could not recover any penalties against his workmen for a breach of the same under the statute?—No, not under the Explosives Act.

1957. In the case of factories under "continuing certificates," do the general and special rules apply?—Yes.

1958. Does the certificate itself contain regulations similar to those in a licence?—Yes, *mutatis mutandis*; but if the occupier wishes to add a new building, or to make an alteration in an existing building, then we assign the same safety zone as in a licensed factory.

1959. Is it the practice in the Home Office to include as one of the terms of the licence that inflammable clothing is to be worn, but no pockets?—Yes.

1960. Do Her Majesty's Inspectors of Explosives pay particular attention to the observance of that



regulation; do they attach considerable importance to it?—Yes, I examine the men very particularly.

1961. Just at haphazard?—Yes. Sometimes I take three or four men in succession in one room, but I do not necessarily examine all who are in the room. It all depends upon the factory I am inspecting.

1962. Do you consider that a system of occasional search of the workpeople by the foremen of the different houses is a satisfactory one?—No; the search should be made every day, and at the time the men come into the factory.

1963. Then you would think 10 or 15 per cent. quite inadequate?—I should not consider that satisfactory.

1964. What sort of system do you think should be enforced to ensure every workperson being subjected to an efficient daily examination?—A man should be searched when he comes into the factory, and then after he has changed his clothes, the clothes left behind should occasionally be searched, because very often things are found which were not detected in the examination at the gate. The second search would be a very good thing, because if the men know that an examination of that kind may be carried out they will be almost certain to search themselves beforehand so as not to bring anything into the factory.

1965. Do you think it is desirable that the responsible person reporting having searched the workpeople should make such a report in writing?—Yes.

1966. Is that practice adopted in the better regulated factories?—Yes.

1967. In the case of the women, do Her Majesty's Inspectors insist upon some woman searcher being made responsible?—Yes, always a forewoman; we speak to the forewomen and ask them whether the inspection has been rigidly carried out. If I suspect that a workwoman is wearing her own dress under her inflammable clothing, I ask her to turn up her inflammable clothing to see that she has no pockets in her own clothing.

1968. Then you do actually look at the clothing of the workpeople when you visit the factories?—Yes.

1969. Are those visits made without notice?—Yes, any sort of notice would spoil the whole thing, and if we happen to find out that it is known that we are in a district we sometimes leave it, and go to another.

1970. With reference to the general rules, relating to gunpowder factories, can you point out to the Committee any rule relating to oiled cotton, rags, and other articles liable to spontaneous ignition?—Yes, Subsection 4 of Section 10 of the Act says, "Charcoal, whether ground or otherwise, and oiled cotton, oiled rags, and oiled waste, and any articles whatever liable to spontaneous ignition shall not be taken into any danger building, except for the purpose of immediate supply and work or immediate use in such building, and upon the cessation of such work or use shall be forthwith removed." That is a point to which we pay particular attention, and I do not think that, with one exception, I have found any cotton waste in a building for the last five years. Not long ago I found a piece which had been momentarily left behind.

1971. Do you consider that a rule to which considerable importance is attached?—Yes, undoubtedly.

1972. Can you point to any rule relating to repairs to danger buildings?—Yes, Subsection 5 of Section 10 of the Act says, "Before repairs are done to, or, in any room in or other part of a danger building, that part shall, so far as practicable, be cleared by the removal of all gunpowder and wholly or partly mixed ingredients thereof, and the thorough washing out of such room or part."

1973. Does that rule apply to repairs to machines?—Yes.

1974. That would stop the working of all machines while repairs were going on?—Yes.

1975. In your judgment, is that a rule of con-

siderable importance?—Yes, of the greatest importance, because numerous accidents have resulted from repairing or altering machines while explosives were in the rooms; here is a list of such accidents [handing in the same, *vide* Appendix VIII.].

1976. Do the rules require full statements to be posted up of the quantities of explosive allowed, and the number of persons, and the regulations applicable to the building?—Yes, Subsection 6 of Section 10 of the Act says, "There shall be constantly kept affixed in every danger building, either outside or inside, in such manner as to be easily read, a statement of the quantities of gunpowder or ingredients allowed to be in the building, and a copy of these rules, and of any other part of this Act required by the Secretary of State to be affixed, and of such part of the licence and special rules made under this Act as apply to the buildings, and with the addition in a factory of the name of the building, or words indicating the purpose for which it is used." The number of work persons must also be posted up.

1977. Does any obligation rest upon the manufacturer under any section of the Act of using due diligence to enforce the observance of the Act?—Yes, Section 23 of the Act says, "The occupier of every factory, magazine, store, and registered premises for gunpowder, and every person employed in or about the same, shall take all due precaution for the prevention of accidents by fire or explosion in the same, and for preventing unauthorized persons having access to the factory, magazine, or store, or to the gunpowder therein, or in the registered premises, and shall abstain from any act whatever which tends to cause fire or explosion, as is not reasonably necessary for the purpose of the work in such factory, magazine, store, or premises. Any breach (by any act or default) of this section in any factory, magazine, or store, or registered premises, shall be deemed to be a breach of the general rules applying thereto," and is liable to the same penalty of 10*l.* Section 87 of the Act says, "Where any offence under this Act for which the occupier of any factory, magazine, store, or registered premises is liable to a penalty, or forfeiture, has, in fact, been committed by some other person, such other person shall be liable to a penalty not exceeding 20*l.* Where such occupier is charged with an offence so committed by some other person, the occupier shall be exempt from any penalty and forfeiture upon proving that he had supplied proper means and issued proper orders for the observance, and used due diligence to enforce the observance of this Act, and that the offence in question was actually committed by some other person without his connivance, and if the actual offender be alive, that he has taken all practicable means in his power to prosecute such offender to conviction." These two sections deal with the matter very fully.

1978. Is it consistent with the general rules that steel tools or implements should be used in the repairs to any danger building?—No, Subsection 7 of Section 10 of the Act says, "All tools or implements used in any repairs to or in a danger building shall be made only of wood or copper or brass, or some soft metal or material, or shall be covered with some safe and suitable material."

1979. *Sir F. Abel.* The whole of a steel spanner could not be covered, could it?—No, not quite the whole of it.

1980. *The Chairman.* In regard to the keeping of the building free from grit, is it important that the magazine boots should never be placed where they can come into contact with grit?—Yes.

1981. In your judgment is there a liability of their coming into contact with grit where they are worn along an unprotected external platform?—Yes.

1982. I presume with regard to the exclusion of grit, you consider that it is very important that the "clean" boundary should be carefully defined?—Yes, that is absolutely necessary, otherwise the boots must take up grit.

1983. Do you consider that mats to wipe the feet

upon should be allowed within the "clean" boundary?—No, that would be a most objectionable practice; mats are not required at all if there is a proper clean floor boundary. If mats are placed outside a building to wipe the feet on, they are very liable to throw grit into the building.

1984. Is it the practice in the private trade to allow meals to be taken in the danger buildings, or in any part of the same?—That is absolutely forbidden.

1985. *Sir F. Abel.* Can they take their meals in the shifting rooms?—Yes.

1986. Are they not in close proximity to the danger buildings?—No, they are invariably the same distance from the danger buildings as those buildings are from one another.

1987. *The Chairman.* Would you object to their having meals in the danger buildings, if you found such a practice in operation?—Yes, because there would be the liability of their bringing cups and saucers and earthenware basins, and iron or steel knives into the buildings. We are very particular upon that point, and if we find there is the slightest approach to such a practice we at once put a stop to it.

1988. With regard to smoking, is that absolutely prohibited in the private factories, or do the rules allow of certain places being assigned where smoking may be carried on?—Yes, that is done under Subsection 9 of Section 10 of the Act, "No person shall smoke in any part of the factory or magazine, except in such part (if any) as may be allowed by the special rules." In some factories smoking is entirely prohibited, in others it is allowed, but only in the watch-houses and dining rooms. Of course if there is any dwelling house within the factory area smoking is allowed there.

1989. Does not that entail searching the men who come from such places and go into danger buildings?—Where matches are allowed to be in a factory, we always provide that they shall only be safety matches, and that they shall be kept in one particular place from which they must not be removed, so that if a man wants a light he has to go to that place for a match, and when he has struck it, then, of course, there is an end of it.

1990. With regard to the quantities allowed to be in a building, do they include powder in process of removal from or to the building?—Yes. Section 24 of the Act says, "All gunpowder and ingredients within the radius of 20 yards from the buildings, and in course either of removal from the building or of removal to the building for the supply and work thereof, shall be deemed to be in the building; provided that if while the gunpowder or ingredients so in course of removal are within the radius every machine and manufacturing process in the building is wholly stopped, these may, in addition to the quantity so allowed as aforesaid to be in the building, be within the radius, a further quantity of gunpowder and ingredients so in course of removal as aforesaid not exceeding the quantity specified in that behalf in the licence, or in the case of an existing building in a lawfully existing factory for gunpowder, 10 cwt." That is to say, that all gunpowder within 20 yards of a building is considered to be in the building.

1991. Is there any statutory obligation on the occupier of a factory to take all due precaution for the prevention of accident irrespective of specific rules directed to that end?—Yes. Section 23 of the Act lays down that, "The occupier of every factory, magazine, store, and registered premises for gunpowder, and every person employed in or about the same, shall take all due precaution for the prevention of accidents by fire or explosion."

1992. Have Her Majesty's Inspectors any power of requiring the abandonment or alteration of any practice which in their judgment may be dangerous?—Yes, under Section 56 of the Act we have power to require the occupiers of factories to discontinue any operation which we may consider dangerous; if the occupiers object to our ruling they may appeal to

arbitration, but, as a matter of fact, we have never had such an appeal.

1993. Do you ever have occasion to require the discontinuance of any operations?—Yes, and the manufacturers, as a rule, are only too glad to have such things pointed out to them.

1994. Is it your practice to interfere, as a rule, with machinery in use, or do you limit such interference to cases where a machine may appear to you to be actively dangerous?—Only where it is dangerous; we then call the manufacturer's attention to the matter and he has to discontinue it, or appeal.

1995. Have you had an opportunity of looking at some of the rules in use at Waltham Abbey, especially those called the general rules and the rules relating to the cam houses?—Yes, there are some very good rules among them, but I think they are generally capable of improvement; in fact, there are certain points in which I think considerable alterations and improvements are required. For instance, in the general rules, No. 2 says "Matches are on no account to be brought into any part of the works or grounds," but they must have matches for lighting the engine fires. That rule requires amplification because at present it must be broken, and it is no use making rules which cannot be observed. Rule 4 deals with changing shoes, but it does not say where the clean shoes are to be left. Then again, men should be required to submit to being themselves searched in going in or out, but Rule 7 does not seem to provide for that.

1996. Do you consider that every man ought to be searched?—Yes. His pockets should be turned out and shown; it ought to be a real search. Rule 13 provides for the cleaning of the exterior of the powder houses, but it does not seem to provide for the same in regard to the interior, though I notice that that is dealt with in the cam-house rules. Rule 23, dealing with the mats, requires alteration; in fact, mats should be altogether forbidden. I notice also that there is no prohibition in these rules with regard to pockets, nor is there any rule providing that oiled cotton waste should be taken out of a building immediately it has been used. There does not appear to be any rule providing for the observance of the limit of explosive in a building, as specified in the notice posted up; nor is there, apparently, any rule that if gunpowder is spilled on the floor it shall be at once swept up. There is no rule referring to the meals, nor any rule forbidding anyone to enter a danger building in which he is not employed. We find men do go into buildings in which they are not employed, and that is not only a risk to themselves, but also to the men who are employed at the time in the building. There is no proper rule as to repairs, nor with reference to machines when they are defective. When that happens a machine should be at once stopped, and on no account should work be resumed until the foreman has given his permission. There ought to be a rule (it goes without saying) that if a person on coming back to work appears to be in any way intoxicated, that person should not be allowed to remain. Generally, I think, the present rules are a little too much mixed up, though it would be possible to have very good rules based upon them. There should be one part of the rules applying to the factory generally, and another part applying to the danger buildings, and then, if necessary, others applying to the particular houses.

1997. In regard to the limitation of the number of workpeople allowed to be in a building, can you give the Committee any information as to the maximum number allowed to be in buildings where gunpowder is compressed into pellets or prisms?—We would not allow more than six under any circumstances. Here is a list of the different factories which have houses such as you mention, showing the number employed in each [handing in the same, *vide* Appendix IX.].

1998. The object of any such limitation is, I presume, to prevent an unnecessary number of persons being involved in a single disaster?—Yes.



1999. Then may we take it that you consider the number present in or at the cam house at Waltham at the time of the explosion, viz., 11, was unduly large?—Yes.

2000. *Sir F. Abel.* There were two separate houses?—So far as we are concerned we consider it only one house, because it is all under one roof.

2001. Have you had instances of powder being brought in to a danger building by a boatman?—Yes.

2002. Would you include him in the number allowed in a building?—No. Recently we have made provision in the licences that, in addition to the work-people, there may be "service waiters," as we call them, that is the men who bring in the powder and take it away, but a boatman would not be allowed to go into a building; all he could do would be to pass the powder out of the boat up to the outside of the building.

2003. *The Chairman.* Do you think it right that the powder should be carried or rolled on the chine of a barrel into a house whilst the machines are work?—Yes, I see no objection to that.

2004. When you fixed the quantities of gunpowder, I suppose the limit of explosive allowed to be in a house was made to bear some relation, not only to the requirements of the house, but also to its distance from other buildings?—Yes, the distances are shown in the line marked "workshop" in the table which I have already handed in (*vide Appendix XIV.*)

2005. *Sir F. Abel.* Are the distances the same whether the place is planted with trees or not?—Yes, but we have always encouraged the planting of trees.

2006. *The Chairman.* Then apparently the object of the limitation is to prevent the communication of explosion from one building to another?—Yes.

2007. Does your department attach considerable importance to the lining of danger buildings with some material, such as wood?—Yes, in all cases they should be lined throughout with wood, and, moreover, they should be kept painted or varnished; that provision is in all the licences recently granted, and in the general rules there is a stipulation that there shall not be any exposed iron.

2008. Do you consider that a building having an unlined slate roof is an improper construction for a danger building?—Yes, certainly.

2009. Do you think it desirable that such instruments as steel spanners, which may be needed for purposes of repairing or adjusting the machinery, should be allowed to be kept in the houses?—No.

2010. Would you approve of the use of a steel spanner for whatever purpose while the house contained explosives?—It might be impossible to get any other metal hard enough for the purpose; we should then be obliged to allow them to use a steel spanner, but we should take every precaution to see that it was covered with leather, so that if it fell it would not cause an explosion.

2011. Can you give us a reference to any accident or accidents due to a steel implement in a danger building?—Here is a list of such accidents [handing in the same, *vide Appendix VIII.*]

2012. *Sir F. Abel.* Would you allow steel spanners to be used while a machine was, more or less, charged with powder?—No, not under any circumstances.

2013. It should not only be free and empty of powder, but it should be cleaned down?—Yes, certainly.

2014. *The Chairman.* Is nightwork common in powder factories?—Yes, and where there are mills it is practically universal, because the output of a factory depends upon the number of mills kept going. In glazing-houses also they work at night, but there is no one required to attend them.

2015. Do you consider that such work can be safely carried on if properly and efficiently supervised?—Yes, I think so; we should not object to nightwork.

2016. Do you think that the night visits of persons charged with the inspection of the various buildings should be checked by tell-tale clocks?—Yes; I am afraid if they are not checked, they lapse.

2017. Do you insist upon that?—No, we leave it to the proprietors of the factories, and in the larger factories there are such clocks.

2018. *Sir F. Abel.* Do you interfere at all with reference to the times at which the inspections should be made?—No.

2019. Then, so far as you are concerned, a man may visit early in the night and not go again?—Yes.

2020. *The Chairman.* Can gunpowder be exploded by friction when in contact with hard surfaces or particles of grit?—Yes, certainly.

2021. In your opinion, would there be any risk of explosion if a barrel of gunpowder were roughly dragged over a wooden floor having indurated powder upon it?—Yes.

2022. Would such risk be increased by the presence of gritty particles?—Yes.

2023. And correspondingly diminished by the floor being covered with leather?—Yes.

2024. It would be possible to explode it on a leather floor, would it not, if the barrel were dragged roughly?—Yes, if the temperature were high enough.

2025. Can you furnish us with any particulars of experiments which tend to show that powder may, under certain conditions, be readily exploded by a blow, without the presence of a spark or visible form of heat?—Yes, experiments were made some years ago with these results:—A 25-lb. weight was allowed to fall 2 feet upon small packages of gunpowder, consisting of about 5 grains of Government powder wrapped in tinfoil, so as to exclude the possibility of a spark reaching it. The packages were placed between two metal plates, and the blows struck as follows:—

Material of plates.	No. of blows.	No. of explosions.
Both plates steel .. ..	10	10
One plate steel, one plate brass.	10	4
Both plates brass .. ..	10	2
Both plates lead .. ..	10	No explosion, even when the fall was increased to 40 feet.

2026. Would a metal body raised by friction or otherwise to a temperature at which the naked hand could be borne upon it be capable of exploding gunpowder?—No, the hand cannot bear even 212 degrees fahrenheit, the temperature at which water boils, so that shows the utter impossibility of bearing the heat, about 560 degrees, at which powder explodes.

2027. Do you consider that an arrangement of a danger building which required every barrel of gunpowder brought into it to be lifted up a step, about 9 inches in height, at the doorway, satisfactory?—No, I think that is a very bad arrangement indeed, the powder is liable to fall and so is the man.

2028. Have any cases come under the notice of your department of explosions or accidents during the pressing of gunpowder into pellets or prisms, whether for cannon, or blasting, or small arms?—Yes, here is a statement with regard to that [handing in the same, *vide Appendix X.*]

2029. *Colonel Lloyd.* Are you acquainted with the relative positions of the Waltham Abbey powder buildings?—No, I have been over the factory a very large number of times, though not of late years, but I have never looked at the buildings critically, *qua* their distances from one another.

2030. Then you have formed no opinion as to whether the distance and the quantities of powder kept in those houses conformed to the regulations you have referred to?—No; but as distances and amounts go hand in hand, if I knew the amount allowed in any building I could say the distance it should be from the other buildings.

2031. In private factories is there any system of inspection that would prevent the distances being reduced, or the quantities increased, beyond the prescribed rules?—If on visiting a house we found too much in it that would be the subject of proceedings unless there were very good reasons for not instituting proceedings.

2032. Do you think there would be any danger of spontaneous combustion from a small number of sponge cloths, or from a small quantity of oily waste which was in continual use?—Yes.

2033. Say six sponge cloths?—Even with small quantities there is a liability of explosion, and so particular are we upon that point that we have insisted upon their getting rid of every bit of cotton waste directly after using it.

2034. Then where a machine constantly requires the use of material of that sort would you have it removed from a danger building?—Yes; put into a box outside, and brought back again as required.

2035. Do not you think there would be more danger in that course than in keeping it in the house?—No; it could be kept outside in a special box into which grit could not penetrate.

2036. In the case of a danger building, where they are at work day and night, would you think it necessary to periodically remove the oily waste?—Yes, it should be removed every night.

2037. Do you think it would be necessary to have two receptacles, one for the dirty oily waste that could not be used again, and the other for the oily waste that could be used again?—The dirty waste might be at once taken to the engine room and burned.

2038. Would you permit the use of clean movable boards in the shoe room?—I have never seen such an arrangement; if I did I might not object to it, but it seems to me to be quite unnecessary.

2039. A shoe room would always be dirty, I presume?—Half dirty and half clean, with a barrier in between; but I do not think that there should be little clean islands, so to speak, on the dirty part.

2040. But, *prima facie*, you think the practice of having such movable boards objectionable?—I think so.

2041. Is it the custom in danger buildings that are covered with hides to have them washed out at frequent intervals?—The hides are wetted from time to time, but I cannot say how often they are washed; the important point is that they should be clean.

2042. Is there any good reason against wetting the hides; are they liable to become ingrained with powder dust?—I do not know.

2043. Would you be satisfied with their being constantly swept?—I think they may be wetted.

2044. One witness has said that if the hides were wetted there would be a continual efflorescence of saltpetre on the surface when they dried?—I have not found any such thing.

2045. Would there be any objection to an efflorescence of saltpetre?—No.

2046. In a very dusty house where hides were used, do you think that the effect of their being wetted would be likely to attract more dust into the substance of the hide, and thus cause the danger which we desire to prevent?—I am not able to say how far wet would penetrate into a hide that was properly tanned. I should think in that case the wet would continue on the surface; but any way, if it is wetted only by washing, then I think the penetration would be very small.

2047. Are hides generally used in danger buildings?—Yes, in many of the best factories.

2048. And are wood floors always used where there are no hides?—Yes; sometimes lead is used, in the case of stoves for drying powder, but as a rule lead is going out of fashion.

2049. Do the regulations require that the roofs of danger buildings should be lined?—Yes, the whole of the interior.

2050. There are many cases in which traverses faced with brick have been erected between contiguous danger buildings. Are the bricks so liable to disintegration as to render it probable that pieces will fall into the building?—We should never allow exposed bricks to be on the inside of a building; we require them to be covered with wood.

2051. *The Chairman.* Would you approve of the foremen periodically searching the men in their gangs?—We should certainly approve of that. In the best factories there is a system of reports, more or less elaborate, upon that, but it is a matter in which we do not interfere. If we find the work is properly done, and things are in proper order, we leave the manufacturers as much as possible to themselves.

2052. If you knew of a factory in which there was not a written report, would you consider their system faulty?—Yes; and if an accident happened I should call very prominent attention to it.

2053. *Sir F. Abel.* With regard to the searching in private factories, are books kept in which the foremen have to record the fact that they have searched the workmen in the different buildings?—In the better regulated factories reports are filled in by the foreman, and they are put into a book.

2054. Is that book always open to your inspection?—Yes. In fact, when, after an accident has taken place, we want to know when the workpeople were searched we go to that book. In some cases the men keep their private clothes in lockers, but the foreman has a master key of all the lockers, and he can go to one and search the clothes when he wishes.

2055. Are the details with reference to the searching of clothes left to the judgment of the owners of the factories?—Yes.

2056. *Colonel Lloyd.* Are the reports in the private factories made for the purpose of securing the safety of the buildings and their contents, or for ensuring that a proper amount of work is done by the men, or for both?—I think both to some extent.

2057. *The Chairman.* With reference to the oiled rags, I understand you would not allow any to be kept in the place where the powder is?—If I saw an oiled rag lying not in use in a danger building, I should at once have it put out, and want to know why it was there; I should call attention to the rules, and possibly threaten proceedings.

2058. If you found out that it was the habit to leave those lying about, clearing them out only once or twice a-week, would you consider that faulty?—Yes, it could not be worse.

2059. Is there anything else you desire to bring before the Committee?—Yes. A circular letter was some short time ago addressed to the different manufacturers asking whether in their manufacture of the present powders accidents had occurred, and if so, would they give us the details. Here is an abstract of their replies [handing in the same, *vide Appendix XI.*]

2060. Does that correspondence refer to heating of machines?—I cannot say.

(*The Witness withdrew.*)



## APPENDICES.

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## APPENDIX I.

## ROYAL GUNPOWDER FACTORY, WALTHAM ABBEY.

## STRUCTURE OF NO. 2 CAM HOUSE.

*General.*

The building consisted of three compartments—

1. The southern one, containing Nos. 2 and 3 cam machines;
2. The central one, containing the water-wheel; and
3. The northern one, containing Nos. 4 and 5 cam machines.

The inside dimensions of these compartments were, approximately—

1. Southern, 26 feet by 17 feet 6 inches.
2. Central, 9 feet 8 inches by 17 feet 6 inches.
3. Northern, 24 feet by 17 feet 6 inches.

Communication between them was along a covered platform, from either end of which an open platform led down to the river. Both these platforms were "clean," and their relative positions and those of the various doors are shown on the Plan.

*Walls.*

The south wall of the building was of brick, 18 inches thick at the ends and  $22\frac{1}{2}$  inches thick between the side walls of the building. The other walls of the house were of wood framing, covered on the outside with weatherboarding and on the inside with  $\frac{3}{4}$ -inch matched boarding, all copper-nailed. The south end brick wall was also lined with matched boarding. The outer wall of the covered platform was weather-boarded and copper-fastened, but not match-lined.

*Roof.*

Wooden trusses covered with tarred felt on boarding. A lining of matched boarding, copper-fastened, was fixed as a ceiling under the tie-beams of the trusses. There were some iron screws in the roof trusses outside the lining, but none that could have fallen into the house until after the lining was burned. Height of eaves above floor, about 10 feet. Pitch of roof, 45 degrees, fitted with copper lightning conductor.

*Floor of North and South Compartments.*

$1\frac{1}{4}$ -inch boards, covered with hides, copper-fastened.

*Floor of Covered Platform.*

$1\frac{1}{2}$ -inch boards, ploughed and tongued, copper-fastened.

*Open Platforms.*

2-inch boards, laid with  $\frac{1}{2}$ -inch space between them, copper-fastened, fitted with fender boards and handrails.

*Doors.*

All opened outwards, and swing-doors were fitted with lead weights running in casings and gunmetal pulleys.

*Lighting.*

Outside electric lights.

M. T. SALE, Colonel.  
Superintendent, Building Works Department.

3rd March, 1894.

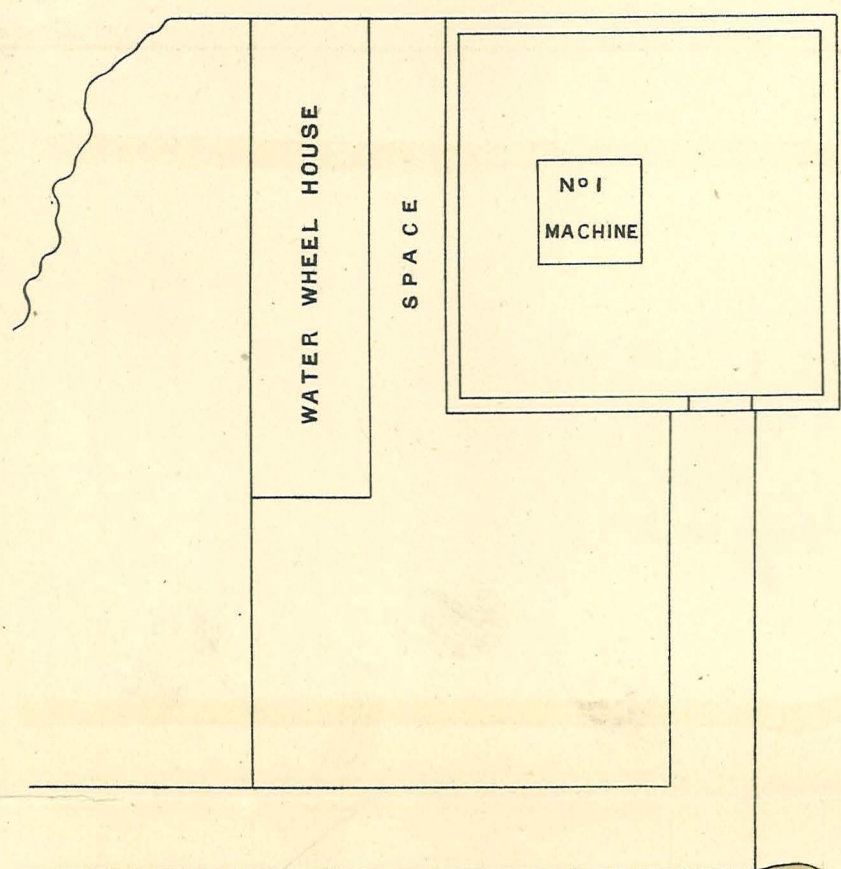


# PLAN OF No. 2 CAM HOUSE, ROYAL GUNPOWDER FACTORY, WALTHAM ABBEY.

(DETAILS OF MEASUREMENTS, ETC., ARE SHOWN ON SEPARATE SHEET.)

T  
A  
I  
L  
S  
T  
R  
E  
A  
M

POSITION OF CAM HOUSES  
Nos. 1 AND 2 LOWER ISLAND.



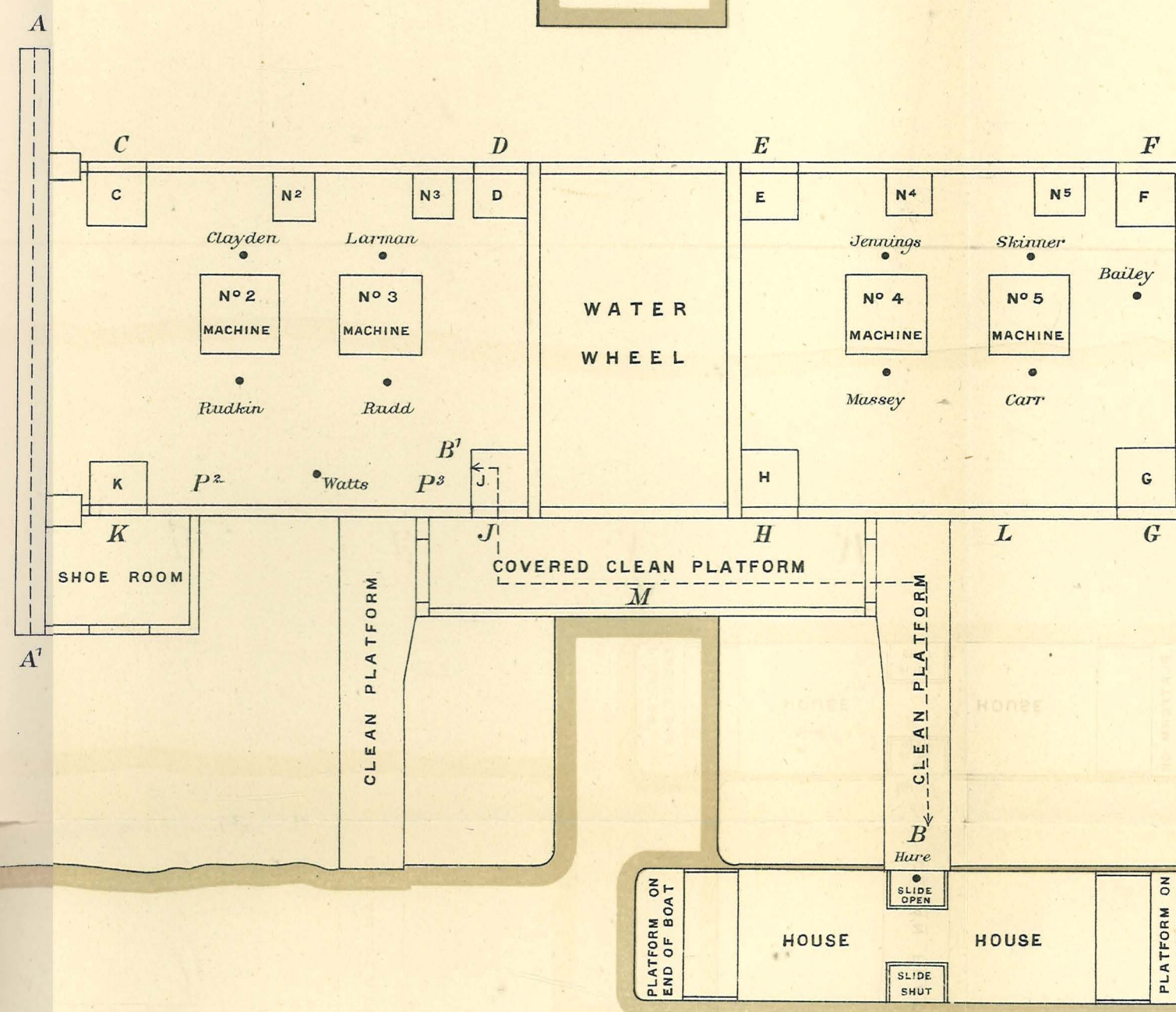
### REFERENCE

- A to A'.—Brick Wall.
- B to B'. Route by which barrels of powder were being brought on the night of the accident from the boat to the South End of the house.
- B'. A Step of about 9 inches up to the floor of the house.
- C, D, E, F, G, H, J, K.—Doors opening outwards.
- c, d, e, f.—Wells or recesses about 9 inches below the level of the floor of the house in which were dirty mats (Questions 1,444, 1,535-6, 1,748).
- g, h, j, k.—Ditto, in which were clean mats (but see Question 1,749)
- L.—Spot where Watts's hand was found (Question 1,189).
- M.—Electric light, lighting the platform.
- N. 2, 3, 4 and 5.—Positions of the tables at which the men working in front of the machines, so numbered, placed the prisms on the racks.
- P<sup>2</sup>, P<sup>3</sup>.—Alleged positions of seats of men working behind Nos. 2 and 3 machines (Questions 1,591-2, 1,777-83).

N.B.—The positions assigned on the plan to the men are those which they occupied at the time of the first report or explosion; that assigned to Watts, the only man who did not get away from the building, being that where his body was found. According to one witness, Watts's body was found nearer the machines. (Questions 1124-5.)

SOUTH  
END

NORTH  
END



Magazines → 141.5 Feet.

H  
E  
A  
D  
S  
T  
R  
E  
A  
M





Fig. 1.



Fig. 2.

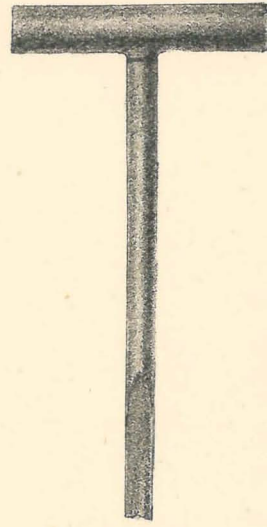


Fig. 3.

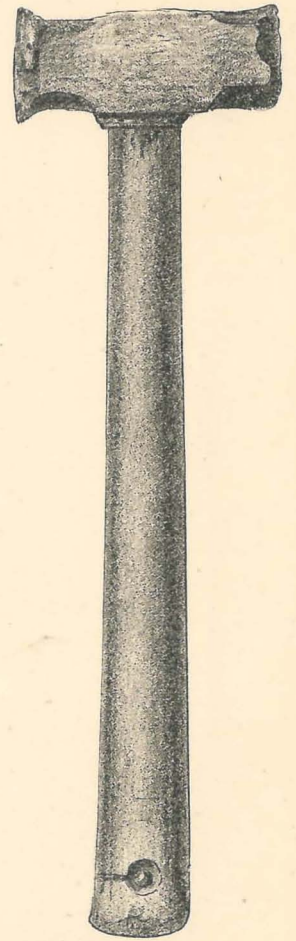


Fig. 4.

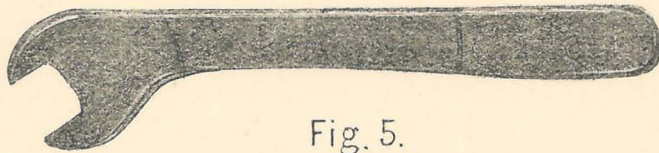


Fig. 5.



Fig. 8.



Fig. 6.



Fig. 9.

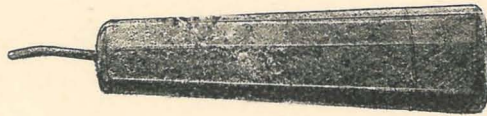


Fig. 7.

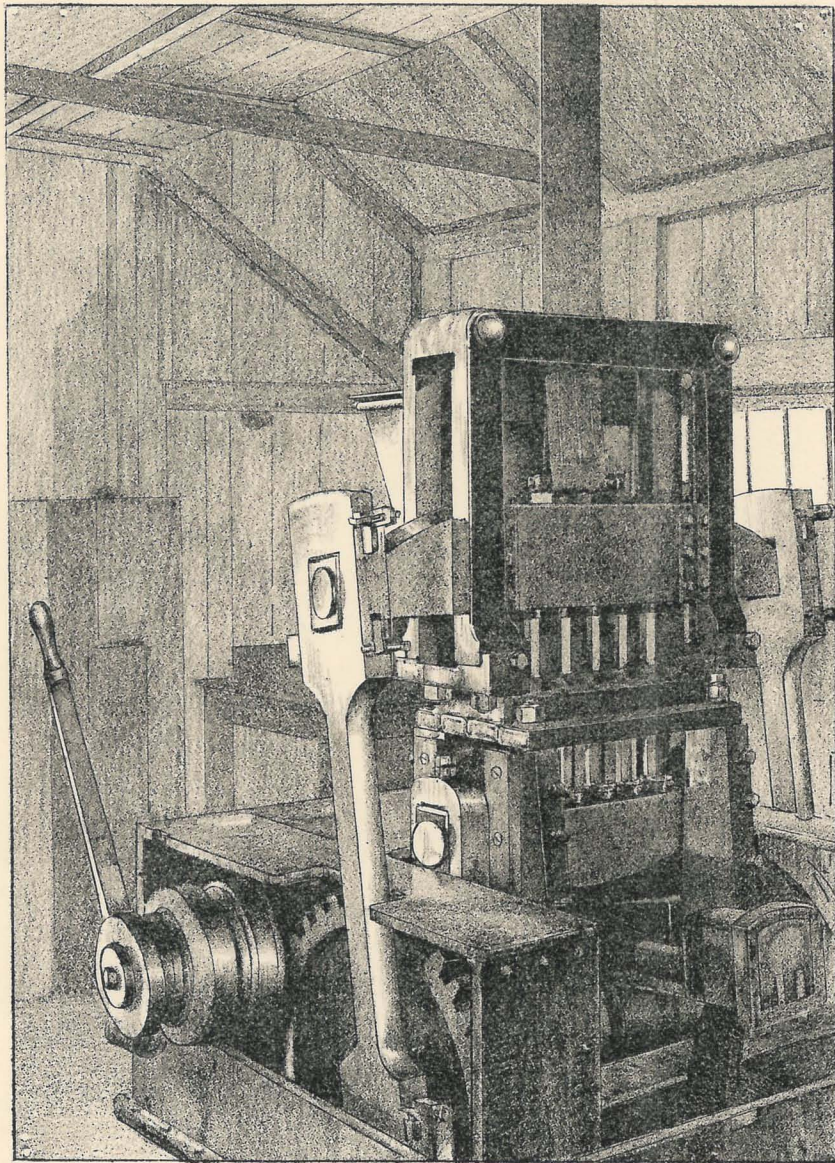


Fig. 10.

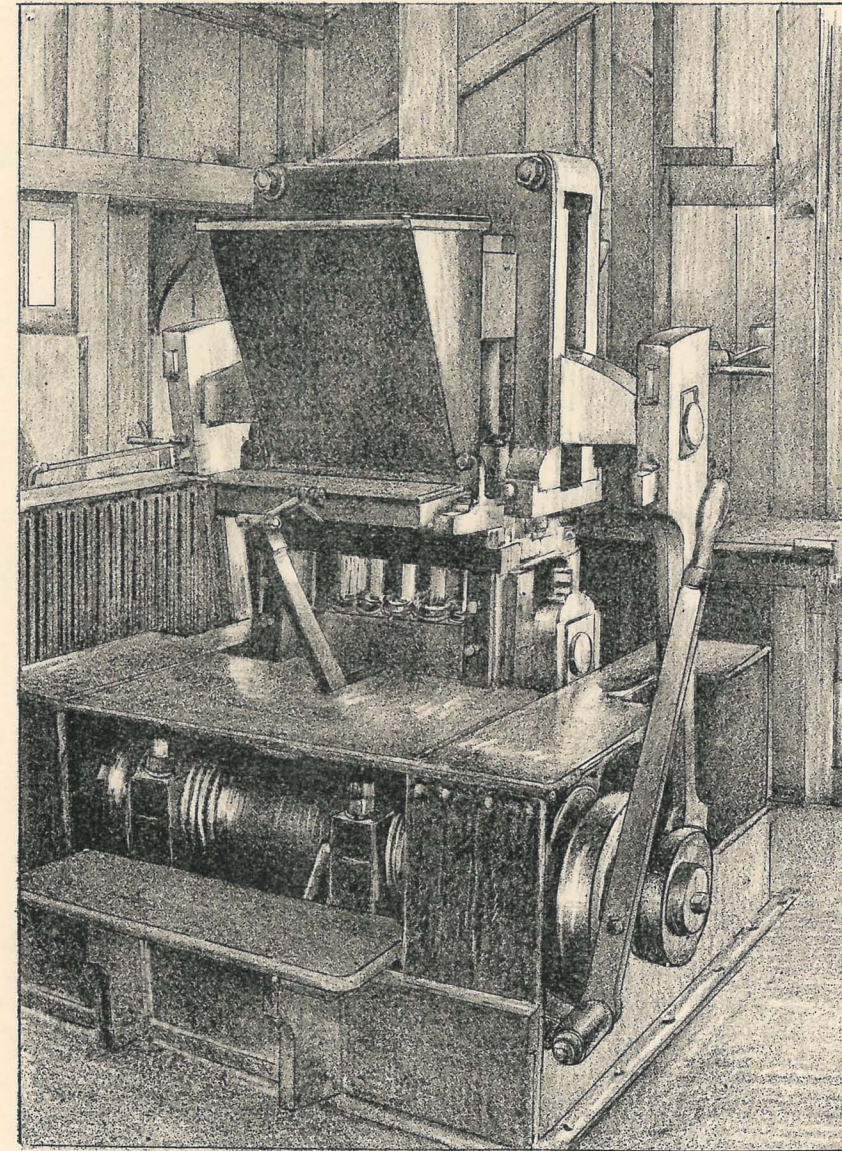


VIEWS OF No. 1 CAM MACHINE.

FRONT VIEW.



BACK VIEW.



*The front view, above, shows the cross-heads carrying the top and bottom plungers respectively. The plungers have met in the matrices or bushes and are pressing the powder into prisms.*

*The back view shows the charger or carrier brought back under and receiving the charge from the hopper.*



## APPENDIX II.

### DESCRIPTION of the Cam Machine as used in the Royal Gunpowder Factory, Waltham Abbey.

This machine is fitted with six plungers and works automatically.

The press virtually consists of a matrix-table (or bush-block) containing the matrices or "bouches" (bushes), and of two movable cross-heads carrying the plungers. The former is fixed to the frame, and the cross-heads are set in motion by rods connected with the eccentrics fixed on the right and left of the machine.

At each revolution the cross-heads approach one another—and with them the plungers—to within a minimum adjustable distance of each other, both upper and lower plungers entering the bushes and compressing the powder. In the centre of each of the lower plungers is a pin which pierces the centre of the prism during the pressure.

As soon as compression is completed the upper plungers are withdrawn, while the lower plungers continue sliding through the bushes, and force the prism of powder to the surface of the matrix-table (or bush-block).

The machines in use at Waltham Abbey are so worked as to complete four compressions a minute.

A plate (or charger), which slides on the matrix-table, and which is connected with a hopper on the back of the machine, serves to fill the matrices (or bushes), and, at the same time, to remove the prisms of powder as they emerge to the surface of the matrix-table (or bush-block).

The eccentrics are connected with two friction wheels fixed to the axle of the machine, and working in two other friction wheels of the main shaft.

The plungers and the pins are made of phosphor-bronze, which is also used for the lining of the matrices or bushes. The cross-heads and the other parts of the machine are made of steel. All light parts are now painted since the accident.

## APPENDIX III.

### DESCRIPTION of Tools that were used in Cam House, No. 2.

Fig. 1.—"Steel tongs," 10 $\frac{1}{8}$  inches long,  $\frac{3}{4}$  inch wide at the gripping part. Shanks taper down to  $\frac{3}{8}$  inch diameter; weight, 1 $\frac{1}{4}$  lb.  
Used for removing pins from pin blocks.

Fig. 2.—"Steel screwdriver," with 2 driving points, one at right angles to the other. Length, 6 $\frac{3}{8}$  inches; width of driving point,  $\frac{3}{4}$  inch; width of handle, 1 inch; thickness,  $\frac{3}{8}$  inch, tapering to  $\frac{1}{4}$  inch; weight, 9 $\frac{1}{2}$  oz.

Used for removing and tightening steel screws that secure plungers to cross-head.

Fig. 3.—"Tool,  $\frac{1}{2}$ -inch round bit," made from a piece of an old phosphor-bronze pin, with a tee bar of delta metal for a handle. Length over all, 6 $\frac{3}{4}$  inches; length of handle, 3 $\frac{1}{2}$  inches; diameter of handle,  $\frac{5}{8}$  inch; diameter of tool,  $\frac{3}{8}$  inch base; weight of tool complete, 8 $\frac{1}{2}$  oz.

Used for cleaning pin holes in top plungers, after using "cane rod."

Fig. 4.—"Gunmetal hammer," with wood shaft; head fairly worn. Length of head, 3 $\frac{1}{2}$  inches; sides of head 1 $\frac{1}{4}$  inch square, with corners chamfered; length of shaft, 12 inches; weight of tool complete, 1 lb. 11 $\frac{1}{2}$  oz.

Used for adjusting keys in connecting rods.



Fig. 5.—“Gunmetal spanner,” single end. Length,  $8\frac{3}{8}$  inches; width of jaw,  $1\frac{3}{8}$  inch; width of handle, 1 inch; thickness,  $\frac{1}{2}$  inch, tapering to  $\frac{3}{8}$  inch; weight, 1 lb. 1 oz.

Used for adjusting keys in connecting rods.

Fig. 6.—“Iron spanner,” double-ended. Length,  $7\frac{3}{4}$  inches; thickness,  $\frac{1}{2}$  inch, size of large jaw, 1 inch; size of small jaw,  $1\frac{3}{8}$  inch; weight, 1 lb. 1 oz.

Used for removing or securing screws of pin blocks to pin plate.

Fig. 7.—“Bronze awl,” made from a piece of phosphor-bronze wire, driven into a wood handle. Length of awl,  $1\frac{1}{4}$  inches; diameter of awl,  $\frac{1}{8}$  inch; length over all,  $6\frac{1}{2}$  inches; weight,  $2\frac{3}{4}$  oz.

Used for clearing water-way in bottom plungers.

Fig. 8.—“Delta metal drift.” Length 4 inches; diameter,  $\frac{3}{4}$  inch; weight,  $8\frac{1}{2}$  oz.

Used when adjusting keys of connecting rods when being struck by hammer. The drift is held in the left hand against the key, while the hammer in the right hand strikes the blow; the drift being between the hammer and the key.

Fig. 9.—Bronze wire, flattened at one end, and a ring formed in the other. Length, 5 inches; diameter,  $\frac{1}{8}$  inch; weight,  $\frac{1}{2}$  oz.

Used for cleaning out oil holes.

Fig. 10.—“Cane rod.” Length, about 22 inches; diameter,  $\frac{5}{16}$  inch; weight, about  $\frac{3}{4}$  oz.

Used for washing and clean top plungers, and holes through top crosshead. The cane is passed through, and worked up and down while the water is being passed down.

NOTE.—Nos. 2 and 6 should have been kept in cupboard in shoe room, and only used by mechanics: one of each of the other tools was kept in the cam house for the use of the men when the machines required washing out.

W. McCLINTOCK, Colonel,  
Superintendent Royal Gunpowder Factory.

ROYAL GUNPOWDER FACTORY,  
14th March, 1894.

#### APPENDIX IV .

RETURN of the Number of men searched by Police when entering or leaving the Royal Gunpowder Factory, Waltham Abbey, from January, 1893, to 28th January, 1894.

Weeks ending.	Number Searched.		Remarks. In each case the man was stopped on entering the factory.
	Entering.	Leaving.*	
1893.			
1st January .. ..	336	229	One man stopped, drunk.
8th " .. ..	474	279	
15th " .. ..	496	201	
22nd " .. ..	520	258	
29th " .. ..	519	210	
5th February .. ..	508	264	
12th " .. ..	542	282	
19th " .. ..	523	329	
26th " .. ..	533	343	
5th March .. ..	338	249	
12th " .. ..	497	235	
19th " .. ..	470	307	
26th " .. ..	499	320	
2nd April .. ..	313	209	
9th " .. ..	359	209	
16th " .. ..	438	249	
23rd " .. ..	416	266	
30th " .. ..	395	264	

\* The men are searched when leaving the factory, with a view to see that they are not in improper possession of Government property.

#### RETURN of Number of men searched, &c.—continued.

Weeks ending.	Number Searched.		Remarks. In each case the man was stopped on entering the factory.
	Entering.	Leaving.*	
1893.			
7th May .. ..	464	251	One man stopped, with matches.
14th " .. ..	453	294	
21st " .. ..	459	263	
28th " .. ..	230	133	
4th June .. ..	271	334	
11th " .. ..	474	243	
18th " .. ..	434	247	
25th " .. ..	476	281	
2nd July .. ..	386	285	
9th " .. ..	494	294	
16th " .. ..	503	331	
23rd " .. ..	506	381	
30th " .. ..	494	353	
6th August .. ..	465	373	
13th " .. ..	434	241	
20th " .. ..	520	265	
27th " .. ..	542	360	
3rd September .. ..	559	255	
10th " .. ..	569	314	
17th " .. ..	556	357	
24th " .. ..	590	302	
1st October .. ..	495	380	
8th " .. ..	574	312	
15th " .. ..	469	303	
22nd " .. ..	542	271	
29th " .. ..	539	317	
5th November .. ..	592	323	
12th " .. ..	536	418	
19th " .. ..	565	383	
26th " .. ..	542	383	
3rd December .. ..	602	416	
10th " .. ..	682	505	
17th " .. ..	582	464	
24th " .. ..	577	377	
31st " .. ..	360	253	
1894.			
7th January .. ..	600	349	One man stopped, with box of fuzees. Four men stopped, with matches and one man with pipe.
14th " .. ..	621	307	
21st " .. ..	1,082	365	
28th " .. ..	1,093	370	
Totals .. ..	27,308	17,356	

\* The men are searched when leaving the factory, with a view to see that they are not in improper possession of Government property.

RETURN of the Number and Names of men stopped with matches, &c., in their possession, from January, 1893, to 28th January, 1894.

Names.	Date of Entrance.	Date of Discharge.	Remarks.
S. Woollard .. ..	27th November, 1891 ..	16th January, 1893 ..	Drink.
W. H. Ellis .. ..	22nd June, 1893 .. ..	24th June, 1893 .. ..	Matches.
J. Howard .. ..	25th January, 1886 ..	11th October, 1893 ..	Drink.
J. Walker .. ..	6th July, 1893 .. ..	25th " .. ..	Drink.
W. Skinner .. ..	10th August, 1891 ..	15th September, 1893 ..	Matches.
A. Gossett .. ..	2nd November, 1893 ..	27th November, 1893 ..	"
Ed. Steed .. ..	1st January, 1894 .. ..	13th January, 1894 ..	"
J. Chesham .. ..	11th December, 1893 ..	15th " .. ..	"
J. Appleton .. ..	2nd January, 1894 .. ..	" .. ..	"
W. Poulton .. ..	" .. ..	" .. ..	"
A. Merris .. ..	" .. ..	" .. ..	"



## APPENDIX V.

## ROYAL GUNPOWDER FACTORY, WALTHAM ABBEY.

## A.

## GENERAL RULES.

1. Smoking is strictly prohibited in any part of the grounds, roads, or houses, belonging to the factory.
2. Lucifer matches, cigar lights, or other combustibles, are on no account to be brought into any part of the works or grounds.
3. Men are forbidden to carry keys, knives, or other articles of iron, when employed in or about the houses, mills, or boats. If from the nature of their employment any knives or tools are required, they will be supplied.
4. Before going to work in any "clean" house, mill, or boat, men are to change their own clothes in the shifting room appointed them, and put on the working dress of black lasting provided for the purpose; they will change their own boots for magazine shoes at the barrier, before entering any "clean" house, mill or boat. On leaving work they will resume their own boots and clothing. Trowsers of working dress are not to be turned up, as small stones and particles of grit are likely to be carried into the houses thereby. The working clothes supplied to men and boys of the guncotton branch are intended to protect their own clothing from acid, and are only to be used whilst at work in the factory.
5. As shifting rooms have been provided in which men will leave their own clothing, and put on that provided for them, no clothes are to be kept about the several workshops, lobbies, boiler houses or engine rooms. This rule will not apply to the guncotton, machinery, or refinery department, or to millmen at steam mills, or stokers at stoves.
6. No person is to enter or leave the factory except by the main and refinery entrance gates; those individuals having keys of the works are on no account to use them except for themselves, when on duty. In case of an accident happening, they are authorized to admit those who are employed in the factory, should their services be required, but none others.
7. Men employed in the factory are to remember that they are bound to answer civilly all questions put to them by the inspector of police, serjeant, or constable, on duty at the gates, as to the contents of bags, &c., or any articles taken by them in or out of the factory. The police have orders to search and examine from time to time persons taking anything in or out of the gates.
8. All persons employed in the factory are cautioned not to answer enquiries from strangers, with regard to any of the arrangements of the factory. No information with respect to these arrangements must ever be given to unauthorized persons.
9. No workman employed in the factory is to enrol himself in any of the Reserve Forces without the permission of the Superintendent.
10. Instances having occurred of men rupturing themselves while lifting boxes or barrels of powder, all concerned are cautioned against lifting any heavy weight while the feet are apart. The danger of rupture is greatly lessened by keeping the feet close together.
11. Men employed in handling gunpowder or its materials, in any stage of manufacture, must be careful to keep their hair and beards cut short, in order to lessen the risk of introducing particles of sand or grit.
12. Men employed in powder houses are specially cautioned to carry on the work entrusted to them in as careful and gentle a manner as possible. No undue haste must ever be made, and no greater force employed than is absolutely needed to effect the object in view. It must be remembered that a degree of friction which may be safely endured by powder alone, might cause accident if by chance any foreign substance has become mixed with it.

13. The greatest care must be taken to keep the platforms, floors, and exterior of powder houses and boats perfectly free from dirt or grit. The platforms and outsides of houses should be constantly wetted in dry weather.

14. No implements are to be used in any powder house, mill, or boat, except those provided, and these tools are to be handled carefully, and never to be thrown down violently.

15. Open powder barrels and charge tubs are always to be rolled on their chines, and never dragged along the platforms or the floors of houses or boats; they are never to be placed one in the other when filled with powder, but each rolled separately.

16. Special care must be taken to redouble every precaution during the prevalence of hot dry weather, when particles of sand or grit are more likely to be blown into the houses, or to be carried about in men's dress or hair than at other seasons.

17. When a thunderstorm is seen passing over the factory, the men employed in powder houses, mills, or boats, are carefully to close the window shutters and doors, stop the machinery, and quit the vicinity of such houses, mills, or boats, until the storm has passed.

18. All foremen and men of the factory are to obey, without hesitation, the orders of the chief foremen, or their assistants; in the same manner, the men are to obey the foremen placed immediately over them. Should a man consider himself aggrieved, he can afterwards make a complaint to his chief foreman, who will bring the case to the notice of the assistant superintendent.

19. There is no thoroughfare past No. 1 Mill, or on the mill head; no men are allowed to pass that way except those whose duties oblige them to do so. The men employed at the barrel houses must go round by the long walk.

20. Men employed in "clean" houses, mills, or boats, will be searched by the foremen under whom they work, after they have put on their lasting clothes. The foreman will report daily having carried out this order.

21. Greatcoats are only issued to those men whose duties necessitate their being much exposed to bad weather when wearing powder clothes; they are never to be taken out of the factory without special permission from the Superintendent. When not required for use, they will be hung in the main shifting room, or other place allotted to the wearer for changing his clothes. In bad weather, when not actually worn, they may be hung in the lobbies of the houses in which the wearers are employed, but are to be restored to the shifting rooms after the work is over.

22. Magazine shoes will only be issued to men employed in "clean" houses and boats; men of the store and machinery branches will only wear them when actually employed in "clean" houses.

Worn magazine shoes may be issued to the foreman and men of the cylinder, sulphur, and saltpetre houses, only to be worn by them while actually at work.

Goloshes, or overboots, are to be in charge of the master-worker, and shown on the "use lists" of houses; they are intended for the use of persons entering powder houses casually, and are never to be worn by the workmen.

23. Mats will be placed just within the *outside* doors of the lobbies of "clean" houses, and not inside "clean" houses themselves; they will be very frequently removed for shaking.

24. No person employed in the factory, either permanently or temporarily is permitted to remove bundles of chips or shavings from the grounds of the factory. At the completion of a job, or when otherwise authorized, they may be taken away in bulk, with a pass duly signed.

25. Persons occupying Government cottages, whether rent free or on payment, are prohibited to receive any inmates, except the wife and children of the tenant, without the express sanction of the Superintendent. All incoming tenants are to sign an agreement to this effect.

W. McCLINTOCK, Colonel,  
Superintendent.



## B.

### RULES FOR CAM HOUSES, LOWER ISLAND.

1. Before work is commenced, the foreman on duty will examine all the machinery, and see that everything is "clear" before starting the machine.

2. Great care must be taken to prevent any undue straining of the machine, as a neglect of proper precautions has led to serious accident. The men working the machine must perform their duties with vigilance, and they will be held responsible should any accident happen from their neglect.

Attention is called to the following precautions:—

It is most important that no grain beyond the proper quantity is in the "bouches" when a pressing is commenced.

The hopper of the machine should be emptied before cleaning down.

When starting afresh, the machine should first be run several times with the hopper empty, and stopped so that the chargers are over the dead plate. The hopper should then be loaded up and the machine started.

If this be done, a larger charge than that given by the natural motion of the machine cannot get into the "bouches."

After any stoppage of the press, from whatever cause, the grain in the charging rings should be partly taken out before the machine is again started. Care must be taken that there is no obstruction to its free working on starting, and that at all times the prisms delivered from the "bouches" are properly discharged down the machine and clear of the return stroke of the top plungers. If the prisms hang back from any cause the machine must at once be stopped.

If there be any suspicion of undue straining, due to any cause, the machine should be stopped, and the circumstance reported to the master worker or the foreman of machinery at the Lower Island.

3. The quantity of powder in the house for each cam machine must never exceed 200 lb.

4. No gunpowder is to be kept in the house when not at work.

5. The floors must always be kept cleanly swept, and no powder dust is to be allowed to accumulate in the house or on the machinery.

6. No person, except those who are properly instructed and duly authorized, are at any time to meddle or interfere with the machinery.

7. Any defect in the machinery, or any repair required, should be at once reported to the master worker and to the foreman of machinery, Lower Island.

8. The foreman is responsible that the moulding records are duly entered in the book provided for the purpose.

W. McCLINTOCK, *Colonel,*  
*Superintendent.*

## C.

EXTRACT from the *Rules and Regulations of the Ordnance Factories.* A copy of which is in the possession of each workman employed.

47. Workmen are to render implicit and unhesitating obedience to the orders of the foremen, or others, under whom they are employed. They are also to obey the orders of the warden. Any act of disobedience or insubordination will lead to the immediate suspension of the offender, and, in aggravated cases, to his dismissal.

48. Machines are not to be cleaned when in motion. Workmen are strictly forbidden to replace bands on main shafting unless specially authorized by their foreman to do so. Any person, other than those so authorized, who shall be detected in replacing or removing bands, will be liable to dismissal.

49. Any man coming to his work intoxicated, or known to lose time through intemperance, will be discharged.

50. No employé is permitted to keep a public house, beer house, or marine-store dealer's shop.

55. If any workman has any communication or complaint to make, he must do so through the foreman under whom he is employed. The foreman will at all times forward every complaint he may receive to the manager, who will investigate it, and, if he considers it necessary, report to the Superintendent. All complaints made in a proper and respectful manner will receive careful attention, and it is to be distinctly understood that every workman has a right of appeal to the Superintendent. Workmen are cautioned against making misrepresentations or frivolous complaints of any kind, or forwarding complaints through any other than the proper channel. Any infringement of this order will render the offender liable to dismissal.

57. Any workman who may inadvertently bring lucifer matches or other dangerous articles, or a tobacco pipe, into the works, should immediately deliver them up to his foreman, otherwise he will render himself liable to suspension or, on repetition of the offence, to discharge. Any workman found with such articles in danger buildings will be at once dismissed.

Smoking is, however, permitted to men on night shift when no danger is incurred thereby. Superintendents of factories will decide what men are to be permitted to smoke, and will specify places and hours for the purpose.

58. Workmen employed in danger buildings should make themselves thoroughly acquainted with the printed instructions in regard to the work, which are posted in the workshops, as ignorance of these will not be accepted as an excuse for irregularities.

## APPENDIX VI.

### REPORT from Colonel W. McClintock, R.A., Superintendent of the Royal Gunpowder Factory.

Royal Gunpowder Factory,  
Waltham Abbey,

31st January, 1894.

Sir,

As directed, I now forward a short statement with reference to points 1 to 4 of Colonel Majendie's memorandum—

1. "Exactly when and how the accident occurred."

At 2.35 a.m., on the 13th December, 1893, an explosion, or rather two explosions, took place in the south end of No. 2 Cam House, Lower Island; and after a short interval the north end of the cam house exploded, as also the powder boat which was lying alongside. The two ends of the house were separated by a water wheel, and a wooden wall on each side of the wheel. In each end of the house there were two cam machines, two men working each machine. A foreman had charge of both ends of the house, passing from one end to the other along a clean covered passage in front of the wheel. The powder boat was worked by two men, so at the time of the explosion eleven men were present.

2. "The quantity of gunpowder, whether in the form of grains or prisms, which exploded or burnt."

The total amount of powder destroyed was 1,200 lb. It is believed that half of this amount was in grain and half in prisms, because it was the duty of the boatmen to bring the grain to the house and to remove the prisms already made.

3. "The effects of the explosion as regards (a) personal injury; (b) structural damage; and (c) injury to machinery, and other damage."

(a.) Of the eleven men present at the time of the explosion, one escaped unhurt, one was killed on the spot, eight died from shock and burns, and one is now doing well. List "A" gives the men's ages and length of service.

(b.) The explosion blew out the windows of the house, but as far as I could see did not damage the walls or roof. The house was set on fire, and was almost entirely consumed before the fire was extinguished.



(c.) The water wheel continued to revolve and to work the machines after the explosion, and was only stopped when the roof fell in and jammed it. Owing to this the wheel was quite uninjured by fire, as the fire was almost extinguished when the roof fell in. The cam machines were slightly damaged, one had a top plunger broken by a screw from the roof falling into the bush, and others had bushes damaged by prisms exploding in them. The boat had one-half of the hood blown away. Photographs of the house and machines have already been forwarded to you.

4. "The various possible causes of the accident."

The only possible cause of the explosion, that I can imagine, is, that in some way a match found its way into the house and was ignited by the powder barrel being rolled over it. As the machines were working at the time of explosion no repairs or alterations to them could have been going on. The machines were in good order, as proved by the evidence of the foreman of the day shift. The foreman of the night shift was a very careful trustworthy man, and would have seen that all regulations were carried out. I forward the result of examining 28 men who had been accustomed to work these cam machines (*see* Appendix VII). The electric light was outside the building, and the wind which was blowing a gale, did not come from the direction of any source of fire, besides heavy rain was falling, so I do not consider it possible that the fire came from any external source. Grit might have got into the building, but as nearly all the working parts of the machines are of phosphor bronze, a spark from this cause is not likely. The floor was covered with leather, so that even if some grit had got upon it, I doubt if rolling a barrel over it would have caused a spark.

I have, &c.,  
W. McCLINTOCK, Colonel,  
Superintendent.

The Secretary of the  
Waltham Abbey Explosion Committee.

A.

LIST showing men who were killed or injured, &c., in the explosion at the Lower Island, Cam House No. 2, on 13th December, 1893.

ROYAL GUNPOWDER FACTORY, WALTHAM ABBEY.

Name.	Employment.	Age.		Length of service at R.G.P.F.		Remarks.
		Yrs.	Mths.	Yrs.	Mths.	
Bailey, James .. ..	Foreman .. ..	30	8	15	7	Died 19th December, 1893.
Carr, William John .. ..	Skilled labourer .. ..	20	0	6	2	Injured.
Clayden, James .. ..	" .. ..	22	5	7	5	Died 14th December, 1893.
Massey, Henry .. ..	" .. ..	24	0	6	2	" 13th " "
Larman, Edward .. ..	" .. ..	21	0	6	0	" 18th " "
Jennings, Henry .. ..	" .. ..	28	0	2	3	" 14th " "
Rudkin, William .. ..	Labourer .. ..	23	0	2	1	" " " "
Rudd, George .. ..	" .. ..	25	0	1	3	" " " "
Watts, Walter .. ..	" .. ..	27	0	1	5	Killed on the spot, 13th December, 1893.
Hare, Benjamin .. ..	" .. ..	21	0	1	1	Died 19th December, 1893.
Skinner, Henry .. ..	Skilled labourer .. ..	35	0	6	3	Escaped uninjured.



STATEMENTS (in the form of Answers to certain Questions) of Workmen familiar with the Working of the Cam Machines in use at the Royal Gunpowder Factory, Waltham Abbey.

Name.	Present employment?	When employed in cam house?	At which machine employed?	How did the machine work?	Did you have any difficulty with		Did you find the pins get hot, if so, so hot, that you could not bear your hand on them?	Did you consider the machine dangerous; if so, in what way?	Did you ever complain about the machine; if so, to whom?	Did you ever know of any skylarking going on during the working hours amongst the men, such as throwing prisms or other articles at one another.	Was the house sufficiently lighted?	Were men anxious to work in the cam houses or not?	Is there anything connected with the cam house work which you would like to mention?
					(a) Pins?	(b) Plungers?							
1. Adams, Samuel ..	Stores .. .. .	About four years to summer 1891.	Foreman .. .. .	Pretty fairly, on the whole ..	I don't recollect any difficulty with pins (gun-metal.) The steel pins used to score, and they were rather hard to clean at times. Never worked machine without getting water to run.	The top ones very seldom used to clog; used to stop and clean by probing or washing with hot water.	Never noticed the pins get hot, and never heard any complaints about this. The bush block used to get very hot at end of run, so that the hand could not be borne on it.	No .. .. .	Complained about charger hanging up.	No .. .. .	Might have been better.	Don't know .. ..	No.
2. Argent, Daniel ..	No. 3 breaking-down house.	For four or five months to Saturday before explosion.	No. 4 .. .. .	Pretty fairly, all but the pins..	At times ran warm .. .. .	Top plungers got choked; freed with a cane, or removed and soaked in hot-water.	Never so hot, could not bear hand on them.	No .. .. .	To Foreman Ephgrave about pins running warm.	No .. .. .	Yes; beautiful light..	Heard several say they would like to work there.	No.
3. Beach, Alfred ..	Blending house ..	About four months. Worked up to 12th December, 1893.	No. 5 .. .. .	All right on 11th and 12th ..	Difficulty in getting water to run with the new pins the previous week. Foreman's orders were never to leave the pins until the water had been made to run, and had always made the water to run before leaving them. Left them all right on Tuesday the 12th by special orders of the foreman. Never knew machines restarted till water had been made to run.	..	Warm. Never so warm that the hand could not bear it, the hot water used for washing made them warm.	No .. .. .	No .. .. .	Never .. .. .	Yes .. .. .	Were anxious to work there; better pay.	Nothing.
4. Biss, Percy .. ..	Drum house .. ..	About five or six months to stop for new water wheel.	No. 2 .. .. .	Middling .. .. .	Water would not run very well. Always got it to run before restarting the machine.	No .. .. .	Nothing out of the way; the hot water used for washing made them warm. Never so hot, could not bear hand on them.	No .. .. .	No .. .. .	No .. .. .	Yes .. .. .	..	Was at drum house on night of explosion, on platform near shoe house. Heard a report, looked round and saw sparks issuing from the cam house, ran into shoe hole, changed shoes, took lamp out of cupboard, and ran towards cam house. Heard another explosion when in shoe hole, and a third when between No. 1 cam and press houses. With A. Carr, got Rudkin out of head water, and Clayden and Larman out of tail stream. Clayden said, "it was my machine which went first," Larman told me in hospital on Saturday after the accident that it was Clayden's machine which went first (No. 2.)
5. Brace, Alfred W. ..	No. 1 moulding house ..	Was boatman from April to August, 1893.	No. 2 when restarted in November.	Well, except when the new pin was put in about a fortnight before the accident. The machine worked well in the day shifts, Monday and Tuesday, 11th and 12th December.	None on the 11th and 12th. Water would not run freely when new pins were put in, but got it to run before restarting, although it took longer than usual. Never restarted without clearing the pins.	None .. .. .	Always worked that I could bear my hand on them. Mum said they were out about a week before the accident.	Never had any fear .. ..	Only that I could not get the water to run very freely at times: to the foreman.	Never .. .. .	Well lighted .. ..	Never heard any objection to the cam house work; those that have worked there prefer them to the moulding houses.	Nothing.
6. Carr, Arthur H. ..	.. .. .	From starting of new water wheel.	No. 4 .. .. .	Very well .. .. .	Just a little while to get water through sometimes, but always got it through before restarting.	No .. .. .	No, except when washing out with boiling water.	No .. .. .	No .. .. .	No .. .. .	Yes .. .. .	Never heard complaints.	I was working at the drum house. Biss and I were on our way to the drum house shoe room when we heard a report, and saw burning prisms flying about. We ran into the shoe room, took off shoes and put on boots, took the two electric lamps, and ran up as hard as we could to the cam house. A second explosion took place while we were changing our boots, and a third whilst we were running up, having got about to the press house. Carr's brother told him that the boat went last. Clayden told him as soon as he got him out of the water that it was his machine which "blew."
7. Carr, Frederick ..	Chargeman, No. 4 moulding house.	About six months ..	Nos. 4 and 5 ..	Very well .. .. .	Nothing much; sometimes water would not run very freely.	None .. .. .	Just warm, could always bear my hand on them.	No .. .. .	No .. .. .	No .. .. .	Yes .. .. .	Yes; rather than in some of the other houses.	Nothing.
8. Carr, Herbert .. ..	No. 4 moulding house..	From a month before new water wheel was put in to 12th December, 1893.	No. 5 .. .. .	Very well .. .. .	Yes, difficult to get the water to run down in cleaning out, but managed it after working some time.	None .. .. .	Yes, but not so hot but that I could bear my hands on them.	No .. .. .	No .. .. .	No .. .. .	Yes .. .. .	Yes; I would rather work there than in A, B, D, or G houses.	No.
9. Clarkhall, W. .. .	Mixing house .. ..	Up to three months ago.	Nos. 1, 2, 3 and 5 ..	Sometimes well, sometimes troublesome.	No. 2, the worst, difficulty in getting water to run. Never restarted working until had got water to run.	Top plunger got clogged; removed and soaked in hot water.	Never knew them get hot, only warm; could always bear my hand on them.	Yes, when the charger would not come over, owing to powder getting under.	No .. .. .	No .. .. .	Yes .. .. .	..	Improve means of cleaning out pins and plungers.
10. Ephgrave, George ..	Foreman of cam house..	From 17th April to 12th December, 1893.	..	Generally satisfactory .. ..	With new pins generally, a little extra trouble to get the water to run.	None .. .. .	No, only warm; could always bear the hand on them.	No .. .. .	No .. .. .	No .. .. .	Yes .. .. .	Never heard any objections to work in the houses.	Would suggest holes in bottom crosshead in which pins work be made with a hole in the side, so as to squirt water into them.
11. Eve, Alfred .. ..	Charcoal house .. ..	On day shift for about 8 months to day of explosion.	No. 3 .. .. .	All right .. .. .	Last lot of pins the worst; very difficult to get water to run. Never restarted machine without getting water to run.	None .. .. .	Got warm, could always bear hand on them.	Thought the iron roller for counter-weight band over machine dangerous, as there was nothing to prevent its falling on the machine if it broke.	No .. .. .	No .. .. .	Yes .. .. .	..	Pipes to bottom of machine, to take washing water and powder away. Steel parts of machine might be painted.
12. Guthridge, S. .. .	Water millman .. ..	About six months to stoppage of old wheel.	Nos. 3 and 5 .. ..	Very well, except that charger used to hang up.	Trouble at times to make the water run. Always got it to run before restarting the machines.	Top plunger sometimes got blocked; if it could not be cleared with the cane, removed it and soaked in hot water.	Warm, never so warm; could not bear hand on them.	No danger in them at all ..	No .. .. .	No .. .. .	Very good light ..	..	No.
13. Hickman, A. .. .	No. 3 granulating house	For three or four years to stoppage for new water wheel.	All .. .. .	Pretty fair, except on prism brown. Charger used to hang up.	Difficult to get water to run. Sometimes took half-hour, but never restarted machine until had got water to run.	No; broke occasionally ..	Warm, not so warm; could not bear hands on them.	Could not see any danger in them.	No .. .. .	No .. .. .	Light very bad at times.	..	No. Cannot see where any improvement can be made in the machines.



Name.	Present employment ?	When employed in cam house ?	At which machine employed ?	How did the machine work ?	Did you have any difficulty with—		Did you find the pins get hot, if so, so hot that you could not bear your hand on them ?	Did you consider the machine dangerous; if so, in what way ?	Did you ever complain about the machine; if so, to whom ?	Did you ever know of any skylarking going on during the working hours amongst the men, such as throwing prisms or other articles at one another ?	Was the house sufficiently lighted ?	Were men anxious to work in the cam houses or not ?	Is there anything connected with work which you would not do in a cam house ?
					(a) Pins ?	(b) Plungers ?							
14. Hollingbury, George ..	Tankman, No. 5 moulding house.	From October, 1892, to January, 1893.	Boatman .. ..	Sometimes heard complaints about the chargers hanging up.	.. ..	.. ..	.. ..	.. ..	.. ..	No .. ..	Yes; quite enough to see to take powder in and out.	A great desire amongst the men to work in the cam houses.	Nothing; would willingly go to work there.
15. Knooler, Ernest ..	Blending house ..	From April to September, 1893, and a week previous to the accident.	No. 4 on 11th and 12th, No. 5 previous week at night.	No. 5 worked all right ..	Difficulty in getting water to run through pins at No. 4 on Monday. In the afternoon restarted the machine without getting the water to run. Left machine on Monday night in that condition. Tuesday, machine worked all right, and left it clean.	Top plungers sometimes got stopped, but always managed to clear them with cane or with hot water and upper rod.	Warm, but not so warm that I could not bear my hands on them.	No .. ..	No; thought it one of the safest houses in the factory.	Never .. ..	Yes .. ..	.. ..	Nothing.
16. Lane, Walter .. ..	Millman.. ..	For two or three years to about two years ago.	No. 2, mostly ..	Pretty fair .. ..	Sometimes when worn, difficult to get water to run. Never restarted working till water was got to run.	Top ones got clogged. Cleared with cane or old pin, or removed and soaked in hot water.	Sometimes warm, but not so warm that I could not bear my hands on them.	No .. ..	No .. ..	No .. ..	Yes .. ..	.. ..	Nothing.
17. Loder, Thomas ..	Chargeman, No. 1 moulding house.	From 1887 to 1893 ..	All .. ..	.. ..	When pins were worn, there was a little difficulty in washing out, but always got the water to run before restarting.	A little difficulty with top plunger when pins were hot, obstruction easily removed by using the cane.	No, could always bear the hand on them.	No .. ..	No .. ..	Never .. ..	Yes .. ..	Three parts of the men in the factory were always anxious to go there.	.. ..
18. Mead, Harry .. ..	Drum house .. ..	For eight days before the accident (day shift that week).	.. ..	Worked very bad the first four days; could not get water to run. Friday and Saturday went a bit better. Monday and Tuesday could not have worked better. Left them all right for Tuesday night.	Always got the water to run before restarting, in accordance with orders from Ephgrave and Bailey.	No .. ..	Got warm, not so warm I could not bear my hand on them.	Wanted a lot of watching. Dangerous, as the charger was likely to hang up. Not much experience.	No .. ..	No .. ..	Yes .. ..	.. ..	.. ..
19. Mumford, Samuel ..	General.. ..	A week last year, and since the new water wheel was put in.	No. 4.. ..	All right till the new pins were put in	Yes, in getting water to go down on the Friday night and Monday, did not succeed in getting water to run through pins of Nos. 2 and 4. Left them so on Monday night. Tuesday morning they were better, and left them all right on Tuesday night.	No .. ..	No. 4 ran hot on Monday; could bear the hand on it. I have been in south end and felt pins on No. 2; they were very hot and could not bear hand on them for long. This was between bottom plunger and cross-bar to which pin is screwed.	Yes, I thought it dangerous because the water would not go through the pins properly.	Complained to foreman that water would not run down the pins in No. 4 machine.	Never saw prisms thrown about.	Yes .. ..	.. ..	Objects to some machines working up for others which have been delayed from some cause or another, but has no real reasons for the objections.
20. Pearman, George ..	Main shifting room ..	For over two years to within two years ago.	All .. ..	Fairly .. ..	Could not get water to run down the pins freely sometimes. Never restarted working until had got water to run; had to unscrew pin from block and work it up and down until free when very bad.	Top plungers got stopped sometimes; removed obstruction by means of a cane, or, if very bad, with water and old pin, or removed and soaked.	Warm all over; could always bear hand on them.	No .. ..	No .. ..	No .. ..	Yes .. ..	Yes, rather at that time.	No.
21. Ponder, Joseph ..	Boatman, granulating house.	During August, 1893 ..	Boatman .. ..	Never heard any complaints ..	.. ..	.. ..	.. ..	.. ..	.. ..	No .. ..	Yes, sufficient to take powder in and out.	.. ..	.. ..
22. Robinson, Herbert ..	No. 2 granulating house.	For about 5½ years to three or four months ago.	All .. ..	.. ..	Sometimes water would not run freely. Never restarted work without first getting water to run; this was the order, and was always carried out.	Top plungers sometimes got clogged; cleared with a cane, and if this did not answer, plunger was taken off and soaked in boiling water.	They got warm, due to the hot water used for washing. Never got so hot in working that could not bear hand on them. Never heard of it.	Wanted great care, especially the charger. Did not consider the machine dangerous.	No .. ..	No .. ..	Yes .. ..	A good many used to ask for it.	Nothing.
23. Saville, Charles ..	Millman.. ..	For about two years to within three years ago.	Nos. 1 and 4, chiefly..	Charger used to work very bad, did not come over with certainty.	At times. Difficult to get water to run; always got it to run before restarting.	Top one used to get blocked; cleaned it out with cane or old pin, or removed and soaked in hot water.	Middling warm, but never so hot I could not bear my hand on them. No part so hot.	No .. ..	Complained to engineer occasionally about charger and pins.	No .. ..	Yes, a nice light ..	Yes, I knew several..	No.
24. Skinner, Henry ..	Machinery .. ..	For about 18 months to night of explosion, when he was working No. 5 machine.	.. ..	All right .. ..	A little difficult at times to get water to run. Never restarted until pins ran properly.	No .. ..	Warm, but never so warm could not bear hand on them.	No .. ..	No .. ..	No .. ..	Yes .. ..	I believe they were. I have heard them ask to go there.	No.
25. Steele, Henry .. ..	.. ..	For about three weeks to day of accident (day shift).	No. 3.. ..	All right, very good machine..	Difficulty with last lot of pins to get water to run. Never restarted without getting water to run.	None .. ..	Got warm after washing out with water (boiling).	Not at all .. ..	No .. ..	No. Place always kept in good order, and clean platforms and all.	Yes .. ..	.. ..	Tramcar between cam house and magazine. Carr told Nurse Jones this morning, and I heard him, that he saw sparks go in under the hood of the magazine.
26. Taylor, George ..	No. 4 moulding house	From April to December, 1893.	Nos. 2 and 5.. ..	Very well .. ..	Yes, to get the water to run down in cleaning. No. 2 worse than No. 5. Always got the water to run before restarting the machine.	None .. ..	Only warm; could always bear my hand on them.	No; otherwise I should not have volunteered to go back to them the other day.	No .. ..	No .. ..	Yes .. ..	Heard no opinion as to machine being dangerous.	Nothing.
27. Wackett, Alfred ..	No. 3 dusting house ..	For three or four years to six months ago.	All .. ..	All worked well .. ..	Sometimes, when pins were difficult to get water to run. Never restarted working until water had been got to run. This was the order.	Sometimes top ones would clog. Removed and soaked in hot water till clean.	Just a little warm .. ..	No .. ..	No .. ..	No .. ..	Yes .. ..	.. ..	Nothing.
28. Wraighte, Cyril ..	No. 1 press house ..	For about a year four years ago.	All .. ..	Very bad. Chargers hung up..	Could not get water to run sometimes. Used to restart working without getting water to run.	Top plungers sometimes got clogged, removed them and soaked them.	Yes, got very warm; could not bear hand on them for long; also the bed.	Yes, because the charger sometimes came forward too sharply, cutting the prisms and sending them so that they hit the boards of the house. On one occasion in unscrewing screw securing bottom plunger, the steel plunger key-spanner slipped and struck side of the machine, causing sparks. This happened when at No. 1 machine. Reported it to Foreman S. Adams, to Mr. John Turnham, and Mr. Findlay. Machine had been washed out.	To Colonel Barker about the charger of No. 5 hanging up, and the manner in which the machines were working.	No .. ..	.. ..	I believe a number of them were anxious.	Steel plunger-keys should not be used when there is powder in the house. Emery should not be used in cleaning the machines. Shoeroom requires alteration to prevent grit getting from mat into house. Experienced men should be employed to work the cams.



APPENDIX VIII.

ACCIDENTS caused by Implements, &c.

Date of Accident.	Where Accident occurred.	Nature of Accident.
1854 .. .. .	Roslin .. .. .	Man killed whilst chipping indurated powder from mill bed with a copper hammer.
16th June, 1870 ..	Lower Island Press-House, Waltham.	Five persons killed and four injured in an explosion caused by the use of a copper chisel, or spud, to separate the press plates.
22nd October, 1871 ..	Sedgwick .. .. .	Some workmen were engaged in covering the roof of the corning house with roofing-felt, and for this purpose were driving a 3-inch nail into the roof, which was composed of sheet-iron. A spark fired the gunpowder in the house, and communicated to the press-house. Three killed, three injured.
30th March, 1872 ..	Tuckingmill .. ..	An iron "arm" of a machine in a fuze-spinning room fell on to the floor, and ignited some powder dust, which set fire to some fuze. Eight girls were suffocated.
17th April, 1872 ..	Ballincollig .. ..	Removing hard powder with a copper hammer, or scraper, from mill bed. One killed, one injured.
22nd December, 1872 ..	Melfort .. .. .	A man chipped off incrustation of gunpowder in a mill with a metal tool, causing an explosion, which killed him.
24th July, 1874 ..	Gatebeck .. .. .	A man killed whilst removing indurated powder from a mill bed.
3rd August, 1874 ..	Chilworth .. .. .	A man killed whilst removing indurated powder from a mill bed.
12th October, 1875 ..	Factory 13. Westmoreland.	Two men killed whilst removing indurated powder from mill bed with a mallet. Attributed to grit.
15th October, 1875 ..	Factory 32. York.	A steel file fell in an earthenware bowl containing squib composition, and ignited it. Three killed and three injured.
12th May, 1876 ..	Factory 24. Cornwall.	Explosion (attributed to striking a wooden mallet on grit) occurred in the breaking-down house; communicated to expense magazine, press-house, and mill. Three killed.
14th October, 1876 ..	Factory 24. Cornwall.	An explosion occurred in the corning house, caused by removing indurated powder from metal rolls by a metal implement. Two killed.
9th March, 1877 ..	Factory 30. Cork.	One man killed whilst removing indurated powder from mill bed with a copper hammer.
2nd June, 1877.. ..	Factory 19. Westmoreland.	Millman trying to remove the "trod" by means of a wooden mallet without having taken the precaution to put on magazine overalls. One killed.
10th August, 1878 ..	Factory 15. Derby.	Gunpowder exploded in mill at Fernilee, through a hammer falling on iron lining of a runner while the mill was undergoing repairs. One killed, two injured.
27th March, 1879 ..	Factory 49. Middlesex.	Some powder dust, which had collected under the leather covering of one of the bolts, exploded while the leather was being removed. No one killed or injured.
11th April, 1879 ..	Factory 91. Nottingham.	An engineer using a steel chisel to ease part of a machine, to clean and overhaul it, struck a spark which ignited sweepings of powder. One injured.
21st April, 1879 ..	Cartridge Factory. Royal Laboratory.	A boy was killed by an explosion of some explosive on a table, which he is supposed to have struck with an iron spanner.
19th March, 1881 ..	Factory 40. Lancashire.	The gunpowder in the press-house exploded, possibly through a blow struck by a wooden hammer whilst breaking down mill cake, or in the operation of removing the pins of the press-box. Three killed and three injured.

Name.	Present employment?	When employed? (can hours?)	At which machine employed?	How did it happen?
14. Hollingbury, George ..	.. .. .	.. .. .	.. .. .	.. .. .
15. Knicker, Ernest .. .. .	.. .. .	.. .. .	.. .. .	.. .. .
16. Lane, Walter .. .. .	.. .. .	.. .. .	.. .. .	.. .. .
17. Loder, Thomas .. .. .	.. .. .	.. .. .	.. .. .	.. .. .
18. Mead, Henry .. .. .	.. .. .	.. .. .	.. .. .	.. .. .
19. Mansford, Samuel .. .. .	.. .. .	.. .. .	.. .. .	.. .. .
20. Parnes, George .. .. .	.. .. .	.. .. .	.. .. .	.. .. .
21. Pender, Joseph .. .. .	.. .. .	.. .. .	.. .. .	.. .. .
22. Robinson, Herbert .. .. .	.. .. .	.. .. .	.. .. .	.. .. .
23. Saville, Charles .. .. .	.. .. .	.. .. .	.. .. .	.. .. .
24. Skinner, Henry .. .. .	.. .. .	.. .. .	.. .. .	.. .. .
25. Steele, Henry .. .. .	.. .. .	.. .. .	.. .. .	.. .. .



Date of Accident.	Where Accident occurred.	Nature of Accident.
21st July, 1881 ..	Factory 19. Westmoreland.	The gunpowder in the press-house exploded, possibly due to a blow on the press-box, given by one of the men removing cake from the press. Two killed.
11th April, 1883 ..	Factory 29. Cornwall.	During repairs to mill, a blow from a sledge hammer on curb ignited some incrustated powder. One injured.
24th April, 1883 ..	Factory 1. Yorkshire.	Slight explosion while removing indurated powder from curb of mill with phosphor-bronze pick. No one injured.
15th November, 1883 ..	Factory 11. Surrey.	Attempted removal of indurated powder by a copper spud. One injured.
9th July, 1885 ..	Factory 2. Edinburgh.	Removing incrustations from mill with heavy metal spud. Two killed.
20th July, 1885 ..	Factory 21. Kent.	Mills were not working. The millman stated that the accident was his own fault, that he drew fire, but what was the exact act of imprudence that he committed did not transpire. One killed.
17th April, 1886 ..	Factory 11. Surrey.	Mill exploded at Chilworth, due to a wooden shovel being left on the bed. No one injured.
3rd June, 1886 ..	Factory 19. Westmoreland.	While changing mould block in cartridge press-house, and removing incrustated powder with a brass disc, the powder flashed. No one injured.
14th May, 1887 ..	Factory 22. Cornwall.	An old incorporating mill, which had been out of use for some time, was being taken down, a spark is supposed to have been caused by striking an iron bolt with an hammer. No one injured.
6th September, 1887 ..	Factory 23. Lancashire.	Two men were repairing Mill 25, using iron setters, or dogs, and a sledge hammer, and thus ignited some powder dust, which burned them fatally.
7th November, 1887 ..	Factory 29. Cornwall.	Press-house exploded, two killed; probably due to some percussion or friction in taking the press-box to pieces, &c.
16th February, 1888 ..	Factory 19. Westmoreland.	Millman was working at the "trod," the mill itself was free of powder except the "trod." The explosion fired some powder at the door. One injured.
18th March, 1888 ..	Factory 15. Derby.	Millman hit a portion of incrustation on curb with a brass hammer, it ignited and burned the man's face and hands. One injured.
27th April, 1889 ..	Factory 20. Argyll.	A worked charge had been removed, and the head mill keeper was engaged in preparing the mill for the reception of a green charge; while so engaged he employed a copper hammer incautiously, either in connection with the removal of some powder incrustations, or for other purposes. One killed.
22nd October, 1890 ..	Factory 2. Edinburgh.	An explosion occurred in the Kirkettle glazing house, due to improper repair of glazing reel, while containing gunpowder, with a steel wrench. Two killed.
6th May, 1891 ..	Factory 18. Westmoreland.	The accident was caused by dragging the box (into which the worked charge is taken off) over the powder incrustated mill bed. Two injured.
11th September, 1891 ..	Factory 20. Argyll.	706 lb. of gunpowder exploded while a delta metal liner, or brush, was being forcibly removed from an iron die plate, used for compressing "303" pellets, with a steel-ended punch. One killed.
10th November, 1891 ..	Factory 26. Brecon.	Millman was trying, in direct defiance to rules, to remove some powder incrustations from the bed with a copper paddle. One injured.
24th March, 1893 ..	Factory 15. Derby.	Engineer tapping the machinery with a brass hammer fired the clinker. Two injured.

The above list does not include cases of accidents from spindles and nuts on becoming fractured or detached.

APPENDIX IX.

EXPLOSIVES ACT, 1875.

NUMBER of persons allowed in houses in which the pressing of gunpowder into pellets or prisms, whether for cannon or blasting, or small arms, is authorized to be carried on.

No.	Factory.	No. of persons.	No. of building.	Remarks.
1	Worsboro Dale ..	2	Cartridge press house ..	A.L. 298.
2	Roslin ..	4	Nos. 15 to 20 ..	" 397.
11	Chilworth ..	3	No. 12 ..	" 309.
15	Derby ..	2	Nos. 37, 38, 39 ..	" 458.
		6	No. 55 ..	" 130.
19	Gatebeck ..	6	" 56 ..	" 232.
		3	" 57 ..	" 539.
20	Kames ..	4	" 93 ..	" 463.
21	Tunbridge ..	6	" 97 ..	" 280.
		6	" 57 ..	" 219.
23	Lowwood ..	3*	" 22 ..	} 302.
		3*	" 61 ..	
		3*	" 62 ..	
24	Herodsfoot ..	4	Cartridge press house ..	" 268.
26	Glyn-Neath ..	6	Pellet press house ..	" 312.
		6	No. 70 ..	" 576.
33	Sedgwick ..	4†	" 17 ..	" 113.
			" 24 ..	" 248.
			" 28-29 ..	" 597.
34	Elterwater ..	6‡	" 27 ..	" 160.
		4	" 39 ..	" 225.
37	Oare Works ..	4	" 23 ..	" 51.
38	Marsh Works ..	2§	" 110 ..	" 262.
			" 32 ..	" 32.
40	Blackbeck ..	10	Pounding house ..	" 126.
			" 146 ..	" 146.
53	Dartford ..	6	No. 180 ..	" 414.
127	Dolgelly ..	2	" 33 ..	L. 72.
143	Midcalder ..	2	" 17 ..	A.L. 493.

\* 3 with machinery, 6 without.

† 4 with machinery, 8 without.

‡ 6 with machinery, 10 without.

§ Total 12, but no more than 2 in any compartment.

|| When licensed for 10 it was not at all contemplated to carry on making of the compressed cartridges. In other two houses since licensed for 10 it is expressly stipulated that no machinery is to be used. They do not, however, work to more than 6 persons.



## APPENDIX X.

## INSTANCES of Explosions in Cartridge Press Houses.

Date.	Particulars.	Killed.	Injured.
AT EASTWOOD FACTORY.			
11th April, 1879 .. ..	A man struck a spark with a steel chisel with which he was repairing the machinery, and caused an explosion.	..	1
AT EASTWOOD FACTORY.			
About end of 1880.. ..	A piece chipped off press plunger and fired some grains of powder.	..	..
AT EASTWOOD FACTORY.			
14th January, 1881 .. ..	Probably same cause. ( <i>See</i> Special Report, No. XXXII.)	3	..
DARTFORD GUNPOWDER FACTORY. (Messrs. Pigou, Wilks & Laurence, Limited.)			
23rd November, 1882 .. ..	In pressing a set of 40 prisms, one fired, igniting 20 others. The others escaped. Probable cause, friction.	..	..
NEW SEDGWICK GUNPOWDER FACTORY.			
12th April, 1883 .. ..	Probably, friction. No cause ascertained. ( <i>See</i> Special Report, No. LII.)	3	..
GATEBECK GUNPOWDER FACTORY.			
3rd June, 1886 .. ..	Slight ignition of powder dust in changing mould block.	..	..
AT FERNILEE FACTORY.			
22nd March, 1888.. ..	Explosion in cartridge press house, due to pressing machine being out of order. ( <i>See</i> Special Report, No. LXXXIV.)	2	1

## APPENDIX XI.

## REPLIES from Gunpowder Makers in the United Kingdom, relative to Cam Presses, including a report on the use of these machines in Germany, by Mr. Heidemann.

Home Office Index No. of Factory.	Substance of reply.
40	Have never seen a cam machine.
143	Have no experience of cam machines.
33	Have never used cam machines, but after an accident in 1883 had cam and hydraulic presses under consideration, and decided in favour of latter.
11	Have four machines, of which two are identical with the Waltham Abbey ones. They have been in constant use since 1886, and the experience of them is entirely favourable; "of course it is essential that the machines are kept in proper condition."
37	Were the first to introduce the principle of the "cam" machines about 20 years ago, and have used that process continuously since, for compressed cartridges, for blasting purposes, and for prismatic military powder. Their experience is in favour of this form of manipulation, and they know of no special risk connected with its use.
34	Have no experience of cam machines; they have used hydraulic machines for about 12 years without any accidents.
24	Have no experience of cam machines; they use hydraulic power in preference.
	Have not any experience of cam cartridge pressing machines; in their opinion the working of such a machine would be attended with danger.
49	They forward the following extract from their manager's letter:—"In the year 1890 we erected two cam machines, with the requisite driving gear, at a cost of between 2,000 <i>l.</i> and 3,000 <i>l.</i> , for the moulding and pressing of S.B.C. and other brown prismatic powders. After starting the machines, and before we had taken out about a dozen pressings, we had trouble with the plungers and pins, the first bending and breaking, and the latter getting bent and jamming. We thought perhaps we might get over the difficulty, but before we had made 20 cases of S.B.C. we had to abandon the use of these machines from their extremely dangerous character, and lose our 2,500 <i>l.</i> , as we have never worked them since this time. In fact, from the continual jamming and breaking of the plungers and pins, our men expressed so much anxiety over the danger in working these machines that we consulted our chief engineer, who agreed that the cam presses were dangerous, and the responsibility resting upon us was too great to insist upon the men working, as we were persuaded from the experience we had had that an accident sooner or later must follow."
53	Their manager's experience with cam presses has been for pellets only, but they add that "he is well acquainted with those used for prismatic powder, and that he has no hesitation in giving his opinion that from the quick action of these machines and the number of frictional parts there is a great deal more risk attending their use than with machines worked by hydraulic pressure. With the latter one pressing is performed in about five or six minutes, and the machine is completely under control. With the cam machines from 10 to 15 pressings can be turned out per minute, and as they work automatically they are not under immediate control, but if they were made to work slowly the risk would be much reduced and would hardly exceed that with hydraulic machines."
1	The machine in use at their mills for making compressed blasting cartridges has a "cam" action. It has worked very satisfactorily for 10 years, there has been no accident, and they are not aware of any special danger or risk attending the use of it.
2	Their experience is very limited, as they have only used such a machine for pressing cartridges for mining purposes, that only more experimental than otherwise. They gave up the machines, not as a matter of danger, but unsatisfactory working. They are now erecting a large hydraulic machine to do the work.



## REPORT by Mr. Heidemann on the use of Cam Presses in Germany.

[TRANSLATION.]

Cologne,  
19th March, 1894.

Replying to the questions put by Sir Frederick Abel, and transmitted to me by Messrs. E. Kraftmeier & Co., respecting my experience with cam presses, I beg to state as follows:—

1. Sixteen Excenter (cam) presses have been in use since the year 1865 in our factories under my personal notice.

2. Besides several accidents to workmen, attended by a few contusions and bodily mutilations, which were the consequences of offences against the factory regulations and of carelessness on the part of the workmen in attending to the machines, the following more serious accidents causing loss of life have occurred with these presses during the period mentioned above:—

- (a.) In 1878 an explosion took place at Hamm a/Sieg in an Excenter (cam) press during the manufacture of seven-hole black prismatic powder, by which two other presses were fired. The explosion was caused by a workman, notwithstanding the strictest prohibition, forcing a brass needle by hard blows into one of the channels of the upper bar while cleaning the same.
- (b.) Another explosion took place in 1881 also at Hamm a/Sieg in an Excenter (cam) press during the manufacture of one-hole black prismatic powder. In this case the cause was the working of the press contrary to special instruction, after the breaking of a steel pin, without previously removing all the powder from the press.
- (c.) In 1885 the loose remnants of powder were fired in an Excenter (cam) press at Dueneberg without doing any damage; this was caused by the carelessness of the workmen in removing a broken pin.

3. The velocity with which our presses are worked varies from 3 to 4 pressings a minute, the maximum in exceptional cases is  $4\frac{1}{2}$  pressings.

Besides the above-mentioned Excenter (cam) presses we have also in use at our factories three hydraulic presses for prisms with accumulators, which, as a rule, have 12 stamps or dies, and work at a velocity of  $4\frac{1}{2}$  pressings a minute. These presses allow of a larger production and of the use of higher pressure than the cam machines. They require a specially trained and thoroughly reliable staff of workmen. For the working of these presses, generally the following special factory rules are in force:—

- (a.) During the working of the presses the quantity of powder in the house must be reduced to the smallest possible limit.
- (b.) While the presses are working, every movement must be carefully watched, and they must never work without supervision.
- (c.) When the least irregularity is noticed, the press must be stopped immediately, all powder must be removed, and then only may the cause be looked for; should any repairs or alterations of the press become necessary, the press itself, as also the floor within a radius of 3 meters, must be thoroughly wetted with water; during such repairs a watering-pot full of water must be kept handy.
- (d.) The channels in the upper stamps as well as in the upper bar must always be kept clear, and for this purpose they must frequently be examined by inserting a wooden spill, which also serves to clean them.
- (e.) The presses must be erected carefully, and must fit tightly and well into all beds and moving parts; to ensure safe and smooth movements, all friction must be avoided.

HEIDEMANN.

## APPENDIX XII.

## Copy of Forms used for Magazine Licences granted by the Home Office.

Form B.

No. \_\_\_\_\_

Magazine Licence.

Home Office }  
Registry No. }

Licensee's Name, \_\_\_\_\_

" Calling, \_\_\_\_\_

" Address, \_\_\_\_\_

Situation of the Magazine. { County, \_\_\_\_\_  
Parish, \_\_\_\_\_  
Place, \_\_\_\_\_

## EXPLOSIVES ACT, 1875 (38 VICT. C. 17).

In pursuance of the power vested in me by the above-mentioned Act, 1, the Right Hon. \_\_\_\_\_, one of Her Majesty's Principal Secretaries of State, grant and confirm this licence, authorising explosive to be kept at the magazine at the above-named situation, subject to the provisions of the said Act, and of any Orders in Council, Orders of a Secretary of State, bye-laws, regulations and rules made and to be made thereunder, and in force for the time being, and subject also to the terms hereunto annexed.

HOME OFFICE, WHITEHALL,

day of \_\_\_\_\_

Form B\* (3).

Home Office }  
Registry No. }

## TERMS OF LICENCE.

The following are the terms annexed to the Licence No. \_\_\_\_\_, dated \_\_\_\_\_ for a magazine for explosive:—

- The site of the magazine shall be that shown on the plan signed by a Government Inspector, hereto attached, lettered A at the place marked
- The distances to be maintained between the magazine and such buildings and works as are specified in the first schedule hereto shall be those set forth in the said schedule; and if at any time after the grant of this licence, by reason of the approach of any such buildings or works, the magazine ceases to be beyond the distances therein specified, this licence shall cease to authorise the use of the magazine for the keeping of explosive.
- The mounds, buildings, and works in or connected with the magazine shall be those shown on the plan signed by a Government Inspector, hereto attached, lettered B, and their construction shall be as follows:—

The walls of the magazine shall be well and substantially built of good Portland cement concrete, containing not less than one part of best Portland cement, and five parts of clean, sharp, flinty gravel or ballast, with a proper proportion of sand. The roof shall be either of the same construction as is above directed for the walls, or shall be slated or tiled, and so secure internally by means of stout beams or cross pieces of



wood placed at close intervals, or by stout wire netting, iron bands, sheets of galvanized iron, or other suitable material, as in the opinion of a Government Inspector to afford reasonable security against unlawful entry.

The magazine shall be lined throughout with wood, and be provided with a close-joined wooden floor, and with two good and substantial doors securely affixed to the structure, and having hinges, as far as may be practicable, inaccessible from the exterior. The said doors shall open outwards, and the outermost door shall be of iron, or be faced externally with iron. Each of the said doors shall be fitted with not less than two strong locks, or with one lock throwing three bolts. The locks shall be of such a character as not to be easily picked or forced from the exterior.

The magazine shall be of the dimensions shown on the said Plan B, and the whole of the interior thereof (floor excepted) shall at all times be kept painted or varnished to the satisfaction of a Government Inspector.

If at any time it shall appear to the Secretary of State desirable that a wall or fence shall be erected about the magazine or any part thereof, there shall forthwith be erected and maintained such wall or fence as may be specified by the Secretary of State in his requisition for the erection of the same, and such wall or fence shall be deemed to be a part of the mounds, buildings, or works in or connected with the magazine.

4. No explosive shall be kept in the magazine other than
5. The quantity of explosive in the magazine shall not at any one time exceed

Form B\*\*<sup>(2)</sup>.

Home Office }  
Registry No. }

SCHEDULE.

Distances to be maintained between the magazine and other buildings and works :—

	From every	Not less than
Room used in connection with the magazine, in pursuance of Section 46 of the Act.		
Workshop used in connection with the magazine, in pursuance of Section 47 of the Act.		
Mineral or private railway, whether worked by steam or otherwise ..	..	..
Highway or public footpath .. .. .	..	..
Promenade or open place of resort for the public or for persons carrying on any trade or business .. .. .	..	..
Canal or navigable water .. .. .	..	..
Dock .. .. .	..	..
River wall or sea wall .. .. .	..	..
Pier or jetty .. .. .	..	..
Reservoir .. .. .	..	..
Room or workshop in connection with another magazine, store, or registered premises .. .. .	..	..
Any other room or workshop, or any shop .. .. .	..	..
Magazine for explosive .. .. .	..	..
Store .. .. .	..	..
Furnace, kiln, or fire for the use of any boiler, engine, or machine, or for any manufacturing purposes .. .. .	..	..
Public railway .. .. .	..	..
Dwelling house, with the consent in writing of the occupier .. .. .	..	..
Dwelling house, without such consent .. .. .	..	..
Factory not belonging to Government .. .. .	..	..
Church or chapel .. .. .	..	..
University, college, or school .. .. .	..	..
Hospital or public institution .. .. .	..	..
Town hall or court of justice .. .. .	..	..
Covered market .. .. .	..	..
Theatre or building wherein persons are accustomed to assemble .. .. .	..	..
Public building in charge of the Commissioners of Her Majesty's Works and Public Buildings.		
Factory or magazine occupied by a Secretary of State, the Commissioners of the Admiralty, or other Department of the Government, with the consent, in writing, of the Secretary of State, Commissioners, or Department .. .. .	..	..
Do. without such consent .. .. .	..	..
Palace or house of residence of Her Majesty, Her Heirs, and Successors ..	..	..

Provided that, in the case of any building or work above mentioned which is so screened from the magazine by the natural features of the ground, or by good and sufficient artificial mounds of earth as not to be visible from any part of such magazine, the distance assigned above as that to be observed between such building or work and the magazine may be reduced by one-half.

Provided also that, in the case of any building or work above mentioned which is so screened from the magazine by an intervening hill that, a line drawn from any part of such building or work to any part of such magazine would pass through such hill, the distance assigned by this schedule as that to be observed between such building and work and the magazine may be reduced by three-fourths, subject nevertheless to a notification in writing from a Government Inspector that, in his judgment the intervening hill, in respect of which such reduction is claimed, is not of a character to justify such reduction, whereupon this proviso authorising such reduction as aforesaid shall be deemed not to apply in respect of the said building or work.

APPENDIX XIII.

Copy of Forms used for Factory Licences granted by the Home Office.

Form A.

No. . . . .

Home Office }  
Registry No. }

Factory Licence.  
EXPLOSIVES.

Licencee's Name,

„ Calling,

„ Address,

Situation of the }  
Factory. } County,  
                          } Parish,  
                          } Place,

EXPLOSIVES ACT, 1875 (38 VICT. c. 17).

In pursuance of the power vested in me by the above-mentioned Act, I, the Right Hon. one of Her Majesty's Principal Secretaries of State, grant and confirm this licence, authorising explosive to be manufactured at the factory at the above-named situation, subject to the provisions of the said Act, and of any Orders in Council, Orders of a Secretary, byelaws, regulations, and rules made and to be made thereunder, and in force for the time being, and subject to the terms hereunto annexed.

HOME OFFICE, WHITEHALL,  
day of

From A.  
(See alternative Form in case of Firework Factories.)

TERMS OF LICENCE.

The following are the terms annexed to the Licence No. . . . . dated . . . . . for a factory for

1. The site of the factory shall be that shown on the plan signed by a Government Inspector hereto attached,
2. The distances to be maintained between the factory, and such buildings and works as are specified in the schedule hereto, shall be those set forth in the said schedule; and if at any time after the grant of this licence, by reason of the approach of any such buildings or works, the factory ceases to be beyond the distances therein specified, this licence shall cease to authorise the use of the factory for the manufacture of explosives.
3. The mounds, buildings, and works on or connected with the factory shall be those shown on the aforesaid plan, and their construction shall be
4. No explosive shall be manufactured at the factory other than
5. The processes to be carried on in each part of the factory, and the place at which each such process is to be carried on, shall be



6. The limitations set forth in the schedule hereto, as to the description and amount of explosive and ingredients and articles liable to spontaneous ignition, or inflammable or otherwise dangerous, shall be duly observed.

7. The maximum number of persons to be employed in each building of the factory shall be

8. All the outer clothing of all persons engaged in any danger building shall be of woollen or other unflammable material; and no pockets shall be worn by any person employed in any danger building.

9. Good and sufficient escape for all persons employed in any danger buildings; and every building in which explosive is present, or is liable so to be, shall be provided and maintained in connection with each such building.

Form A\* (3).

(This Form is used in case of a Firework Factory.)

TERMS OF LICENCE.

The following are the terms annexed to the Licence No. dated for a factory for fireworks:—

1. The site of the factory shall be that shown on the plan signed by the Government Inspector hereto attached.

2. The distances to be maintained between the factory, and such buildings and works as are specified in the schedule hereto, shall be those set forth in the said schedule; and if at any time after the grant of this licence, by reason of the approach of any such buildings or works, the factory ceases to be beyond the distances therein specified, this licence shall cease to authorise the use of the factory for the manufacture of explosive.

3. The mounds, buildings, and works on or connected with the factory shall be those shown on the said site, on the aforesaid plan, and their construction shall be as specified in the schedule hereto. Each of the danger buildings shall be one storey only.

4. No explosive shall be manufactured at the factory other than fireworks as defined in an Order in Council classifying explosives made under the 106th Section of the said Act.

5. The processes to be carried on in each part of the factory, and the place at which each such process is to be carried on, shall be those specified in the schedule hereto.

6. The limitations set forth in the schedule hereto, as to the description and amount of explosive and ingredients and articles liable to spontaneous ignition, or inflammable or otherwise dangerous, shall be duly observed.

7. The maximum number of persons to be employed in each building of the factory shall be that stated in the schedule hereto, and when no limitation is expressed the number may be unlimited.

8. Each of the following shall be deemed a danger building:—

1. Every magazine.

2. Every building in which any one or more of the following operations is carried on, viz:—

(a.) The mixing, or preparing, or packing of any explosive other than manufactured firework protected by a case.

(b.) The filling or charging of cases with explosive.

(c.) The breaking up or unmaking of any explosive.

3. Every building in which gunpowder or loose explosive composition, or firework unprotected by a case, is present or is liable so to be.

And every other building in the factory shall be exempt from being deemed a danger building.

9. All the outer clothing of all persons engaged in any danger buildings shall be of woollen or other unflammable material.

10. Good and sufficient means of escape for all persons employed in every danger building and every building in which any explosive is present or is liable so to be, shall be provided and maintained in connection with each such building.

Form A†

SCHEDULE.

Distinguishing number, letter, or name of building, mound, or work on plan attached to licence.	Construction of building, mound, or work

Form A\*\*\*\*

SCHEDULE.

Distinguishing number, letter or name of building, room or place on plan attached to licence.	Application of building, room, or place, or process to be carried on therein.	Explosive allowed or ingredients or articles liable to spontaneous ignition or inflammable, or otherwise dangerous, and limitation of quantity to be in each building, room, or place.	Limitation of number of work-people to be in each building, room, or place.

Form A\*\*

SCHEDULE.

Distances to be maintained between each danger building (other than the factory magazines) of the factory, and other buildings and works outside the factory:—

	From every	Not less than
Mineral or private railway, whether worked by steam or otherwise	..	..
Highway or public footpath	..	..
Promenade or open place of resort for the public or for persons carrying on any trade or business.	..	..
Canal or navigable water	..	..
Dock	..	..
River wall or sea wall	..	..
Pier or jetty	..	..
Reservoir	..	..
Room or workshop in connection with any magazine, store, or registered premises in pursuance of Section 46 or Section 47 of the Act.	..	..
Any other room or workshop or any shop	..	..
Magazine for explosive	..	..
Store	..	..



From every	Not less than
Furnace, kiln, or fire for the use of any boiler, engine, or machine, or for any manufacturing purpose.	
Public railway .. .. .	.. .. .
Dwelling house, <i>with</i> the consent, in writing, of the occupier	.. .. .
Dwelling house, <i>without</i> such consent..	.. .. .
Factory not belonging to Government	.. .. .
Church or chapel .. .. .	.. .. .
University, college, or school .. .. .	.. .. .
Hospital or public institution .. .. .	.. .. .
Town hall or court of justice .. .. .	.. .. .
Covered market .. .. .	.. .. .
Theatre or building wherein persons are accustomed to assemble	.. .. .
Public building in charge of the Commissioners of Her Majesty's Works and Public Buildings.	.. .. .
Factory or magazine occupied by a Secretary of State, the Commissioners of the Admiralty, or other Department of the Government, <i>with</i> the consent, in writing, of the Secretary of State, Commissioners, or Department.	.. .. .
Ditto, <i>without</i> such consent .. .. .	.. .. .
Palace or house of residence of Her Majesty, Her Heirs, and Successors..	.. .. .

Form A\*\*\*

## SCHEDULE.

Distances to be maintained between each factory, magazine of the factory, and other buildings and works outside the factory:—

From every	Not less than
Mineral or private railway, whether worked by steam or otherwise ..	.. .. .
Highway or public footpath .. .. .	.. .. .
Promenade or open place of resort for the public or for persons carrying on any trade or business.	.. .. .
Canal or navigable water .. .. .	.. .. .
Dock .. .. .	.. .. .
River wall or sea wall .. .. .	.. .. .
Pier or jetty .. .. .	.. .. .
Reservoir.. .. .	.. .. .
Room or workshop in connection with any magazine, store, or registered premises in pursuance of Section 46 or Section 47 of the Act.	.. .. .
Any other room or workshop, or any shop .. .. .	.. .. .
Magazine for explosive .. .. .	.. .. .
Store .. .. .	.. .. .
Furnace, kiln, or fire for the use of any boiler, engine, or machine, or for any manufacturing purpose.	.. .. .
Public railway .. .. .	.. .. .
Dwelling-house, <i>with</i> the consent, in writing, of the occupier	.. .. .
Ditto, <i>without</i> such consent .. .. .	.. .. .
Factory, not belonging to Government	.. .. .
Church or chapel .. .. .	.. .. .
University, college, or school .. .. .	.. .. .
Hospital or public institution .. .. .	.. .. .
Town hall or court of justice .. .. .	.. .. .
Covered market .. .. .	.. .. .
Theatre or building wherein persons are accustomed to assemble..	.. .. .
Public building in charge of the Commissioners of Her Majesty's Works and Public Buildings.	.. .. .
Factory or magazine occupied by a Secretary of State, the Commissioners of the Admiralty, or other Department of the Government, <i>with</i> the consent, in writing, of the Secretary of State, Commissioners, or Department.	.. .. .
Ditto, <i>without</i> such consent .. .. .	.. .. .
Palace or house of residence of Her Majesty, Her Heirs, and Successors..	.. .. .



Handed to the Committee by Colonel A. Ford, one of Her Majesty's Inspectors of Explosives.

TABLE SHOWING DISTANCES FROM PROTECTED WORKS MAGAZINES AND OTHER DANGER BUILDINGS.

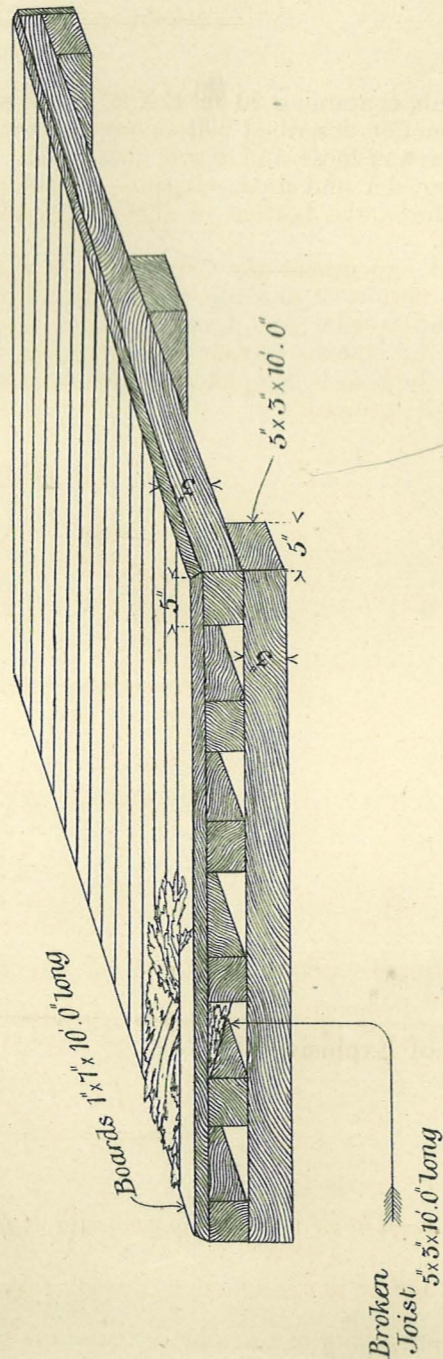
In any case where the Protected Work is effectively screened from the Magazine or Danger Building or mound, the distance from that Protected Work (except for quantities of 1,000 lb. and upwards) will be reduced one-half. Provided that when a natural hill so intervenes as to afford a degree of protection, which in the opinion of a Government Inspector justifies a further reduction, the distance shown in the Table will be reduced to one-quarter. In no case, however, is the distance from Her Majesty's Palaces to be less than two miles.

The figures in *italics* are the distances to be observed when Gunpowder only is to be stored or other Explosives up to the equivalent of 5,000 lb. of Gunpowder, every half pound of such other explosive (with certain exceptions) being reckoned as 1 lb. of Gunpowder.

AMOUNT OF EXPLOSIVE TO BE ALLOWED IN THE MAGAZINE OR DANGER BUILDING ..	pounds		1 "ton"		2 "tons"		3 "tons"		4 "tons"		5 "tons"		10 "tons"		15 "tons"		20 "tons"		25 "tons"		30 "tons"		35 "tons"		40 "tons"		45 "tons"		50 "tons"																																
	500	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000	11,000	12,000	13,000	14,000	15,000	16,000	17,000	18,000	19,000	20,000	22,000	24,000	26,000	28,000	30,000	32,000	34,000	36,000	40,000	42,000	44,000	46,000	48,000	50,000	52,000	54,000	56,000	58,000	60,000	62,000	64,000	66,000	68,000	70,000	72,000	74,000	76,000	78,000	80,000	82,000	84,000	86,000	88,000	90,000	92,000	94,000	96,000	98,000	100,000	
DISTANCES TO BE KEPT CLEAR FROM—																																																													
Room used in connection with the magazine, in pursuance of Section 46 of the Act. . . . .	50	50	50	51	52	52	53	53	54	54	55	56	56	57	57	58	58	59	59	60	61	62	63	64	65	66	67	68	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100		
Workshop used in connection with the magazine, in pursuance of Section 47 of the Act (see note (b)) . . . . .	75	100	101	102	104	105	106	108	109	111	111	112	113	114	115	116	117	118	119	120	122	124	126	128	130	132	134	136	140	142	144	146	148	150	152	154	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200		
Mineral or private railway, whether worked by steam or otherwise . . . . .	75	100	101	102	104	105	106	108	109	111	111	112	113	114	115	116	117	118	119	120	122	124	126	128	130	132	134	136	140	142	144	146	148	150	152	154	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200		
Highway or public footpath . . . . .	75	100	101	102	104	105	106	108	109	111	111	112	113	114	115	116	117	118	119	120	122	124	126	128	130	132	134	136	140	142	144	146	148	150	152	154	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200		
Promenade or open place of resort for the public or for persons carrying on any trade or business . . . . .	75	100	101	102	104	105	106	108	109	111	111	112	113	114	115	116	117	118	119	120	122	124	126	128	130	132	134	136	140	142	144	146	148	150	152	154	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200		
Canal or navigable water . . . . .	75	100	101	102	104	105	106	108	109	111	111	112	113	114	115	116	117	118	119	120	122	124	126	128	130	132	134	136	140	142	144	146	148	150	152	154	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200		
Dock . . . . .	75	100	101	102	104	105	106	108	109	111	111	112	113	114	115	116	117	118	119	120	122	124	126	128	130	132	134	136	140	142	144	146	148	150	152	154	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200		
River wall or sea water . . . . .	75	100	101	102	104	105	106	108	109	111	111	112	113	114	115	116	117	118	119	120	122	124	126	128	130	132	134	136	140	142	144	146	148	150	152	154	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200		
Pier or jetty . . . . .	75	100	101	102	104	105	106	108	109	111	111	112	113	114	115	116	117	118	119	120	122	124	126	128	130	132	134	136	140	142	144	146	148	150	152	154	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200		
Reservoir . . . . .	75	100	101	102	104	105	106	108	109	111	111	112	113	114	115	116	117	118	119	120	122	124	126	128	130	132	134	136	140	142	144	146	148	150	152	154	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200		
Room or workshop in connection with another magazine, store, or registered premises . . . . .	100	150	200	200	200	200	200	200	200	200	205	210	215	220	225	230	235	240	245	250	265	280	295	310	325	340	355	370	400	415	430	445	460	475	490	505	520	535	550	565	580	595	610	625	640	655	670	685	700	715	730	745	760	775	790	805	820	835	850		
Any other room or workshop or any shop . . . . .	65	100	150	175	200	200	200	200	200	200	205	210	215	220	225	230	235	240	245	250	265	280	295	310	325	340	355	370	400	415	430	445	460	475	490	505	520	535	550	565	580	595	610	625	640	655	670	685	700	715	730	745	760	775	790	805	820	835	850		
Magazine for explosive . . . . .	75	100	101	102	104	105	106	108	109	111	111	112	113	114	115	116	117	118	119	120	122	124	126	128	130	132	134	136	140	142	144	146	148	150	152	154	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200		
Store . . . . .	75	100	101	102	104	105	106	108	109	111	111	112	113	114	115	116	117	118	119	120	122	124	126	128	130	132	134	136	140	142	144	146	148	150	152	154	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200		
Furnace, kiln, or fire for the use of any boiler, engine, or machine, or for any manufacturing purpose . . . . .	75	100	101	102	104	105	106	108	109	111	111	112	113	114	115	116	117	118	119	120	122	124	126	128	130	132	134	136	140	142	144	146	148	150	152	154	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200		
Public railway . . . . .	75	100	101	102	104	105	106	108	109	111	111	112	113	114	115	116	117	118	119	120	122	124	126	128	130	132	134	136	140	142	144	146	148	150	152	154	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200		
Dwelling-house, with the consent, in writing, of the occupier . . . . .	50	75	100	110	120	130	140	145	155	165	170	180	190	200	205	215	220	230	235	245	250	265	280	295	310	325	340	355	370	400	415	430	445	460	475	490	505	520	535	550	565	580	595	610	625	640	655	670	685	700	715	730	745	760	775	790	805	820	835	850	
Dwelling-house, without such consent . . . . .	100	150	200	240	280	320	360	405	445	485	525	560	590	625	655	690	720	750	785	815	850	920	990	1,060	1,130	1,200	1,265	1,330	1,395	1,460	1,525	1,590	1,655	1,720	1,785	1,850	1,915	1,980	2,045	2,110	2,175	2,240	2,305	2,370	2,435	2,500	2,570	2,640	2,710	2,780	2,850	2,915	2,980	3,045	3,110	3,175	3,240	3,305	3,370	3,435	3,500
Factory not belonging to Government . . . . .	75	100	101	102	104	105	106	108	109	111	111	112	113	114	115	116	117	118	119	120	122	124	126	128	130	132	134	136	140	142	144	146	148	150	152	154	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200		
Church or chapel . . . . .	75	100	101	102	104	105	106	108	109	111	111	112	113	114	115	116	117	118	119	120	122	124	126	128	130	132	134	136	140	142	144	146	148	150	152	154	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200		
University, college, or school . . . . .	75	100	101	102	104	105	106	108	109	111	111	112	113	114	115	116	117	118	119	120	122	124	126	128	130	132	134	136	140	142	144	146	148	150	152	154	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194	196	198	200		
Hospital or public institution . . . . .	75	100	101	102	104	105	106	108	109	111	111	112	113	114	115	116	117	118	119	120	122	124	126	128	130	132	134	136	140	142	144	146	148	150	152	154	156	158	160	162	164	166	168	170	172	174	176														



PLATFORM AT OUTER BUTTS, SHOWING DAMAGE DONE BY EXPERIMENT 2.



This sketch shows construction of Platform. The surface, however, was covered with Elephant's hide.

*Manning*  
*Suppl. No. 2*  
*1.3.94*

APPENDIX XV.

BURSTING OF BARRELS CONTAINING E.X.E. GRAIN.

A mixing tub, containing 90 lb. E.X.E. grain, was placed on centre of a wooden platform (construction described below) covered with leather hide.

The powder was loose and barrel unheaded. A No. 10 electric tube was placed on top of the powder and fired. Result—tub blown to pieces, explosion violent, no damage to platform, the bottom of the tub remaining on the platform close to its original position.

In the next experiment the arrangements were as above, but a small hole was bored near the bottom of the tub, and a small low tension primer inserted through the hole into the powder and fired. Result—a much more violent explosion than before, pieces of tub blown further and platform damaged. Over an area of about 3 feet by 4 feet, the boards completely broken, and baulk under the explosion, broken and driven into the ground.

E. BAINBRIDGE, Colonel, R.A.,  
Superintendent Royal Laboratory.

1st March, 1894.

APPENDIX XVI.

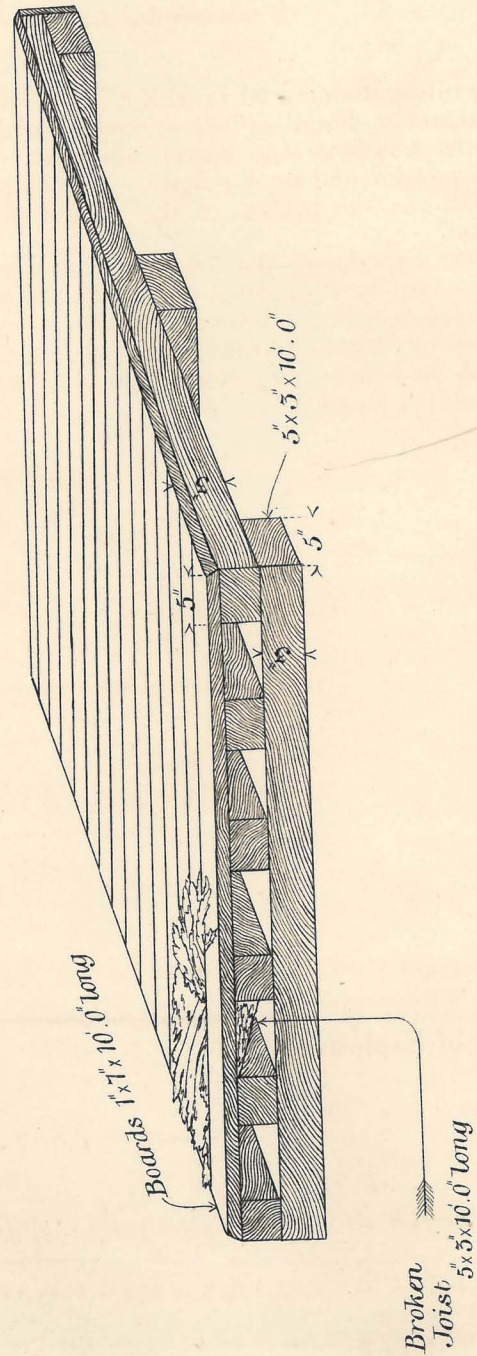
SUMMARY of Causes whence Accidents in the Manufacture of Gunpowder may proceed. Prepared by Colonel Majendie, C.B., Her Majesty's Chief Inspector of Explosives.

A—Causes immediately connected with Tools or Machinery.

1. Inherent defect in construction of machinery or implements.
2. Defective working of machine or tools, due to—
  - (1.) Fracture or distortion by wear or otherwise.
  - (2.) Clogging.
  - (3.) Other disturbance.
  - (4.) Improper application.
3. Fall of tool or portion of machinery.
4. Heated bearing.



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  - (2.) Clogging.
  - (3.) Other disturbance.
  - (4.) Improper application.
3. Fall of tool or portion of machinery.
4. Heated bearing.
5. Ignition caused in repairing or cleaning machinery.



B.—Causes independent of Tools and Machinery.

(A.) Accidental Causes.

6. Lightning.
    - (1) Fire from external source.
    - (2) Adjacent chimney.
    - (3) Passing engine.
    - (3.) Other sources, *eg.*:—
      - (a.) Men taking fire from watch-house or engine room on their clothes, on cooking utensils, or otherwise.
      - (b.) Fire from gluepot.
      - (c.) Concentration of sun's rays.
      - (d.) Lamps or fire.
      - (e.) Electric lighting or other apparatus.
  7. Fire from external source.
    - (1) Adjacent chimney.
    - (2) Passing engine.
    - (3.) Other sources, *eg.*:—
      - (a.) Men taking fire from watch-house or engine room on their clothes, on cooking utensils, or otherwise.
      - (b.) Fire from gluepot.
      - (c.) Concentration of sun's rays.
      - (d.) Lamps or fire.
      - (e.) Electric lighting or other apparatus.
  8. Sparks from—
    - (1.) Articles of iron.
    - (2.) Articles of glazed earthenware.
  9. Spontaneous ignition of cotton waste, &c.
  10. Smoking—
    - (1.) In or near building.
    - (2.) Unextinguished pipe in workman's pocket.
  11. Lucifer match—
    - (1.) From workman's pocket.
    - (2.) Left lying about.
  12. Foreign substances, such as small stones, gritty particles, articles of metal, nuts, bolts, nails, &c., introduced—
    - (1.) On shoes or clothes.
    - (2.) On tools, machines, or cotton waste.
    - (3.) On barrels or barrows.
    - (4.) By being blown in.
    - (5.) In the ingredients—
      - (a.) If imperfectly sifted.
      - (b.) Contracted from walls and roofs of the buildings after sifting.
      - (c.) Derived from a machine or tool.
      - (d.) Contracted during conveyance.
- (B.) Willful Acts.
13. Matches, &c., willfully introduced during the absence of workpeople.
  14. Willful ignition of powder-dust outside.
  15. Willful introduction into ingredients of foreign substance before the same were brought into the building.
  16. Willful act of workmen—
    - (1.) While in a state of insanity.
    - (2.) While in a state of intoxication.
    - (3.) With object of committing suicide.
  17. Explosion of building by fire or other means.

APPENDIX XVII.

List of Explosions and Fires at the Royal Gunpowder Factory, Waltham Abbey, from 16th June, 1870, to 13th December, 1893.

Date and hour.	House.	Nature of accident.	Injuries to workmen.	Damage to buildings.	Damage to plant.	Cause of accident.
16th June, 1870, 11.12 a.m.	Press house and granulating house, Lower Island.	Explosion of "press cake" while unloading press, the granulating house subsequently exploding.	Five men killed, ten injured.	Both buildings, also the machinery in them, completely destroyed.	Completely destroyed (in both houses).	Probably due to a particle of iron or grit in the "press cake," which was being separated, after pressing, by one of the deceased men (Simpson), who was using the regulation spud and mallet, when the explosion took place.
28th February, 1871, 8.30 p.m.	No. 2 mill, mill head ..	Explosion of "green charge" of gunpowder.	Mr. Edward Findlay, assistant master worker, and Mr. Seely of the Kame's Company, severely burnt.	No damage by the actual explosion (which was slight). Slight damage by fire.	None .. .. .	Explosion took place immediately after the runners had been set in motion. Probable cause not stated.
17th July, 1871, 10 p.m.	No. 10 mill, Lower Island	Explosion of "mill charge" for pebble powder.	None .. .. .	Very slight .. ..	Runners and mill bed slightly injured.	Not stated.
21st May, 1873, 12.15 p.m.	No. 9 mill, group "A" steam mills.	Explosion of "dust charge" of gunpowder.	None .. .. .	Considerable, estimated cost of repair at 75 <i>l.</i> to 100 <i>l.</i>	Not serious .. ..	Could not be ascertained.
25th July, 1873, 9.30 p.m.	No. 6 mill, mill head ..	Explosion of "green charge" of pebble powder.	None .. .. .	Very slight .. ..	None .. .. .	Probable cause, a gunmetal bolt, which held the "plough" to the plough-arm, broke, and the runners "skidded" over it producing friction enough to cause explosion.
6th October, 1873, 9 p.m.	No. 1 mill, mill head ..	Mill "fired" while running on charcoal.	None .. .. .	None .. .. .	None .. .. .	Mill had been under repair, and was run on charcoal previous to being put in order. Cause of "firing" not discovered.
19th May, 1874, 1 a.m.	No. 1 mill, mill head ..	Explosion of picric powder (57 per cent. saltpetre, 43 per cent. picrate of ammonia).	None .. .. .	None .. .. .	None .. .. .	Must have been due to the accidental presence of some particles of iron or grit upon the bed of the mill.
15th July, 1876, 12.15 a.m.	Group "A" steam mills..	Explosion of a "green charge" of gunpowder.	None .. .. .	A few panes of glass in skylight broken and canvas roof torn off in a few places.	None .. .. .	No apparent cause assignable. Probably occurred through one of the runners coming in contact with the bed.



APPENDIX XVII.—continued.

Date and hour.	House.	Nature of accident.	Injuries to workmen.	Damage to buildings.	Damage to plant.	Cause of accident.
9th September, 1877, 6.10 a.m.	No. 6 mill, mill head	Explosion of 60 lb. "rework charge" of L.G. powder.	None	South end blown completely away, north end found blown out, windows broken. No. 3 mill slight damage.	South end mill bed cracked.	Impossible to assign exact cause. Most probably caused by the "licking up" of the charge, i.e., the runners "licking up" the charge in one of their revolutions and coming on the bare bed the next revolution.
4th May, 1878, 9.45 a.m.	Saltpetre extracting house	Fire	Barnard severely burnt, died 7th May, 1878, at L.45.	Slight by fire	None	Barnard removing hard refuse from powder-pot, with iron spud, when cleaning out house for repairs; a copper spud should have been used.
16th July, 1879, 7.30 p.m.	Sulphur refinery	Fire	None	Portion of roof burnt	None	Over-heating of the woodwork in the roof in the vicinity of the chimney or iron tube, leading from the iron funnel suspended over the refining-pot to carry away the fumes.
7th July, 1882, 9.50 p.m.	Group "B" mills, Lower Island.	Explosion of a "green charge" of gunpowder.	None	Roof partially injured	None	Possibly due to a small piece of grit being accidentally present in the "green charge."
22nd August, 1890, 6.35 a.m.	No. 1 breaking-down house, mill head stream.	Explosion in "breaking down" R.F.G. mill cake.	Napthen and Maynard killed, A. Wilson injured.	House demolished	Breaking-down machine destroyed.	No cause could be assigned.
4th November, 1890, 8.25 p.m.	Group "C" steam mills, No. 15A mill.	Explosion of an 80 lb. blank L.G. "dust charge."	None	Shutters, doors and woodwork of roof blown away and other damage to it, and to 13A, 14B and 15B group of mills.	Mill bed cracked and crown wheel broken and other slight damage.	No cause could be assigned.
4th May, 1891, 6.7 a.m.	Group "E" steam mills.	Firing of "green charge" of small arm G.F. powder.	None	None	None	No cause could be assigned.
11th March, 1892, 10.50 p.m.	Group "G" steam mills, No. 27 mill.	Explosion of a 60 lb. small arm pellet powder "green charge."	None	Roof destroyed and other damage to it, and adjoining mills of "G" and "D."	Bed plate cracked and other slight damage.	No conclusive proof of cause.
13th December, 1893, 2.35 a.m.	No. 2 cam house, Lower Island.	Explosion of "E.X.E." grain and prisms.	One man killed, eight men died subsequently, one badly injured.	Completely destroyed by fire.	Hoppers of four machines destroyed.	No cause could be assigned.

21st March, 1894.

W. McCLEINTOCK, Colonel,  
Superintendent Royal Gunpowder Factory.

APPENDIX XVIII.

EXTRACTED from the Appendix to the Report from the Select Committee of the House of Commons on Explosive Substances, 1874. (Appendix, No. 19, pages 366 and 367.)

PAPER HANDED IN BY MAJOR MAJENDIE.

LIST of Articles found at various times in the Gunpowder Works at Waltham Abbey, or in Barrels of Gunpowder at the Government Establishments at Purfleet and Woolwich, and at present deposited at Waltham Abbey.

The following list shows that, even with the strictest precautions and the most scrupulous vigilance, there is no absolute security that all risks which attend the storage, manufacture, and manipulation of powder can be invariably estimated. It is, therefore, imprudent to assume that even those buildings which (from their freedom from complicated or dangerous machinery) are comparatively free from the more serious manufacturing risks—such as magazines, and the packing rooms, dusting and glazing houses of gunpowder factories—are wholly free from the risk of explosion. To the following list may be added a case which occurred a few years ago, when a lucifer match was found, with some percussion caps, in a barrel of Government gunpowder at the Royal Cartridge Factory, Woolwich. This barrel of powder had come from a Government magazine.

In another case a detonating tube was found by Major Keates, R.A., in a barrel of gunpowder at the Government establishment at Bull Point.

D. MAJENDIE, Major, R.A.,  
Her Majesty's Inspector of Gunpowder Works.

List of Articles in the Cupboard.

1. Iron nut, 1½ inches square by ½ inch thick. Found in the charcoal mill while grinding dogwood. By it three cogs were broken out of the pit wheel. 23rd April, 1857.
2. Piece of beech wood, 5½ inches long, 2½ inches wide, ¾ inch thick. Found on the screens of No. 2 granulating machine, after passing the top pair of rollers. 7th October, 1859.
3. Stone, 1¼ inches by 1¾ inches thick. Found on top plates while loading No. 1 press. 20th February, 1860.
4. Stone, ¾ inch square. Found in press cake at No. 1 press when unloading. March, 1860.
5. Iron fragments. Found on bed of steam mill D, when vertical shaft broke. 17th July, 1860.
6. Iron key of cupboard. Found in the chucks from the granulating machine, No. 1, while making Enfield rifle powder. 18th June, 1861.
7. Knife blades, &c. Found in charcoal mill while grinding. 20th September, 1861.
8. Iron bolt, 1¾ inches at head, 4½ inches long. Found on the south end of No. 11 mill, L.J. The runners had passed over it. 7th November, 1861.
9. Copper knob-cover of lubricator, 2¼ inches diameter. Taken from No. 1 granulating machine, after having passed through the top pair of rollers. January, 1864.
10. Pieces of iron, 3½ inches by 1¼ inches, ½ inch thick. Found in the press plates of No. 2 press while loading the press. 3th August, 1864.
11. Copper bolt, 1¼ inches diameter head, 3½ inches long. Found on the bed at the north end of No. 4 mill. It had been brought there in a dust charge, as the washer and part of the nut were found in the granulating machine next day. 12th May, 1865.



12. Copper bolt,  $\frac{7}{8}$  inch at head,  $2\frac{1}{2}$  inches long. Found under the curb of No. 6 mill. This bolt belonged to a reel at No. 1 dusting house, and was sent from there in a dust charge. Caused the explosion of the north end of the mill, and also the north end of No. 3 mill, on the opposite side of Mill Head; both mills on dust charges of R.L.G. 13th June, 1866.

13. Copper bolt to fasten screens to frame,  $1\frac{1}{2}$  inches at top,  $2\frac{1}{4}$  inches long. Shaken out of the lower screens of No. 2 granulating machine, having been taken up with the chucks, and passed all through the machine. 13th December, 1866.

14. Piece of iron,  $2\frac{1}{4}$  inches long,  $\frac{5}{8}$  inch diameter. Found in a bundle of dogwood at the cylinder house. 19th May, 1868.

15. Pieces of iron, from 5 inches to 3 inches long,  $\frac{1}{2}$  inch diameter. Found while picking dogwood charcoal at different times. 15th December, 1868.

16. Grit. Found in new magazine, having fallen from joints of brickwork. 16th July, 1869.

17. Copper bolt to fasten plough, 3 inches long. Found on the bed of No. 12 mill, north end, while the millman was uncharging, the runners having passed over it several times without causing explosion. 31st August, 1869.

18. Steel needle. Found in L.G. powder received from Upnor, while examining at Purfleet. 22nd November, 1869.

19. An iron rivet head. Found in charcoal mill while grinding common charcoal. 13th April, 1870.

20. An iron rivet head. Found while picking charcoal. April, 1870.

21. Small pieces of iron. Found in cotton waste supplied for cleaning machinery in powder and other houses. September, 1870.

22. Small pieces of iron and iron wire. Found in cotton waste supplied for cleaning machinery in powder and other houses. October, 1870.

23. Bullets and caps. Found in R.F.G. powder, sent from Purfleet for redusting March, 1871.

24. Copper tack. Found in a barrel of blank R.F.G. powder while being sifted in the Royal Laboratory, Woolwich. 15th August, 1871.

25. Copper nails and piece of copper hoop. Found in a barrel of returned Service L.G. powder sent to Woolwich for small-arm ammunition. 1871.

26. Clay pipe. Found while picking dogwood charcoal; it had been enclosed in a bundle of dogwood, and was burnt with it. 5th July, 1872.

27. Small stones. Found at Woolwich, in a barrel of powder, marked (Powder, L.G., 100, redusted, July, 1872). 13th August, 1872.

28. Copper nail, 2 inches long. Found in a piece of picric mill cake, on breaking it up for granulating. 19th December, 1872.

29. Stones. Found at No. 1 dusting house, while sifting F.G. powder for redusting. 20th December, 1872.

30. Stones. Found at No. 1 dusting house, while sifting F.G. powder for redusting. 24th December, 1872.

31. Copper nail and caked powder. Found at Royal Laboratory in a barrel of L.G. powder, marked from examination, 1872. February, 1873.

32. Bullets, cartridges, caps, &c. Found in powder received from Purfleet for redusting. February, 1873.

33. Bullets. Found in F.G. powder, received from Purfleet for redusting. February, 1873.

34. Iron bolt,  $4\frac{3}{4}$  inches long,  $\frac{1}{2}$  inch in diameter. Found in a barrel of R.L.G. powder, by Captain Majendie, R.A.

35. Refuse, hair, &c. Found in powder at Purfleet, returned for examination.

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