Investigation of the circumstances of an explosion which occurred in the Lyddite Establishment, Royal Laboratory, Royal Arsenal, Woolwich, on the 18th June 1903

CONFIDENTIAL

W. 15.

REPORT

OF THE

COURT OF ENQUIRY

APPOINTED TO INVESTIGATE THE

EXPLOSION AT THE LYDDITE ESTABLISHMENT, ROYAL ARSENAL, WOOLWICH,

ON THE

18th June 1903;

WITH

MINUTES OF EVIDENCE AND APPENDICES.

1903.

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1903

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NAMES OF MEMBERS OF THE COURT.

PRESIDENT :

REAR-ADMIRAL A. A. CHASE PARR, Vice-President of Ordnance Committee, and Associate Member of Explosives Committee.

MEMBERS :

DR. A. DUPRÉ, F.R.S., Home Office.

LIEUT.-COLONEL and BT.-COLONEL C. F. HADDEN, C.B., R.A., Member of Ordnance Committee, and Associate Member of Explosives Committee.

MAJOR F. L. NATHAN, R.A., Superintendent Royal Gunpowder Factory, Waltham Abbey.

CAPTAIN J. H. THOMSON, His Majesty's Chief Inspector of Explosives, Home Office.

CAPTAIN J. G. M. WATSON, R.A., Secretary.

TERMS OF REFERENCE.

70
Gen. No.
1121.

"It is desired that you should take such evidence, make such inquiries, and carry out such experiments as you think necessary, to enable you to ascertain, if possible, the cause of the explosion; and that you should render a report on the whole subject, and make any recommendations which you consider necessary, with a view to guarding against risks attendant on all the operations of charging shells with lyddite."

Approved by the Secretary of State on the 19th June 1903.

On the 22nd July 1903 the Director-General of Ordnance forwarded for the consideration of the Court the following rider of the coroner's jury, submitted to the War Office by the Clerk to the Woolwich Borough Council :—

"That the jury desired to express their strong opinion that the evidence revealed a negligent system of working, and that the arrangements up to the time of this explosion within the danger area were faulty; particularly in the following respects:—

"That the buildings are dangerously close together.

"That the spaces between the buildings ought to be traversed by danger mounds.

"That the least possible number of men should be employed in any one building conducive to the work engaged upon.

"That there should be an independent form of inspection under the Home Office.

"That the fellowship piece-work system of danger working should be abolished, and that the rate of pay of such work should be brought to the level of the amount now earned by the men.

"Further, that in the opinion of the jury, foremen, assistant foremen, and overlookers engaged upon explosive work should have a practical knowledge of it."

1 27608. 50.—9/03. Pk. 468. E. & S.

REPORT.

SECRETARY OF STATE,

In accordance with your instructions the Court of Enquiry appointed to investigate the circumstances of an explosion which occurred in the Lyddite Establishment, Royal Laboratory, Royal Arsenal, Woolwich, on the 18th June 1903, assembled at Woolwich on the following day.

The Court have visited the scene of the accident and have examined a number of workmen and others connected with the work or who were in the vicinity at the time of the explosion, as well as members of the staff of the Royal Laboratory and other Departments of the Arsenal.

Experiments have also been carried out at Shoeburyness, *vide* Appendix XI., and investigations have been made by Dr. Dupré, Dr. Kellner, and his assistant, Mr. Deering. The result of these investigations will be found in Appendices XVI. and XVII.

The Court now beg to submit their report :—

Circumstances of the Accident.

The explosion took place at 8.10 a.m. on Thursday the 18th June 1903, in No. 9 Filling House of the Lyddite Establishment, Royal Laboratory. In this building the operation of filling shells with melted picric acid was carried out, the shells, when filled, being allowed to remain in the house until the acid had cooled and set.

Construction of the Building.

No. 9 Filling House was a light structure, length about 24 ft., breadth 14 ft. 6 ins., running N.E. and S.W. The framework was of "H" section iron, the uprights being embedded in concrete. Appendix XXII.

The walls were of corrugated iron lined to a height of about 4 ft. 6 ins. with matchboarding, and the roof was of slate, on $1\frac{1}{4}$ in. boarding. The floor consisted of $1\frac{1}{2}$-in. planks laid longitudinally, carried on joists supported by concrete pillars, and raised about 2 ft. from the ground, thin strips of wood being placed under the junctions of the floor boards.

Under the southern portion of the building, and extending about half its length, was a bed of concrete 6 inches thick.

At each end of the building were two double doors opening outwards. The two at the southern end opened on to the "clean" platform, and were protected by a light "lean-to" porch projecting about 9 ft. from the building. A line of rails, laid on the "clean" platform outside, and used for transporting shells to and from the building, terminated under the porch opposite the eastern of the two double doors. The doors at the northern end of the building opened on to a "clean" covered way connecting it with the Melting House (No. 7).

The building was lighted by four windows in each of the side walls. A shelf was attached to each side wall about 2 ft. from the floor, extending about half the length of the building from the northern end.

The limits for men and explosives in the building were 12 and 1,500 lb. respectively. Appendix IX., D. and E.

Description of the Process of Filling Shells with Lyddite.

The following is a description of the operations in the Filling House as they should be carried out when dealing with heavy shells.

The Filling House having been cleared of all completely filled shells the first thing in the morning, a fresh supply of empty shells is brought in and arranged in two or three rows, the shells in the rows being about 6 ins. apart. The plugs are then removed, a canvas jacket put over each shell and a

Appendix XXVI. metal tray placed on the bush and secured by a metal socket screwed into the fuze hole. A metal funnel is then inserted into the socket, resting on one or more asbestos washers. The object of the canvas jacket and metal tray is to protect the shell from splashes and overflow of lyddite during filling. Any shells which have been partially filled the previous day remain in the house, similarly arranged and fitted.

Q. 120, 1070. The picric acid, which has been placed in the Melting House about 6 a.m., is sufficiently melted for use about 11 a.m., and is carried to the Filling House in the cans in which it has been melted. Each can contains about 30 lb. of acid.

Appendix V. Para. 13. The shells are then filled, the melted acid being poured from the cans through the metal funnel until it reaches a height of about 2 ins. below the bottom of the bush of the shell, the height being ascertained by means of a copper wire gauge. The filling funnel is then withdrawn and the "former,"* itself fitted with a supplementary funnel, is inserted through the metal socket into the liquid acid.

Appendix XXVII.(*d*).

Q. 1089. During the cooling of the acid the "formers" are frequently turned by hand in order to prevent their becoming fixed, men walking up and down the rows for this purpose. When "formers" have been inserted during the morning the necessary number of men remain during the dinner hour to turn them. These men leave work an hour earlier in the evening.

Q. 642, 1201.

Appendix V. Para. 15. Shrinkage takes place as the acid cools and solidifies, necessitating a final filling up with melted acid, the time for doing this being known by the "former" holding slightly in the shell. The filling is then completed through the "former," sufficient melted acid being poured in to partially fill the funnel, and the "former" is turned as before till the lyddite has solidified.

Q. 11, 34, 172, 1040, 1041. Should there be any difficulty in turning a "former" by hand, spanners which are provided for the purpose are used, one being placed on the socket to prevent it or the shell being turned, the other on the "former." The Directions for the Guidance of Overlookers, No. 185, lay down that no unnecessary force is to be employed in withdrawing "formers," but it is recognised that the spanners may be used for this purpose. There are, however, no written instructions regarding the use of these spanners.

Appendix V. Para. 19.

Q. 244.

Appendix V. Para. 17. If on examination after a "former" has been withdrawn it is found that the shell has not been quite filled up to the bush, a short "former" is inserted and the filling is completed through this. This is commonly known as "topping" the shell. There is usually sufficient time for the lyddite to set before the men leave at 5.40 p.m., but if this is not the case, one or more remain to complete the operation.

Q. 280, 956, 960.

Appendix V. Para. 19. If it is found impossible to withdraw a "former," Directions No. 185 lay down that the shell shall be placed in a melting chamber for such a time as will enable the "former" to be easily withdrawn. The time at which this is to be done is, however, not mentioned.

Q. 14, 26.

Q. 101, 102. When the "former" has been removed from a shell, the socket is unscrewed and taken with the tray to the boiling-out house to be cleaned. The canvas jacket is drawn off and laid over the fuze hole, and the shell remains in the Filling House for the night to thoroughly cool.

Q. 177.

If for any reason a shell cannot be completely filled at one filling, acid is poured in until its surface in the shell is just below the position in which the lower extremity of the "former" will be when inserted. The acid is then allowed to cool and the filling is completed at the next opportunity.

Q. 120, 628. The men connected with the Melting House commence work at 6 a.m. when they fill the ovens with cans of picric acid. They should also place in the oven any shells left overnight with fixed "formers," and as to which they have received instructions from the foreman. A certain number of cans may have to be removed in order to make room for large shells.

Q. 901, 232, 233, 609. Q. 989, 49, 118, 901, *et seq.*

Q. 936, 974, *et seq.* Appendix V. Para. 37. In the same oven are placed trays of "formers" full of lyddite. This lyddite is melted out and used again for filling, the "formers" are afterwards boiled out with soda to remove all traces of lyddite.

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* For drawing and description of "former," *see* Appendix XV.

On the arrival of the men employed in the Filling House, usually at 8 a.m., their first duty is to remove the canvas jackets which have been left on top of the completely filled shells the previous evening. Q. 177.

The cavity is tested as to depth with the flat gauge, and examined with the finger to ascertain whether "topping" is necessary. Q. 77, 285, 289, 320, 748.

The screw threads of the fuze hole bush of each shell are then brushed out and the plugs inserted and screwed in by hand. After this the shells are moved to the southern end of the building by means of a barrow, placed on a truck standing on the line outside, and removed to the Rectifying Room three or four at a time. Q. 322, 202, *et seq.*, 317, 493, 631. Q. 191–241, 492, 621, 491. Q. 200, 606, 1176. Q. 199, 93.

Particulars of the Explosion.

On the day of the accident, firing of heavy guns was to take place at the Proof Butts from 12 noon till 2 p.m. This would have entailed stopping the work in the Danger Buildings during that period, instead of for one hour only for dinner, as is usually the case. In order to make up full time, Usher, Marshall, Herbert, Swords, and Pinhorn came to work in No. 9 Filling House at 7 instead of at 8 a.m. Usher was in charge in place of Burns, who did not come to work that morning. Q. 976. Q. 968. Q. 974.

On the previous evening nineteen 10-inch shells had been partly filled, and twenty-one 9·2-inch shells completely filled in addition to a 5-inch howitzer shell. According to the evidence of Burns, the leading hand then in charge of No. 9 Filling House, the "formers" had all been removed the same evening from the shells, so there was, presumably, nothing to be done to the 9·2-inch shells in the morning, beyond examining, plugging, and topping if necessary. Q. 1. Q. 166 *et seq.*

By 8 a.m. ten 9·2-inch shells had been removed to the Rectifying Room. At that time Morley, Connor and Johnson arrived, Connor then taking charge. They were to have remained turning "formers" from 12 noon to 2 p.m., and consequently commenced work an hour later than the other men. At 8.10 a.m. the explosion occurred.

There were, therefore, in and about the building at the time of the explosion nineteen 10-inch shells, partly filled, one 5-inch howitzer shell, and eleven 9·2-inch shells completely filled. After the explosion nineteen 10-inch shells, one 5-inch howitzer shell, and five 9·2-inch shells were recovered whole, leaving six 9·2-inch shells to be accounted for, all of which were presumably destroyed. Q. 1.

From the evidence it appears that the 9·2-inch shells were probably standing in the eastern corner of the building as shown in Appendix XXIX., and from the position of the crater there is no doubt it was among these that the explosion occurred. From the size of the pieces recovered, some 750 in all (total weight about 330 lb.) the largest of which weighed 11 lb. 14 oz., and from the appearance of the fractures, it seems evident that all six shells had detonated more or less completely. Four of the five 9·2-inch shells recovered (Nos. 22, 23, 24, and 25) were lying on the platform, just beyond the S.E. door of the house. From the evidence and from the condition of the shells, and also from the position as well as condition of a truck found some little way along the platform, it is more or less certain that they had been actually loaded on to the truck, awaiting removal to the Rectifying Room. Q. 64, 163, 264.

The fifth shell (No. 10) was recovered in the latrine. From its appearance, and from the distance to which it was projected, it must have been within a few feet of the shells which exploded, and it is probable that at the time of the explosion it was being moved on the barrow to the door. This hypothesis is strengthened by the fact that all the portions of the barrow which were recovered, had also been projected in the direction of the latrine. Appendix XXIX.

The 5-inch howitzer shell was recovered on the embankment to the west of the building. A hole had been knocked in its side exposing the lyddite, which had not exploded. Appendix XXV.(*a*).

Results of the Explosion.

Injuries to Men.

Appendix XVIII. Q. 968 *et seq.*

The explosion caused the death of 16 men, and injury to 14 others. In the building at the time of the explosion were, Usher, Marshall, Herbert, Morley, Connor, and Johnson; the last five were blown to fragments, only portions of their bodies being subsequently identified. Usher, although terribly mutilated, was not dismembered to the same extent, and consequently could not have been as near the explosion as the other five. From the evidence, and from the position in which the bodies of Swords and Pinhorn were found, it would appear that these two were standing just outside, attending to the truck. Of the others killed, Edwards, Remington, and Greenless were on the "clean" platform situated to the east of No. 9 building, and running more or less parallel to its length and about 50 ft. from it.

Appendix XXIX.

Newton was in the latrine and was probably killed by No. 10 shell, or by the wall in front falling on him. Curran and Larkin were attending to the melting ovens, and Case was the stoker.

Appendix XXVIII.

As to Adams, it is not clear what he was doing near the melting chamber. It has been ascertained that he was in the act of taking empty cans from the Boiling-Out house, No. 13, to one of the sifting shops, Nos. 4, 5, or 6. His nearest way would have been past the eastern corner of No. 27 building, but apparently he chose the longer route past No. 9 Filling House, and may have stopped at the Melting House to talk to the men employed there, and so met his death.

Q. 506, 522.

One of the fragments found consisted of part of a man's chest, which must have belonged to either Herbert, Morley, Connor, or Johnson, and in it was embedded part of a copper shovel used in the Filling House.

Appendix XXVII.(*g*).

The men injured were mostly struck by splinters, glass, &c. Goldsmith had just passed No. 9 House by the platform on the west side on his way from the Melting House, and was found on the spot marked 12* on the plan shown in Appendix XXVIII. When examined by the Court, he was unable to give any account of what was going on in the building when he looked in at the open doors at the north-east end.

Q. 418 *et seq.*

Structural and other Damage.

Appendix XIX. gives in detail the damage caused by the explosion, and Appendix XXX. shows the areas of serious and minor structural damage, and of damage done by fragments of shell.

Appendices XXIII. and XXIV.

No. 9 building was entirely demolished, the only portion remaining being the bed of concrete under its southern half, the concrete piers on which the building had stood and the iron framework at the S.W. end. A crater was formed close to the north-east end of the building, and about 2 ft. from the position of the south-east wall.

The covered way leading to No. 7 Melting House was entirely destroyed for about three-quarters of its length, the remainder collapsed on to the platform.

Appendix XXIII.

Of the buildings in the vicinity, No. 6 suffered the most, the front wall being blown in. The platform in front of this building was shifted bodily about 1 ft. 6 ins. to the east.

A number of other buildings were more or less damaged, principally by fragments of shell or debris. Pieces of shell were recovered at distances up to 1,200 yards.

Appendix XXVIII. Q. 925.

No. 7 Melting House, which was situated about 50 feet from No. 9, contained at the time about 1,350 lb. of picric acid in cans in process of being melted. Although this house was much shaken, the acid was not affected.

Possible Causes of the Accident.

In an accident of this class where no definite cause is obvious, the idea of suicide or foul play must not be lost sight of, but in this instance, owing to the number of men in the house, it is highly improbable that any such attempt could have been made.

The next point the Court have to consider is whether the explosion originated in a plugged or in an unplugged shell.

As regards plugged shell, ignition must either proceed (1) from some internal cause, or (2) from an external flash finding its way into the shell through the plugged fuze hole.

With reference to (1); the shells are carefully examined before being filled in order to insure that they contain no foreign substance or moisture, and that the varnish with which they are coated internally is intact. Even if the varnish of a shell had broken away, leaving a portion of the steel exposed, no picrate of iron could have been formed. Moreover, it is not conceivable that any treatment to which a plugged shell could have been subjected would cause ignition. This is borne out by the condition of the unexploded shells after the accident and after the experiment at Shoeburyness, also by the large numbers which have been fired without any premature due to the shell. Q. 454, 468 *et seq.* Appendices XXV. and XI.

With reference to (2); the trials carried out by Dr. Dupré show that the lyddite in a plugged shell could not have been ignited by any external flash which might by any possibility have occurred, as such a flash would not penetrate past the plug. Appendix XVII.

The Court are therefore of opinion that the possibility of the accident originating in a plugged shell may be dismissed.

As regards unplugged shell, although there are no written instructions on the subject, from the evidence of the foremen and overlookers it would appear that all the shells should have been plugged before any were moved; the evidence of some of the labourers, on the other hand, shows that this was not always the practice, and that it often happened that shells were moved while the plugging of others was in progress. Q. 131, 495, 240, 278, 945, 1058, 1108, 1308.

The experiments carried out at Shoeburyness on the 20th July proved that, if the lyddite in a 9·2-inch shell is ignited, detonation will follow with great rapidity. Appendix XI.

Assuming, therefore, that one or more of the 9·2-inch shells were unplugged, the following are the means by which ignition might have occurred:—

1. An external flash.
2. Screwing in the plug by force.
3. Dropping a gauge into the cavity.
4. Forcible removal of a jammed "former."
5. Forcible insertion of a "former."

1. External flash.

This might possibly be caused by:—

(*a*) Dropping a tray of "formers" or funnels.
(*b*) Ignition of a picrate on the exterior of the shell.
(*c*) Ignition of a picrate on the floor.
(*d*) Spark from an adjacent chimney or from lighting arrangements.
(*e*) The presence of a match.
(*f*) Smoking in the building.

(*a.*) The "formers" after withdrawal contain a considerable amount of lyddite, and are placed in trays on the shelves until required for melting out. Several portions of "formers" containing lyddite were found after the explosion, and must have been in the building. A tray of these might have been dropped on the floor or on to a shell. An instance has occurred (*vide* Carver's evidence) of an ignition caused by one funnel being dropped on another, followed by a flame of some seconds duration. It is therefore conceivable that an ignition and a considerable flash might have been caused by dropping a tray of "formers." Q. 483 *et seq.*

Considering, however, that lyddite in a shell is not easy to ignite, it is improbable that such an external flash could have caused the explosion.

(*b.*) Experiments and analyses, detailed in Appendix XVII., show that it is extremely unlikely that, even if the shell were not protected during filling by the canvas jacket, sufficient picrate of iron or lime could be formed on the exterior of the shell to carry the flash as far as the fuze hole, while the small percentage of lead in the paint renders it impossible for any danger to arise from the formation of picrate of lead.

Appendix XIII. (*c.*) Picric acid, picrate of calcium, and small flints were found between the boards of the floor of a similar building (No. 34.) This mixture might be ignited, but the quantity was too small to produce a flash of any consequence.

(*d.*) A chimney stack is situated about 50 feet to the north of the building. Coke only is burnt in the furnace, which had been alight for at least two hours. A light wind was blowing from the north, and therefore from the chimney in the direction of No. 9 building. It is unlikely however that a spark would have reached the interior of the building from the chimney, and even if it had, it is not probable it would have ignited the lyddite. No locomotive was in the neighbourhood at the time, and the lighting was by gas lamps outside the windows, no burner being inside the building.

Appendix XXIV.

Appendix XXII.

(*e.*) A match, even if it had been dropped and ignited on the floor, could hardly have caused ignition of the lyddite in a shell.

(*f.*) In view of the number of men present, the idea of smoking may be dismissed.

2. Screwing in the plug by force.

Q. 191, 241, 492, 560, 607, 621, 1079, 1109, 1216, 1353. Appendix V. Para. 44. From the evidence it appears that the verbal instructions were, that the plugs should only be screwed in by hand in the Filling House; a key, however, was frequently used, and two patterns of keys are included in the list of tools. It frequently happened that owing to the lyddite having worked up into the bottom threads of the fuze hole, the plug could not be screwed home easily. The first operation in the Rectifying Room is to insert the "tap" for the purpose of clearing the threads. This implement is an ordinary screw tap of gunmetal, and is suitable for the work, but the fuze plug, having no interruptions on the thread, if forced into the fuze hole, would exert heavy pressure and friction on any lyddite present in the thread. Under ordinary conditions this would probably not be sufficient to cause ignition, but it is possible that conditions might arise, such as the presence of a minute quantity of a sensitive picrate, or of grit or other foreign substance, which would make the operation dangerous if force were used.

3. Dropping the gauge into the cavity.

Appendix XXVII.(*d*). The flat copper gauge used in the Filling House for testing the depth of the cavity, weighs 5 oz., and might be dropped from above the shell a distance of some 18 inches on to the bottom of the cavity.

It is conceivable that conditions might arise under which such a blow would cause ignition.

4. Forcible removal of a jammed "former."

Appendix V. Para. 19. Q. 13, 28, 79, 611, 620, 987–8. Q. 1043, 1185 *et seq.* 34, 235, 611, 1041. The "Directions for the Guidance of Overlookers" lay down that no unnecessary force is to be used in withdrawing the "former." Considerable force can, however, be exercised with the spanners, and the deep scoring on some of the "formers" shows that such force has been frequently used: moreover, there is evidence that "formers" have been unscrewed and even broken in the shell. The force necessary for this would cause considerable heat, which might be sufficient to ignite the lyddite.

From an examination of "formers" which have been in use, it was found that the threads of the joint were often not coated with tin and sweated as was intended, thus allowing picrate of copper to form between the threads.

Appendix XV. The cavity at the end of the thread in the head for clearing the tap also contained the same explosive. (*See* Dr. Dupré's Report, Appendix XVII.)

Appendix XVI. In Dr. Kellner's and in Mr. Deering's experiments, this substance was

exploded by the heat used to melt the tin when removing the head from the body of a "former." Trials to reproduce this ignition by forcibly unscrewing and screwing up the head of the "former" have given negative results; on the other hand, the accident with funnels already referred to shows that a slight blow may cause an explosion or ignition of the substance which forms on the surface of the metal. If this substance is present in the screw threads, a forcible screwing of the "former" head may be quite sufficient to cause ignition. Q. 483.

5. Forcible insertion of a "former."

If "topping" the shell is necessary in the morning, a short "former" has to be inserted, and should the wall of the cavity in the lyddite have bulged, reducing the diameter, there would be difficulty in doing this until the hole had been rimed out. This should be done in the Rectifying House.

There is evidence that on occasions a rectifier has been sent for and used in the Filling House, and it is probable, therefore, that difficulty has sometimes been experienced in inserting the short "former." Q. 225, 267, 1208.

If the "former" is forced into the cavity and turned at the same time, the end would remove the lyddite from the wall of the cavity with considerable friction. This would be increased if any foreign matter were present on the "former," and a dangerous condition would arise. There is also the risk of the "formers" jamming during the above operation and producing the same dangers as described in 4.

The Court have enumerated the above as the possible causes which have suggested themselves from the evidence they have taken, and from a consideration of the operations of filling large shells with lyddite as carried out.

There is no doubt that various irregularities were practised, and when such is the case, it is quite conceivable that some other irregularity of an even more serious nature than those which have come to light, may have been the real cause of the accident.

The evidence does not directly connect the explosion with any of the causes referred to, but after careful consideration the Court consider that the causes 4 and 5 present the highest degree of probability.

No "former" should have been left in a shell overnight, without a report being made by the overlooker or leading hand in charge of the house to his immediate superior. No such report was made, and Burns, who was the leading hand in charge of No. 9 Building the evening before the explosion, states most positively (Q. 175) that all "formers" had been removed on that evening. This statement, if correct, disposes of the probability of the explosion having been caused by the forcible removal of a fixed "former." The Court, however, have grave doubts as to the truth of Burns' evidence. He has denied in the most emphatic manner (Q. 1274, 1283, and 1285) the existence of irregularities which have been amply testified to by other witnesses (Q. 1045, 1095, 1186), and as having occurred in his presence (Q. 1106, 1050). Q. 15, 65.

There is no doubt that placing shells in the oven for the purpose of loosening fixed "formers," was only resorted to in the case of heavy shells, when all other measures had failed. The only definite case which any of the witnesses could refer to, was that of a 10-inch shell with a *broken* "former" on the day before the accident, but no entry was made in the log book of this, or of any other shell, being placed in the oven. Moreover, the removal of fixed "formers" in the morning was by no means an unusual occurrence. Q. 750, 790, 81, 662, 815, 938, 966, 993, 1059. Q. 937, 962, 1142, 1230.

There is practically no evidence corroborating Burns' statement that there was no "former" left in overnight. Foreman McCarthy, who went through No. 9 Building about 7.45 a.m. on the morning of the accident, could only say that he did not notice a "former" in a 9·2-inch shell, and that he thought that if there had been he would have noticed it. It appears, however, to have been a practice to hide a fixed "former" by means of Q. 949 *et seq.*

Q. 1213. canvas jackets placed over it to prevent the foreman seeing it. It is therefore by no means improbable, notwithstanding the evidence of Burns and McCarthy, that a "former" had been left in one of the 9·2-inch shells the previous evening, and that an attempt was made to extract it on the morning of the accident. Moreover, the explosion occurred a few minutes after the arrival of Connor and Morley to work in No. 9 Filling House. Connor was the leading hand; he was a powerful man and "a very good hand at pulling out the "formers." Morley also was a tall man, and that would be an advantage on account of the height of the shell. If there had been a fixed "former," it is very probable that it was left for these men to deal with.

Q. 1105, 1121, 1188 *et seq.*

With regard to the insertion of a short "former" by force, this might also have been left to Connor and Morley.

Difficulty in inserting the short "former" would probably be due to the "former" having been withdrawn the previous evening before the lyddite was properly set.

Q. 843 *et seq.* A walking match for men in the Royal Laboratory Danger Buildings, took place on the Wednesday evening, and some of the men working in No. 9 Filling House were interested in the event, Usher competing and winning a prize. The men may therefore have been anxious to leave work punctually, and for this reason a "former" may have been withdrawn too soon or left in overnight.

If difficulty were experienced in inserting the short "former" for topping, the shell should have been removed to the Rectifying House, for the cavity to be rimed out, but there is evidence that complaints had been made recently by the men in the Rectifying House, of the number of shells having to be rectified. Probably, therefore, the "former" would have been inserted by force in preference to sending the shell to be rectified, and it is doubtful, indeed, if shells were ever so sent.

Q. 346, 351, 378, 404, 733.

Recommendations.

From the above considerations it is evident that there are several sources of danger in the operation of filling lyddite shells as at present carried out, but the Court are of opinion that these may be minimised by alterations in the methods employed, and by further precautions.

The Court, therefore, make the following recommendations:—

(1.) Every building in which lyddite shells are filled and rectified, should be surrounded by a substantial mound of earth or plate-bank.

(2.) Any melting house should be similarly traversed, unless Home Office unmounded distances are maintained.

(3.) The operations of filling and rectifying should be carried out in one building, and no shell should be removed until all the shells are completed, fitted with exploders and plugged ready for issue. Filling and rectifying should not be carried on at the same time, and only those tools and implements required for the operation actually in progress to be in the room.

(4.) During the above operations, no shell in the building should be nearer another than its own length.

(5.) The number of men allowed to be present in any building during the above operations should not exceed four, exclusive of the Overlooker and Inspection Department Examiner; men necessary for bringing acid not being allowed in the building.

(6.) As long as a metal "former" is used it should—(*a*) be manufactured in one piece, (*b*) be more tapered, (*c*) have the bottom edge rounded. When once the lyddite has set and the "former" has been removed, no "former" should be inserted. The operation of "topping," if necessary, to be performed in some other way.

The Court consider, however, that steps should be taken to devise a method of filling which is less open to objection, and one not necessitating rectification of the exploder cavity and the turning over of an unplugged shell.

(7.) The dregs in the melting cans should not be used for filling shells.

(8.) Every precaution should be taken to prevent the formation of picrates.

(9.) Wood or other suitable material should be employed in lieu of metal, whenever possible, for gauges and implements used in the buildings.

(10.) Instructions and special rules for the operations to be carried out in any particular building, with a list of the tools that may be used, should be posted in each building.

(11.) The general rules and regulations referring to Danger Buildings should be revised, and a copy supplied to every workman.

(12.) The methods of searching, supervision, and visiting should be considerably improved. The system of danger-building visitors, as now carried out, has failed to ascertain or to check the irregularities which have been going on, and the supervision by the foremen and overlookers has been equally unsuccessful.

(13.) The fellowship system of payment should be abolished for men working in Danger Buildings.

(14.) In conclusion, the Court have been impressed with the crowded state of the Danger Building Establishments in the Royal Arsenal, but they have not investigated the conditions obtaining in any other buildings than those of the Lyddite Factory. *See* Appendix XXX.

They consider it in the highest degree advisable that steps should be taken to select a more suitable site for this factory, where the work can be carried out under safer and more satisfactory conditions.

A. A. CHASE PARR,
President.

A. DUPRÉ.

C. F. HADDEN,
Lieut.-Col. & Bt. Colonel R.A.

F. L. NATHAN,
Major R.A.

J. H. THOMSON,
Captain.

J. G. M. WATSON,
Captain R.A.,
Secretary.
11th September 1903.

LIST OF WITNESSES.

Date of Examination.	Name, &c.	Numbers of Questions.
1903.		
19th June -	Major H. W. W. Barlow, R.A., Superintendent, Royal Laboratory -	1
20th June -	Mr. W. Edwards, Foreman - - - - - -	2–56
,, -	Mr. J. McCarthy, Assistant Foreman - - - -	57–138
,, -	Mr. W. Cowell, Principal Overlooker - - - -	139–158
,, -	Mr. A. Burns, Leading Hand - - - - - -	159–212
,, -	Mr. S. McGowan, Inspection Department - - - -	213–247
,, -	Mr. W. Potter, ,, ,, - - - -	248–279
23rd June -	Mr. J. McCarthy (2nd time) - - - - - -	280–298
,, -	Mr. A. Burns ,, - - - - - -	299–324
,, -	Mr. W. Wood, Labourer - - - - - -	325–367
,, -	Mr. D. Gaurd, ,, - - - - - -	368–392
,, -	Mr. W. Cowell (2nd time) - - - - -	393–417
,, -	Mr. A. Goldsmith, Labourer - - - - - -	418–430
,, -	Mr. E. Birmingham, Overlooker - - - - -	431–440
,, -	Mr. J. Edser, Labourer - - - - - -	441–450
,, -	Mr. E. Taylor, Leading Hand - - - - -	451–467
,, -	Mr. W. Kearley, Labourer - - - - - -	468–482
,, -	Mr. G. Carver, ,, - - - - - -	483–486
,, -	Mr. C. Griffin, ,, - - - - - -	487–503
25th June -	Major J. R. Mallins, R.A.M.C., P.M.O. - - - -	504–520
,, -	Mr. T. Critchell, Dresser - - - - - -	521–533
,, -	Dr. W. Kellner, F.I.C., War Department Chemist - - -	534–556
,, -	Mr. W. Wood (2nd time) - - - - - -	557–573
,, -	Mr. J. B. Burall, Labourer - - - - - -	574–585
,, -	Mr. W Leverett, Leading Hand - - - - -	586–628
,, -	Mr. F. Cakebread, Labourer - - - - - -	629–681
,, -	Major J. H. Mansell, R.A., Proof Officer - - - -	682–687
29th June -	Major F. F. Minchin, R.A., I.L.S. - - - - -	688–699
,, -	Mr. W. Potter (2nd time) - - - - - -	700–744
,, -	Mr. S. McGowan ,, - - - - - -	745–766
,, -	Mr. W. Leverett ,, - - - - - -	767–811
,, -	Mr. J. Edser ,, - - - - - -	812–842
,, -	Mr. J. Mulvey, Labourer - - - - - -	843–868
,, -	Mr. A. Seguss, ,, - - - - - -	869–891
,, -	Mr. T. Beese, ,, - - - - - -	892–937
30th June -	Mr J. McCarthy (3rd time) - - - - - -	938–989
,, -	Mr. W. G. Widdowson, Labourer - - - - -	990–1008
4th July -	Captain C. D. Freeth, R.A., Danger Building Officer - -	1009–1032
,, -	Mr. G. Fletcher, Labourer - - - - - -	1033–1080
,, -	Mr. W. Hill, ,, - - - - - -	1081–1123
,, -	Major H. W. W. Barlow, R.A. (2nd time) - - - -	1124–1152
,, -	Mr. F. Smith, Labourer - - - - - -	1153–1219
,, -	Mr. W. Edwards (2nd time) - - - - - -	1220–1246
,, -	Mr. W. Wood (3rd time) - - - - - -	1247–1256
,, -	Mr. A. Burns ,, - - - - - - -	1257–1285
10th July -	Mr. W. Murphy, Danger Building Visitor - - - -	1286–1317
,, -	Mr. E. C. Coombs, ,, ,, ,, - - - -	1318–1340
15th July -	Mr. J. C. Aylan, Manager, Royal Laboratory - - -	1341–1373

ENQUIRY

INTO THE

ACCIDENT OF 18th JUNE 1903

AT THE

LYDDITE ESTABLISHMENT, ROYAL ARSENAL, WOOLWICH.

Royal Arsenal, Woolwich.

Friday, 19th June 1903.

PRESENT:

REAR-ADMIRAL A. A. CHASE PARR (PRESIDENT).

Lieut.-Col. C. F. HADDEN, C.B., R.A.
Major F. L. NATHAN, R.A.

Captain J. H. THOMSON, His Majesty's Chief Inspector of Explosives.
Dr. A. DUPRÉ, F.R.S.
Captain J. G. M. WATSON, R.A., *Secretary.*

Major H. W. W. BARLOW, R.A., Superintendent, Royal Laboratory, examined.

Major H. W. W. Barlow.

19 June 1903.

1. (*President.*) What were the contents of the building in which the explosion took place?—In building No. 9, on the afternoon of the 17th June 1903, on close of work there were 19 10-inch shell, part filled, 21 9·2-inch shell completely filled, 1 5-inch howitzer (special shell).

Remain on the 18th after the explosion, on ground and on platform near site of No. 9 building, 19 10-inch shell, 5 9·2-inch shell, 1 5-inch howitzer, and in building No. 27 10 9·2-inch shell, leaving to be accounted for 6 9·2-inch shell.

The charge of a 9·2-inch is 40 lb. of lyddite, and of a 10-inch 46 lb.

(*The Court then adjourned to visit the scene of the explosion.*)

Royal Arsenal, Woolwich.

Saturday, 20th June 1903.

PRESENT:

REAR-ADMIRAL A. A. CHASE PARR (PRESIDENT).

Lieut.-Col. C. F. HADDEN, C.B., R.A.
Major F. L. NATHAN, R.A.

Captain J. H. THOMSON, His Majesty's Chief Inspector of Explosives.
Dr. A. DUPRÉ, F.R.S.
Captain J. G. M. WATSON, R.A., *Secretary.*

Mr. WILLIAM EDWARDS (Foreman) examined.

Mr. W. Edwards.

20 June 1903.

2. (*President.*) What is your position in the Arsenal?—My rank is that of foreman, but I am at the present time acting as assistant manager in the Royal Laboratory Department in the absence of Mr. Morley.

3. What is your connection with the Lyddite Factory?—I am responsible for all the filling, not only in the Lyddite Factory, but also in the Cannon Cartridge Factory. Mr. McCarthy is responsible to me for the actual carrying out of the work.

4. I presume you are fully acquainted with the instructions for the filling of lyddite shell?—Yes.

5. To the best of your knowledge and belief, were those instructions strictly adhered to?—Yes.

6. When were you last in No. 9 filling house?—The previous afternoon, between four and five o'clock.

7. At what time did they close?—5.40 p.m.

8. What was going on when you were there?—They were filling 10-inch shell.

9. Were all the 9·2-inch finished?—I did not notice.

10. Did you notice whether the formers were removed from them?—No, but I should say it was

Mr. W. Edwards.

20 June 1903.

not very likely, as we leave the formers in as long as possible to ensure the cavity being set.

11. The instructions say the formers have to be constantly moved while they are in; can this be done by hand, or are any tools required to move them?—It cannot always be done by hand, and when that is the case, spanners, which are authorised for that purpose, are used.

12. Is there any great force required, so far as your knowledge goes?—I should not term it great force, but at the same time, I do not mean to say they are easily moved, they never have been.

13. Have you ever known a case when it was not possible to move the former with the spanner?—Frequently, it is not at all unusual for a former to be fixed.

14. What is the routine then?—To place the shell in the oven, which is usually done as soon as possible the same day, but if that is not convenient, it would be done the first thing next morning.

15. Is any report made to you when the former becomes fixed?—Yes, the foreman in charge, or the assistant foreman, reports it to me.

16. Would it invariably be the case that if a former were left in for the night the foreman would be informed?—Yes.

17. Would one of the men employed put his whole strength on the former before he reported it as fixed?—No, as there would be no need to use any force, the former being easily removable by placing the shell in the oven.

18. You have never known anything approaching that amount of force used?—No.

19. Was the roof of that building perfectly water-tight?—Yes, as far as I know.

20. You had had no report to the contrary?—No.

21. When you were last in the building you did not notice any drip?—No.

22. Was water freely used in the building?—Yes.

23. What for?—For taking up the splashes which did not fall into the trays.

24. Have you ever noticed any drips of acid on the outside of the shell after it had been filled and the cover removed?—Since we have used the jackets I cannot call to mind a case when I have seen a single drip on the shell.

25. Is the jacket invariably used when filling the shell?—Yes.

26 (*Captain Thomson.*) When a shell is removed to the oven, is that the first thing done in the morning?—It would all depend whether there was room for it in the oven. It would be a usual thing for it to be put in at that time, but it would not be absolutely necessary, and if I went into the filling house and found a shell there I should not raise any serious question about it.

27. You were speaking just now of the force used on the former; if a man used his whole strength on the spanner he would twist off the head of the former?—Not if the former were a new one, but in the case of an old former he might do so, as the action of the acid on the former tends to weaken it.

28. Have you ever known one twisted off?—Yes, but I cannot say it was in the act of using the spanner or the man turning it by hand.

29. (*Lieut.-Col. Hadden.*) If the former is fixed, who is it reported to?—The principal overlooker in the first place. In this case that would be Cowell.

30. Is he one of the men killed?—No.

31. Would Cowell deal with it himself?—Yes, he would see it placed in the oven, and when it was removed from there he would test it and decide whether the former should be taken out.

32. If a former were fixed late in the evening, just before closing, would it be reported to him that evening?—Yes.

33. It might be left till the following morning before being dealt with?—Yes.

34. In using these spanners on the former, how many men would apply the spanners to the shell?—I have known two men, having one spanner each.

35. Why is that necessary?—One turns the former, the other steadies the shell.

36. Would that apply to a 9·2-inch shell?—I should not think it would be necessary to apply the second spanner to a 9·2-inch or 10-inch.

37. Who decides the number of men employed in a building, I mean actually working in the shop for the day?—The foreman or the overlooker.

38. Are there any orders as to what each man in the shop is to do?—No, they are all under the charge of the leading hand, and would do whatever was necessary.

39. You said you sometimes apply water to the floor. How do you do it?—With a mop.

40. (*Dr. Dupré.*) In using the spanner, are men allowed to strike it?—No.

41. (*Major Nathan.*) When they use a mop, where do they damp it?—In a bucket of water.

42. They would just mop where the splash would be, and let it remain a few minutes; would they rinse the mop afterwards?—They would take the mop back again and rinse it.

43. Where is the bucket kept?—Outside.

44. Is there any chance of their touching the shell with the mop?—I should say the mop would frequently come in contact with the base of the shell and wet it.

45. The jackets do not completely cover the bases?—Some do not.

46. I noticed several jackets were torn at the bottom?—That is owing to the shrinkage, and when they get too short I have them renewed.

47. It is quite possible the wet mop may come into contact with the base of the shell?—Yes.

48. Where is the mop kept?—Generally outside.

49. Supposing the shell requires to be put back into the oven, would it be placed there if the oven were full of acid to be melted?—Yes, it would be placed in the passage. If the former were fixed over night, the men who go to work at six o'clock would have orders to leave room for the shell.

50. You do not know whether the oven was full or not?—No.

51. I noticed the oven was not damaged?—Simply the outer door.

52. You have known heads to be broken off the formers; what steps are taken to remove the stalk of the former?—Exactly the same as those taken to remove the former.

53. How often does it occur that you cannot get a former out?—It all depends upon the nature of the acid, which varies very much; some acids seem better for forming a cavity than others.

54. Do you know Read and Holliday's acids as being more like the foreign acids than others we use?—I might say that there is a little more foreign matter in that than the Lowmoor or the other makes of acids.

55. (*Captain Thomson.*) Is it usual, before putting in the plug, to gauge the depth of the hole?—The former is turned until the acid becomes tacky, and when the former is removed then is the time the gauge is used, and if it is not found correct the former is put back again.

56. (*President.*) When the mop is used to sponge up the splashes of picric acid, is it ever used on the jackets or the sides of the shell to remove any splashes that may be on them?—No, the mop would not be used to remove splashes on the shell, but to mop up the floor only. The jackets are washed.

The witness then withdrew.

Mr. JOHN MCCARTHY (Assistant Foreman) examined.

Mr J. McCarthy.

20 June 1903.

57. (*President.*) What is your position in the Arsenal?—I am an assistant foreman in the Royal Laboratory, and assist Mr. Edwards.

58. Were your duties specially connected with the filling of the lyddite shell?—Yes.

59. No. 9 building was in your special charge then?—Yes.

60. When were you last in the building actually superintending the operations there?—About fifteen minutes to eight on the morning of the accident.

61. What was taking place then?—They were removing the shell.

62. How many shell had been removed at that time?—They were loading the ninth shell.

63. What description of shell?—9·2-inch shell.

64. In what position were the remaining shell?—They were standing in rows at the end of the building farthest from the truck.

65. Did you look at those shells particularly?—No, but the evening before when I passed through the chamber the overlooker was asked, "Is all correct?" and he replied, "Yes."

66. Did you ask him?—Yes.

67. You did not look at the 9·2-inch shell specially, either at that time or the next morning?—No.

68. Can you say whether all the plugs had been inserted into those shells?—I did not look at each shell individually, so could not say whether they had been inserted.

69. How many men were in the building at the time, and what were they doing?—There were six. One man was mopping the floor, two were removing the shell from the shop to the truck outside, and another was assisting at the plank. The other men were engaged on sundry smaller jobs, but I cannot say what.

70. Why was the mop being used at that time?—The floor is always mopped when the shells are shifted. We do not shift the shells while they are hot. They stand in the position in which they are filled until cool, and when shifted the floor is mopped in case there are any splashes of lyddite there.

71. At that time the 9·2-inch had had the jackets removed from them?—Yes.

72. Is the mop ever used on the sides of the shell to remove splashes?—No, not on the sides, but it might touch the bottom of the shell near the base.

73. If there are splashes on the shell itself, is the mop *ever* used to remove them?—No, a wet swab would be used to wipe splashes from the shell.

74. You have never noticed splashes on the shell since the jackets have been used?—While the filling is proceeding the air coming into contact with the picric acid causes it to splash, and I have known it do so on the base of the shell.

75. (*Captain Thomson.*) Is the cover ever swabbed?—No, they are all washed at intervals.

76. Is it ever done when it is on the shell?—No, if there are any splashes on one of the covers when the tray and former are removed, that cover is put on one side and washed.

77. Is the gauge ever used before putting in the plugs?—No, a small flat copper gauge is used to ascertain the depth of the cavity when the former is withdrawn.

78. But never in the morning?—It may be used in the morning if there was any doubt about the cavity.

79. You have known cases where the head of the former has been twisted off?—Yes.

80. That is if it is worn?—We have frequently found that the part of the former nearest the head becomes thin from the action of the soda solution in which it is cleaned. We have noticed it very much in the top of the funnel where it is turned round.

81. When did you last have a report of a fixed former?—On Monday of this week and that shell was a 10-inch. It was put into the chamber for melting out on Tuesday morning.

82. Have you found that this batch of acid is worse for gripping the former than other acids?—We have found that we do not get such a perfect cavity, and it has been more difficult to get the former turned. There was at one time a lot of dross which it was found impossible to pour through the spout, and so had to be poured out of the back of the can.

83. Have you any reason to suppose that there was a former fixed in the present instance?—No, when a former is fixed it has always been reported to me, and I have had the shell put into the melting chamber.

84. Do you recollect any instance when it was not reported?—No.

85. Have you formed any idea of the reason of the accident?—No.

86. (*Lieut.-Col. Hadden.*) How many men were working in the shop?—Six.

87. That is the limit of the shop?—Eight men had to do with the shop during the day.

88. When you visited there were six; where were the other two men?—Outside.

89. How were these shell placed in the shop?—They were placed in two rows.

90. At what distance apart were they?—Six inches.

91. In removing the 9·2-inch, which were they removing first?—The shell nearest the river.

92. Were they taking them between the 10-inch and the river side?—They were moving the 10-inch so as to allow the barrow to be taken out.

93. The truck was standing at the door?—Just outside, near the stop.

94. Outside which door was it standing?—The one farthest away from the river.

95. They were removing the shell down the other side?—Yes.

96. Did they take them outside the shop round the truck?—Yes.

97. Had they removed the whole of the 9·2-inch shell?—No, but I could not tell you how many were left on that side.

98. Do you know whether any had been removed from the other row?—I do not think any had been removed from that row.

99. If a shell were splashed with any of the acid would the splashes be removed by the swab immediately on removing the jacket?—Yes, immediately the jacke. is removed from the shell the shell is moved to near the door and the splashes are washed off. The shell is then taken back into the building.

100. If any of these shell had been so treated it would have been done on the previous evening?—Yes, in the ordinary way, but sometimes the splashes are not noticed at the time, and in that case they would be taken off the next morning.

101. Where are the filling trays put?—They are taken to the boiling-out house.

102. Do they wait to take the whole of them at once?—When the trays are removed from the shells a man takes six or eight at a time in his arms and takes them to be boiled out.

103. (*Dr. Dupré.*) How many 9·2-inch shell were there in one row?—The 9·2-inch shell were in two rows, and the 10-inch shell in three rows.

104. How would you know that a former had stuck if it were not reported to you?—The only way would be by seeing it as I was passing through the shop while they were endeavouring to withdraw the former. I have been in the chamber and found one tight and have had that shell placed on one side to be put into the melting chamber to have it withdrawn. Immediately, however, a former sticks it is reported.

105. Have you ever seen anyone strike a spanner?—No.

106. Is the jacket washed as soon as you see splashes on it?—We would not wash a jacket for one splash, but if it were very bad it would be removed for washing

107. It might be splashed and remain unwashed for some time?—Each week the jackets are washed. They are never allowed to go for more than a week.

Mr. J. McCarthy.

20 June 1903.

108. (*Major Nathan.*) Mr. Edwards is principal foreman?—Yes, and Mr. Griffiths and I are the assistant foremen to Mr. Edwards.

109. Do you report to Mr. Edwards direct?—Yes, when I can see him.

110. Has Mr. Griffiths to do with lyddite?—Only in Mr. Edwards' absence.

111. The 10-inch shell were removed for the 9·2-inch to be got out; were they removed toward the river or away from it?—Away from it.

112. The formers are placed in copper trays?—Yes.

113. On which side of the building?—On both sides. There would two trays of formers on one side, and one on the other.

114. Did you notice when you were in the building on which side the formers were?—I did not, but there were three trays of formers on the bench.

115. But you did not notice on which bench they were?—There were some on the river side.

116. Is there any possibility of the men knocking them off the bench?—No.

117. Was there plenty of room to get round?—Yes.

118. If a shell requires to have the former removed, is it put into the oven that night?—Not always. When a small nature of shell becomes fixed it would be put into the chamber on the same day, but one of a larger nature would be put in on the following morning.

119. Would it be put in while the picric acid cans were in?—We should clear the oven sufficiently to allow the shell to be placed in.

120. Were there any cans put into the chamber on the Wednesday night?—The cans are not put into the chamber until six o'clock in the morning.

121. Was the chamber full of cans after the explosion?—Yes, there were 44 in one chamber and 45 in the other. The capacity of the chambers is 44 for one and 48 for the other. The latter chamber was not full, as it would take only 45 cans to contain the 1,500 lb. of lyddite allowed.

122. Were there eight men in that building?—Yes.

123. Who detailed the eight men?—The overlooker, Edwards, who was killed.

124. What was Cowell's duty?—His duty was to see the acid put into the chambers, and take the reading of the thermometers.

125. It would be Edwards' duty to detail the work of these men?—Either Edwards or Cowell.

126. What would be the work for the eight men?—To clear the building of shell, to bring the empty shell into the building, and to fit them up for filling.

127. Was each detailed for any particular job?—No, they would be put to their work by the leading hand.

128. Would these men put the plugs in to start with?—They would clear the bush with a piece of serge, and then insert the plugs.

129. Who examined the men before they went to work?—I did.

130. Did you see all these men yourself?—Yes.

131. (*Captain Thomson.*) Do they ever commence to remove the shell before they put the plugs in all of them?—No.

132. (*Lieut.-Col. Hadden.*) Is there anybody between you and the leading hand?—Yes, the principal overlooker of the shop. On the previous day to the explosion the overlooker's name was Burns.

133. Was Edwards acting for him at the time of the accident?—No, a man named Connor was acting for Burns at the time.

134. Edwards was head overlooker between Connor and you?—Yes.

135. Were the men in this shop the same as were employed the previous day?—Not all the same men. We had to withdraw two men from the sifting house to go to the filling chamber.

136. How many were at work the previous day?—Six or seven.

137. Do you know the men who were employed in the shop the previous day?—Yes, they were all killed with the exception of Burns.

138. (*Dr. Dupré.*) Were they all old hands, or were there any new hands at work?—There was one man who had only been working there about three weeks, a man of the name of Swords; all the others were old standing hands.

The witness then withdrew.

Mr. Walter Cowell (Principal Overlooker) examined.

Mr. W. Cowell.

139. (*President.*) You are a principal overlooker in the Lyddite Factory?—Yes.

140. When were you last in No. 9 shop?—Between five and a quarter past on Wednesday evening, the evening before the accident.

141. What was being done in the building then?—They were then turning a former.

142. In which shell?—A 9·2-inch.

143. At what time did they leave the building?—At 5.30 p.m.

144. So that there was about 20 minutes left after you were there?—Yes.

145. Were any of the formers removed from the shell while you were there?—Not while I was there.

146. How many shell were left then with the formers in?—I did not count them, but I should say about half.

147. Were they in process of removing the formers?—No, they were turning them to form the cavity.

148. Was there sufficient time left for them to remove all the formers?—Yes.

149. Did you give any instructions with regard to them?—No. The overlooker is the man who is responsible for the time the formers are to be withdrawn, and also for the instructions regarding the operation. His name is Burns.

150. Where were you at the time of the explosion?—Just coming out of the shifting house door as I was returning from breakfast.

151. Can you describe what happened?—I had just got the door partly open when I heard the report and ran out of the building On looking about me I saw the debris flying in all directions.

152. Was there more than one report?—Only one.

153. Was there any difficulty in turning the formers while you were there?—No.

154. Were the spanners being used, or were the formers being turned by hand?—By hand.

155. (*Lieut.-Col. Hadden.*) Do you remember how the shell were placed in the shop?—The 9·2-inch were placed on the river side.

156. Were there two rows or three?—The 10-inch were in one row and part of another, and the 9·2-inch in two rows and part of another.

157. Had the 9·2-inch been partly filled on the Tuesday?—Some of them were finished on the Tuesday, and the remainder were done on Wednesday.

158. Did you examine the men before they went to work in this shop?—No, that was Mr. McCarthy's duty.

The witness then withdrew.

Mr. Arthur Burns (leading hand) examined.

159. (*President.*) What is your position in the Arsenal?—I am a leading hand in the Lyddite Factory of the Royal Laboratory.

160. Did your duty lie in No. 9 building?—Yes.

161. When were you last there previous to the explosion?—The night before on locking up.

162. Had you been working in it all day?—Yes, I was in charge there.

163. Will you tell us the position of the shell in that building?—(*Witness sketched the position.*)

164. What was the day's work on the Wednesday?—9·2-inch, 10-inch, and one departmental order.

165. Had any 9·2-inch been partly filled the day previously?—No, they were all filled on that day, and the 10-inch were half-filled.

166. Were the 9·2-inch sufficiently cool in the evening for the removal of the formers before you left work?—Yes, we have to take them out the last thing before leaving.

167. The lyddite was sufficiently cool and would not run after the formers had been removed?—Yes, they had had their full limit of time, and I withdrew the formers.

168. Who took them out?—I and two of the men took them out of the 9·2-inch.

169. Did you take them out all at once, or one after the other?—We went right along the row as the time drew round.

170. So that you may have taken an hour in removing the formers?—No, not so long.

171. Had you any difficulty with any of the formers that day?—No.

172. Had you to use the spanners at all?—Yes.

173. You did use the spanners on that day?—Yes.

174. There was no question as to the formers being set?—No.

175. You are quite sure all were removed?—Yes, quite certain.

176. What became of the trays?—They were put on the floor and covered over, which is the recognised thing to do.

177. The canvas covers were drawn up and laid over the fuze hole?—Yes.

178. (*Captain Thomson.*) Do you remember whether any splashes were wiped off the shells?—There were no splashes on the shells, but there were some on the floor. It frequently happens that the floor is splashed on account of the former getting clogged.

179. Was the floor mopped all round the 9·2-inch shell?—Yes, all round them and close to them.

180. Is that done after the cover is raised?—The mopping takes place after the cooling down.

181. Have you ever known the covers swabbed to take off the splashes?—The mop is used on the floor, and if a shell has not been completely filled, the cover is still on the shell, and you cannot help touching it with the mop.

182. It would not be done on purpose?—No.

183. Would you mop off the splashes from the shell?—No, we should do that with a swab.

184. Would you use a very wet cloth for this purpose?—Sufficiently wet to melt the acid, and the splashes are removed by dabbing the wet cloth on them till they are removed.

185. (*Major Nathan.*) Did you deal with any shell on that evening in that way?—No. *Mr. A. Burns.* 20 June 1903.

186. But you did mop round them on the floor?—Yes, we are continually mopping the floor during the day.

187. Do you ever swab round the nose of the shell?—No.

188. (*Dr. Dupré.*) Where are the plugs kept?—In a tray on the floor of the building.

189. (*President.*) Those that were used next morning would have been on the floor during the night?—Yes.

190. (*Dr. Dupré.*) Would they be covered over?—Yes.

191. Is the plug only screwed in with the fingers, or have they to use a tool?—With the fingers only.

192. (*Lieut.-Col. Hadden.*) You started with all these shell empty the previous day; did you put them into the filling chamber on Wednesday?—Yes.

193. You started with a complete lot of empty shell?—Yes.

194. Did you examine the shells before they were filled?—No.

195. Was the roof of No. 9 building watertight?—Yes.

196. Were the men that were at work in this building the men you usually had?—Yes.

197. After removing the formers in the evening, were the holes gauged?—Yes.

198. Were they all correct?—Yes.

199. In starting work on the shell as they were left, what would be the work of the men?—To get the empty trucks down and the planks, also a piece of cowhide.

200. What else?—The hand barrow for the removal of the shell.

201. Would the men be engaged in plugging the shell?—Yes, all would be engaged on that.

202. Does each man have a piece of serge for clearing out the fuze hole?—They are all brushed out the previous night.

203. Is there nothing done the next morning?—No, only the removal of the jackets.

204. Are the plugs used those which are taken out of the shell?—Yes.

205. Is there no cleaning of the shell done?—Not by us; that is done at the empty shell shop.

206. On the morning of the accident you were not in for the first quarter?—No, I lost the quarter through over-sleeping myself.

207. Was there anything going on the previous evening, any entertainment at which these men were present?—Not that I know of.

208. Was there a walking race?—Yes.

209. Were you present?—No.

210. Do you know whether any of the men engaged in this shop were present at the walking race?—I cannot say.

211. Do you know who organised the race?—I know nothing about it.

212. As far as you know, the men employed in this shop had no interest in it?—No.

The witness then withdrew.

Mr. Samuel McGowan (Inspection Department) examined.

213. (*President.*) Where are you employed?—I am an examiner in the Inspection Department.

214. Were you in the Lyddite Factory at the time of the explosion?—I was just outside and close to it.

215. Will you tell us what happened?—I heard a big roar accompanied by the noise of rushing steam, and when I got into the buildings glass was falling all over the place.

216. The first thing you heard was the roar and then the rushing steam. Did you feel any shock?—No, I smelt a strong smell of acid, and thought it was the cap and detonator place that had gone up. *Mr. S. McGowan.*

217. Will you please point out on this map where you actually were at the time?—(*Witness did so.*)

218. Had you been in the Lyddite Factory previously that morning?—No.

Mr. S. McGowan.

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219. You were approaching it for the first time?—Yes, after I had deposited my ticket.

220. What were you going there for?—I am the examiner for the Inspection Branch, and my work is connected with these shops.

221. What do you examine?—The work in progress. I divide my time between the lyddite and cannon cartridge factories.

222. That is, you examine the shell after they are filled and not the process of filling?—Yes.

223. Can you throw any light on the cause of the explosion?—I have only my own idea. I think it might have been done by removing the former, or by cutting the acid out of a cavity that was too high.

224. Have you any further information to give with regard to it?—No.

225. (*Captain Thomson.*) Have you ever known any case where the acid was cut out in the filling room?—Yes.

226. What for?—Sometimes, if the former is removed too quickly, the acid would have a tendency to swell up by the morning. A small wooden stick is then inserted, and if not found correct it would be cut out with the aid of the trepanning tool.

227. You are sure this was done in the filling room?—Yes.

228. Is it recently you have seen that done?—Not recently. It must have been two years ago.

229. Had they got the rectifying room then?—Yes.

230. And this operation was done in the filling room?—Yes.

231. Why should it have been done there?—If the job were a long one they would do it there. I have seen them do it the first thing in the morning after the lyddite had hardened.

232. (*Lieut.-Col. Hadden.*) Have you ever known the formers to be left in the shell over night?—I have known formers stuck over night, and being left to be dealt with in the morning.

233. How are they dealt with in the morning?—I have seen small shell put back again into the oven. The larger natures are released by a couple of spanners.

234. When it was cold?—Yes.

235. How many men have you seen on the spanners?—I have seen two with a spanner each, and I have also seen two men on a spanner, and a couple more steadying the shell.

236. Have you seen these spanners used recently?—Not recently, as I have not been there lately all day. I am speaking of what I saw when engaged there constantly.

237. Did you see two men on a spanner with big shell?—Yes, I have seen two or three men squat on the ground and hold the shell between them while the other men turned the spanner.

238. Have you ever been in the shop in the morning when they have been putting in the plugs before removing the shell?—Yes.

239. What is the procedure when plugging?—One man goes round with a tinful and inserts the plugs.

240. Have you ever seen men engaged in removing shell while there were still shell remaining without plugs?—Yes.

241. Do they ever use any tool when screwing in the plug?—No, I have only seen them use their fingers.

242. Have you seen that recently?—No.

243. (*Dr. Dupré.*) Where is the trepanning tool kept?—It is kept in the rectifying room, and they go for it if it is wanted.

244. Have you ever seen a man strike a spanner?—No, I have never seen that, but I have seen a man use such force that it grated inside on the lyddite.

245. (*Lieut.-Col. Hadden.*) Have you ever seen one of these formers broken in the process of extraction?—No, but I have seen them have great difficulty in getting a former to start.

246. Have you seen them gauge a shell in the morning?—Yes, they gauge them with a small stick, tapping the bottom to see if it is hard, and to test the depth.

247. You have only seen them use a wooden stick?—Yes.

The witness then withdrew.

Mr. William Potter (Inspection Department) examined.

Mr. W. Potter.

248. (*President.*) What is your position in the Arsenal?—I am an examiner in the Inspection Department.

249. In what way are you connected with the Lyddite Factory?—My duty is to examine shell as they are issued.

250. Where were you at the time of the explosion?—I was in the Issuing Store, No. 26.

251. What do you know with regard to the explosion?—I cannot say that I know anything.

252. Had you been in No. 9 shop that morning, or on the previous day?—I went through No. 9 the previous evening.

253. What was going on then?—The shell were all standing there, and the plugs were out. They were then taking out the formers.

254. What time was that?—Twenty minutes past five.

255. Had they any apparent difficulty in removing the formers?—I did not notice.

256. So you cannot tell us anything that was happening at the time beyond the fact that the formers were being removed?—No.

257 What happened at the time of the explosion? Was it one explosion or more?—It was one thud only.

258. (*Captain Thomson*) Have you any evidence to give concerning the explosion?—No, I do not think I can throw any light upon it.

259. Did you notice the position of the shells?—They were standing on their bases.

260. How were they situated?—They were standing in three rows. The 10-inch were at the oven end of the building, and the 9·2-inch were at the end next to No. 10 building.

261. (*Lieut.-Col. Hadden.*) Could you describe their position on paper?—(*Witness sketched their position.*)

262. Is the whole of your work in the Lyddite Factory?—Yes, but most of my time is occupied in the rectifying shop.

263. Do you go round any of the other shops?—Yes.

264. (*President.*) Which were the shell they were removing the formers from?—The 10-inch. (*The witness showed by his sketch and this reply that he had mistaken 10-inch for 9·2-inch shell.*)

265. And they were taking the formers out and putting them on the bench?—Yes, I only saw them remove two.

266. You are sure that the formers were being removed from the shell at the oven end of the building?—Yes.

267. Have you ever known the rectifying tool to be used in the filling room?—Yes, I have seen it on one or two occasions.

268. At what time of the day?—Early in the morning.

269. Why was it being used there?—I cannot exactly tell you. On one occasion I made it my business to interfere; Mr. McCarthy was using a steel gauge and I asked him whether he knew that it should not be used.

270. What is the steel gauge?—A gauge used for gauging the outside of the body of the shell.

271. Who was actually using it, a foreman or a workman?—A workman.

272. How long ago did you see this?—About two years.

273. Would there be one man or more than one man using it?—Only one man.

274. (*Lieut.-Col. Hadden.*) Was the tool in the building, or did they send for it?—They sent for it.

275. A man came from the filling room for it?—Yes.

276. Do you know who the man was?—No.

277. Have you ever been in the building when they have been inserting the plugs?—Yes.

278. Have you ever noticed whether they were removing the shell at the same time as they were plugging them?—The shell are not removed before the plugging is done.

279. Have you seen them using the gauge before plugging?—No.

Mr. W. Potter.

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The witness then withdrew.

Royal Arsenal, Woolwich.

Tuesday, 23rd June 1903.

PRESENT:

REAR-ADMIRAL A. A. CHASE PARR (PRESIDENT).

Lieut.-Col. C. F. HADDEN, C.B., R.A.
Major F. L. NATHAN, R.A.

Captain J. H. THOMSON, His Majesty's Chief Inspector of Explosives.
Dr. A. DUPRÉ, F.R.S.

Captain J. G. M. WATSON, R.A., *Secretary.*

Mr. JOHN MCCARTHY (Assistant Foreman) examined (second time).

280. (*President.*) Supposing the lyddite in a shell which has been recently filled is not sufficiently set to allow the removal of the former at the time of finishing work, what is the routine followed?—We have permission in such a case to stay until the former has been withdrawn.

281. Have you ever known of instances of the lyddite filling up the cavity after the former has been withdrawn?—Not wholly filling it, but I have known it to partly fill the cavity.

282. Was that found in the morning?—Yes.

283. What would be done then?—It would be removed to the rectifying room to be bored with a trepanning tool in the same manner as other shells are rectified.

284. Have you ever known the rectifying take place in the filling room?—No.

285. (*Lieut.-Col. Hadden.*) Supposing the former to have been withdrawn before the lyddite was set and the lyddite to have partially filled the hole, how would you ascertain that was the case?—With a flat gauge which is put into the cavity. The gauge is marked to show the depth of the cavity, and if it does not go down to the full depth we know it requires attention.

286. That would not show the bulging of the sides?—That would be found out when the shell was taken to the rectifying room and the diameter gauge was inserted into the cavity, as it would not go down properly.

287. There is a second gauge used in the filling room beside the flat gauge?—Yes, for taking the depth of the picric acid, and the flat gauge to take the depth of the cavity.

288. You refer to the latter?—Yes.

289. Is that flat gauge always used the following morning before plugging?—Not always, but in some cases, when formers have been withdrawn in less than the usual time. Shells should be left 4½ to 5 hours, but we may have taken formers out within that time. For the sake of five or ten minutes it is hardly worth while raising the question of staying late. Sometimes five minutes would not interfere with the cavity. It is usual to put on one side the shell which had been tested and had been found high, so that the man in the rectifying room should know.

290. You would not gauge unless you had a suspicion. Do they mark the shell in any way?—We test those we think are wrong, and a chalk mark is made on them. Those shell are gauged the following morning. When they go to the rectifying room it is known that they are to be bored with a trepanning tool.

291. (*Major Nathan.*) Which do they fill first, those nearest the door or farthest from it?—Sometimes those nearest the door. If there are two men filling, they would start on different rows, one at the end nearest the door and the other at the end farthest from it, so that they should not meet.

292. Do you know what time the shell should be completely filled?—They would not have filled any of the shells sufficiently to insert the formers till after one o'clock.

293. Were you in the building after one o'clock on the day before the accident?—Yes, and the 9·2-inch shell were being filled.

294. What time did you say you were in the building?—I was through the building frequently between one o'clock and twenty minutes to six.

295. Were all the shell filled before the men went to dinner?—No, some of the men would be filling while others went to dinner.

296. You do not know whether all the 9·2-inch were filled?—No.

297. Were there any men left in the building?—Yes, there are always men in the building right up to the time of leaving off, which is a few minutes before 5.40 p.m., to allow time for changing clothes.

298. What time do they actually leave the building?—Between 5 30 and 5.35 p.m.

Mr. J. McCarthy.

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The witness then withdrew.

Mr. Arthur Burns (Leading Hand) examined (second time).

Mr. A. Burns.

23 June 1903.

299. (*President.*) Supposing a former is removed, either accidentally or otherwise, too soon from the shell so that the cavity becomes more or less filled up after the removal, what is the routine adopted?—To chalk the shell so as to inform the leading hand in charge of the rectifying room that it needed attention.

300. How do you find out something is required to be done with it?—By gauging it the following morning.

301. Does that often happen?—No, you can tell within a little when you take out the formers, as the formers seem pretty dry if you give them the full time.

302. If it comes out too easily, is it then something is required to be done?—Not in all cases.

303. Had you any idea the previous evening that anything of this sort would be required?—No, I could not have told till the following morning.

304. If you had been in next morning, would you have gauged all those shells?—Yes, before plugging up.

305. Have you ever known the trepanning tool used in the filling room?—Never.

306. Were the fuze holes brushed or cleaned out in the evening?—No.

307. When would this have been done?—The first thing in the morning after the bags had been removed.

308. Are they wiped out as well as brushed?—Brushed only; wiped out in the case of empty shell.

309. At what time of the day were these 9·2-inch shell all finished filling?—Between 12.30 and 12.45.

310. Were all the men at work then, or had any gone out to dinner?—All working.

311. Were you there at the time?—Yes.

312. (*Captain Thomson.*) Were they in a hurry to leave the building that evening?—There was no reason to hurry; all the shells had had full time.

313. (*Dr. Dupré.*) Why do you gauge them in the morning?—For our own satisfaction.

314. You do not rectify?—No.

315. Is it not part of the procedure in the rectifying room to gauge the shell?—Yes.

316. So that there is no advantage gained by your chalking them?—Only that it makes more certain.

317. Is this brushing out done before you gauge?—Yes, then we gauge, then plug.

318. (*Major Nathan.*) You have *never* seen *any* rectifying tool used in the filling house?—No.

319. There are two natures of gauges, one for depth and the other for diameter; you have *never* known them used in the filling room?—No.

320. (*Lieut.-Col. Hadden.*) What gauge do you use in the filling room?—A flat metal gauge.

321. Is that the only gauge used there?—Yes.

322. (*President.*) What description of brush is used for brushing out the fuze hole?—A brush generally known as a sash tool brush, and usually No. 10 size is employed.

323. Is it supplied to the filling house for that purpose?—Yes.

324. One of the regular articles supplied?—Yes.

The witness then withdrew.

Mr. William Wood (Leading Hand) examined.

Mr. W. Wood.

325. (*President.*) Where are you employed?—In the rectifying room, No. 27, at the Lyddite Factory.

326. How long have you been employed in the Lyddite Factory?—Ever since the factory started.

327. In what capacity?—Different capacities, but mostly in the rectifying room.

328. Have you ever been employed in the filling house?—Never.

329. If the men in the filling house find that formers have been removed too soon, and consequently the cavity is not what it ought to be, what is the routine pursued?—They are sent to the rectifying room to be put right.

330. Does it often occur that much requires to be taken out?—We have to do a few every day more or less. It is generally according to the weather.

331. Have you ever known tools borrowed from the rectifying room for the filling house?—No.

332. If tools are required where are they obtained?—From the store.

333. You never lend?—No.

334. As far as your knowledge goes, no tools have ever been lent from the rectifying to the filling house?—No.

335. Had you gauged the shell which were brought out of No. 9 room to the rectifying room on the morning of the accident?—No.

336. Since then you have not touched them?—No.

337. Were you in the room at the time of the explosion?—Yes, there were three of us, and we were all knocked over.

338. Did you notice whether there was more than one explosion?—I only noticed one report.

339. (*Captain Thomson.*) Did you see anything beforehand?—No, we were not looking out of the window at the time.

340. You were all three together?—Yes, all close together.

341. (*Lieut.-Col. Hadden.*) It is customary for some of these shell to come over chalk marked?—Yes.

342. Were any of these 9·2-inch chalked?—I have not had time to look at them. We do not start on them till they are all there.

343. Have you only been employed in the rectifying room?—Mostly there, but I was away a little while as overlooker on the platform, and afterwards returned.

344. (*Major Nathan.*) How many trepanning tools have you?—One.

345. How many did you have on the morning of the accident?—I am not quite sure whether we had one or two. We send to the store if we want another tool for an extra man; we never keep any spare tools in the shop.

346. (*President.*) Have you had reason to complain at all to the foreman of the filling house about the number of shell which have come over to the rectifying room requiring to be rectified?—Yes.

347. To whom did you complain?—To the overlooker, Cowell.

348. What steps has he taken in consequence of your representations?—He sees that the formers are put correct, so that we should not get so many the next day.

349. What has been the principal cause of the shell requiring rectifying? Has it been because the formers have been withdrawn too soon, or owing to some fault in the former itself?—Generally owing to the former being withdrawn too soon.

350. Does it make much difference in withdrawing the formers whether they are left a quarter of an hour longer or not?—I cannot say.

351. When was the last occasion of your making a complaint?—About three weeks ago. Of course we take no notice of one or two being wrong.

352. What was the reason of your speaking about it last time?—Because we had found rather more than usual.

353. How many would that be in a day?—About a dozen or twenty, some of them not requiring much rectifying, but still, high or low, as the case may be.

354. Would you sometimes have as many as twenty in a day?—Yes; probably more.

355. When you get a few only, how many would that be?—About 5 or 10 per cent., and we take no notice of that quantity.

356. Does it happen more often in the smaller natures, or in the larger?—In the larger, but we do not get so many of them. It is the larger natures that require the most rectifying.

357. If a large number require rectifying, does it reduce the earnings of the men in the rectifying room?—I do not know that it does.

358. The work has to be done, but it means more to be done, and that is the reason you are principally interested in it?—Yes.

359. Do you have to finish the rectifying of a batch of shells before you leave?—No.

360. What happens if you do not finish?—Simply that the shells are left untouched.

361. If you get behind with your work, how do you catch up?—They stop the issue for a time, and give us a chance to clear. *Mr. W. Wood.*

362. Are you on piece work or day work?—We work on a system called fellowship. 23 June 1903.

363. How is your pay arrived at?—From the progress of the work.

364. Do you know how your pay is calculated?—I cannot say. We are not allowed to ask the price.

365. Does your share vary much from week to week?—No. Some weeks, if we have not got the work, it varies a little, but when the work is right they manage to give us our regular money as far as possible.

366. What is your rate?—Thirty-three shillings, but I am paid on thirty-six shillings.

367. You always get time and a third, and you get that pretty regularly, unless there is a slackness of work?—Yes; and then I go on day work.

The witness then withdrew.

Mr. David William Gaurd (Labourer) examined.

368. (*President.*) How long have you been employed in the Lyddite Factory?—Between four and five years. *Mr. D. W. Gaurd.*

369. In what part have you principally been employed?—In the rectifying room.

370. Is there more than one rectifying room in use at the present time?—Only one.

371. Do you personally make use of the tools for trepanning and gauging?—Yes.

372. Have you ever known any of those tools lent to men in the filling room?—No.

373. Do the men in the filling room let the men in the rectifying room know if there are any particular shell requiring attention?—Yes, by making a chalk mark on them.

374. Does this often happen?—Not very often; just one or two now and then.

375. Do you find that many shell which are not chalked require rectifying?—Not many.

376. Do those that are chalked usually require much trepanning?—About two or three inches.

377. How long would it take to trepan three inches?—A quarter to half an inch is removed each time you bore, and each operation taking about three minutes would make about a quarter of an hour.

378. (*Captain Thomson.*) Have you ever complained to the men in the filling room that they were sending too many shells requiring to be rectified?—Yes, we have.

379. What did they say?—They said that they could not help it, but would try and avoid it.

380. (*Lieut.-Col. Hadden.*) Who is the complaint made to?—To the overlooker of the rectifying room.

381. To Mr. Wood?—Yes, and he would go and see the overlooker of the filling shop.

382. (*Dr. Dupré.*) When was a complaint made last?—About three weeks ago.

383. Besides a trepanning tool you use a rectifying tool—a rimer; do you use it often?—Now and then.

384. Have you ever lent a rimer?—No.

385. (*President.*) What was the reason for making the complaint? Was it because a number of shell had been sent forward requiring rectifying?—Well, that would be the cause, but if only five or six shells required attention we should not speak of it.

386. Did they all come from one shop or from different shops?—There are two shops, and it would be difficult for us to say which they came from.

387. Was one shop worse than the other in that respect, or were they both about the same?—About the same.

388. (*Lieut.-Col. Hadden.*) How are you paid?—I am on the 23*s.* 6*d.* rate and am paid on fellowship.

389. Does that fellowship apply to the rectifying shop only?—No, throughout the whole factory.

390. So that if you had more shells to rectify it would not affect your earnings?—No.

391. So that it would not matter how many you did?—No.

392. The fellowship brings you up to your money and you do not get much over it?—No. We get about the same each week.

The witness then withdrew.

Mr. Walter Cowell (Principal Overlooker) examined (second time).

393. (*President.*) When you require any additional tools besides those you have in the filling rooms, what steps do you take to get them from the store room?—I go for the key myself. The store is kept locked and no one is allowed to go there unless I or the other overlooker is with him. *Mr. W. Cowell.*

394. Who was the other overlooker?—Edwards, who was killed. The only time that the building would be opened for any other purpose than that of getting tools would be when I was having it cleaned out.

395. Do you ever issue any tools, other than filling tools, to the filling house?—No.

396. Do you ever issue a trepanning tool, or a rimer, to the filling house?—No.

397. When was the last occasion that the foreman of the rectifying room made any complaint about there being too many shell requiring rectifying?—I do not remember the last time. There was an occasion a month or two ago when we had, I think, three or four shells which required a little more than usual to be taken out of them. That might have been on account of too many asbestos washers being put on the formers.

398 Therefore the former would not go down as far as it ought?—No. I may add that we try to prevent the trepanning tool being used at any time.

399. What is usually the cause of the cavity having to be rimed?—If it is found that the cavity has closed in, possibly very slightly but sufficiently to prevent the diameter gauge being inserted into the cavity.

400. What diameter gauge do you use?—We have only the one diameter gauge.

401. Have you a diameter gauge in the filling room?—No.

402. Is your work connected with the rectifying room?—Yes, as well as the filling room.

403. Do you superintend both?—Yes, my duty lies with several buildings.

404. When the foreman of the rectifying room spoke to you about the number of shells requiring rectifying,

Mr. W. Cowell.

23 June 1903.

how did you proceed?—I saw the overlooker in the filling house and called his attention to it and it was attended to at once.

405. Did these shell come more from one room than from the other?—I cannot say which room they came from, as they are all put together.

406. (*Captain Thomson.*) If you saw a man rectifying a shell in the filling room, would you stop him?—Certainly. I may say that I have had rather a wider experience than others, as I served for a time at Messrs. Armstrong's, where I was entrusted with the oversight of the work, and anything like an attempt to use a tool in the filling room I should see to myself.

407. (*Lieut.-Col. Hadden.*) How did you divide the work with Edwards? Was he under you?—We both ranked the same.

408. You had charge of the shop where the explosion occurred?—Yes.

409. Who kept the key of the tool store?—The key was always hung up in the shifting house and was in the charge of the shifting house man.

410. (*Lieut.-Col. Hadden.*) Is the man always in the shifting house?—Yes, all day.

411. The washers you refer to are under the head of the former?—Yes.

412. How many washers are used on each former?—Two or three.

413. (*President.*) Who was actually in charge of No. 9 room on the morning of the accident?—The man Connor.

414. What was he?—He was second in charge. Should the man Burns leave the building, he would inform Connor and the room would be in Connor's charge during the absence of Burns.

415. (*Captain Thomson.*) What sort of a man was Conner?—A very steady man.

416. (*Dr. Dupré.*) How long had he been there?—About 4½ years.

417. (*Lieut.-Col. Hadden.*) What are the names of the men in charge of the shifting room?—Godden and Burall.

The witness then withdrew.

Mr. ALBERT GOLDSMITH (Labourer) examined (in hospital).

Mr. A. Goldsmith.

418. (*Captain Thomson.*) I understand you were in No. 9 building just before the explosion, is that correct?—I had just come out and was going round the building.

419. When you left the building, what was going on?—I saw the men at work, but I did not take much notice of what they were engaged upon. I had just got the bottles to fill the hydrometers.

420. What was your work?—It was my duty the first thing in the morning to fill the hydrometers in the shops, and to get the bags ready.

421. You were not employed in the filling house?—Only in the dinner hour.

422. Did you not notice at all what they were doing?—No.

423. Had you heard any remark as to anything requiring to be done with the shells?—No.

424. Did you have any conversation with the men?—No.

425. Have you had any experience in the filling room?—I have had four or five months' experience there.

426. How long in the Lyddite Department?—I think it is about three years.

427. (*Lieut.-Col. Hadden.*) When you were working in the filling shop, what was the first thing done in the morning on entering?—I did not work in the filling shop the first thing in the morning. I have never worked there except in the dinner hour.

428. When the men come back you leave?—Yes. There is nothing to be done to the shell in the morning, as there are no formers in. They are only cleaning the shop of shell.

429. They were taking them out when you were there?—Yes.

430. Were any of the men plugging the shell at that time?—I did not see them.

Examination ended.

Mr. EDWARD BIRMINGHAM (Overlooker) examined.

Mr. E. Birmingham.

431. (*President.*) You are the overlooker in charge of the picric huts?—Yes.

432. What duty were you performing on the morning of the explosion?—Searching the men.

433. Did all the men coming in go through the usual search?—The men coming on at seven o'clock were searched, some by me, and the others by another searcher. Nothing was found by me.

434. Did anything unusual occur that morning?—I saw nothing.

435. Were all the men perfectly sober?—All that passed me were.

436. Did you search the men after getting into danger building clothes?—No, before changing.

437. On the dirty or on the "clean side" of the barrier?—On the "dirty" side.

438. What had they on at the time?—Socks, drawers, and shirts.

439. Do you know whether the keys are kept in the shifting house?—Yes.

440. If anyone wants the key, who gives it to them?—The shifting house man.

The witness then withdrew.

Mr. JOSEPH EDSER (Overlooker) examined.

Mr. J. Edser.

441. (*President.*) You are an overlooker in the Lyddite Factory?—Yes.

442. Where were you on the morning of the explosion?—At the barrier.

443. What was your duty?—To search the men as they passed over.

444. Were all the men who passed that morning, as far as you know, searched in the usual way?—All the men who came my side were.

445. Was there anything unusual at all that morning?—No, nothing whatever, to my knowledge.

446. Were they all perfectly sober?—Yes, I dare not let them go to work otherwise.

447. What do you do when you are not searching?—I have been in nearly all the shops, but at the time of the accident my duty was in connection with the cleaning and boiling-out room.

448. Do you always do the searching?—There are a certain number of us who take it in turns.

449. Do you ever find anything when searching?—No.

450. Have you ever found anything?—No.

The witness then withdrew.

Mr. Edward Taylor (Leading Hand) examined.

Mr. E. Taylor.

23 June 1903.

451. (*President.*) You are a leading hand in the empty shell store?—Yes.

452. Is it part of your duty to examine the empty shell before they go to the Lyddite Factory to be filled?—Yes.

453. Do you examine *all* the lyddite shell, or is there anyone else examining them?—I examine them all.

454. What is the process of examination?—In the first place, the plug is taken out of the fuze hole, and a G.S. Mark I. plug is inserted to enable the recess in the top of the fuze hole to be cleaned. The plug is put in to prevent dirt dropping into the shell. After this the plug is taken out, and the fuze hole sponged with a sponge cloth. Then the inside of the shell is examined by means of an electric light to see if there is any foreign matter or rust, and also to see if it is properly varnished. If anything is found the shell is suspended by means of a crane, and it is knocked out. When this has been done the Mark II. plug is cleaned and replaced in the shell, the shell is then wiped and placed over the clean side of the barrier.

455. Can you say how long it is after they have been examined before the shell are filled?—It all depends how many shell we have in hand. When clean they are passed over to the "clean" side and left there.

456. Are they removed from the "clean" side as they are wanted for filling?—Yes.

457. So they may be some time on the "clean" side before they are removed for filling?—Yes, but of course they are all plugged.

458. As a certain number are removed, are the others moved forward for removal the next time, or would you put shell recently examined in the place of those just removed?—Those that are put over first are taken away first.

459. Taken away in the order of their being examined?—Yes.

460. Is it possible for damp to get at these shell after they have been examined?—No.

461. (*Captain Thomson.*) What do you ever find in the shell besides dust?—Sometimes we find little pieces of wood or fluff.

462. Do you ever find any filings, or anything of that nature?—Not very often, but we have now and then.

463. (*Lieut.-Col. Hadden.*) Is the fuze hole cleaned by means of a dry sponge cloth?—Yes.

464. No moisture used?—No.

465. (*Dr. Dupré.*) If you find the varnish on a shell defective, what do you do?—Place it on one side.

466. You do not carry out any repairs to it?—No.

467. You only remove loose things found in them?—Yes.

The witness then withdrew.

Mr. William Kearley (Labourer) examined.

Mr. W. Kearly.

468. (*President.*) Is it your duty to examine empty shell before they are taken to the Lyddite Factory to be filled?—Yes.

469. How long have you been at that work?—Three years.

470. Have you ever found anything in the shell you have examined?—Yes, pieces of wood, cotton waste, and now and then brass filings, but the latter very seldom.

471. Is the varnish inside the shell often defective?—I have found it defective at times.

472. What was done then?—I have sent for the head overlooker or foreman and had them examined again, and they have afterwards been put back for relacquering.

473. Are the lyddite shell which are made by contract varnished before they come into the Arsenal?—I cannot say.

474. If any shell is found defective, it is revarnished in the Arsenal?—I believe so.

475. Do you ever find moisture in the shell?—Yes, I have found splashes of water and have mopped them with a mop and thoroughly examined them. In such cases I have frequently stood the shell on one side for days in order to make quite sure they are dry. Mr. McCarthy's attention has always been drawn to instances of this kind.

476. The means for drying them is merely to stand them on one side with the plugs out?—Yes, and mop them.

477. Where is the damaged lacquer usually found?—On the base of the shell.

478. Do you ever find any damaged lacquer round the bush?—The lacquer cannot be seen there as it is right under the shoulder.

479. You do not use anything of the nature of a mirror?—No, only the electric light.

480. (*Dr. Dupré.*) How many shells do you examine in a day?—From fifty to a hundred.

481. You have plenty of time to examine them?—Yes.

482. Are you paid on day-work or piece-work?—Piece-work, or rather a kind of fellowship.

The witness then withdrew.

Mr. George Carver (Labourer) examined.

Mr. G. Carver.

483. (*President.*) You have heard the report* of Mr. Edwards read, giving an account of a slight explosion which occurred in January 1897. Does that give a correct account of what occurred at the time?—Yes, there was a slight explosion and a small light from it. This was caused by dropping one funnel on the other. My hands being wet at the time, one of the funnels slipped from my grasp.

484. (*Captain Thomson.*) Were the funnels hot at the time?—No. I was threading them on the wire and one slipped.

485. Does the wire go through the tube of the funnel?—Yes.

486. And did it slip down on the wire?—Yes.

The witness then withdrew.

* The following is a copy of the report submitted by Mr. Edwards on the explosion which occurred at the Lyddite Establishment on the 20th January 1897:—

"Sir,

"I beg to report that a slight explosion took place at Lyddite Establishment last evening, 20th inst., at about 4.45 p.m.

"No. 6,239 Carver was putting some funnels, from which lyddite had previously been melted, on a copper wire for boiling, when one accidentally dropped from his hand on to the stem of one which had already been placed on the wire.

"A report followed similar to that produced by a large cap, there was also a flame which lasted for some seconds after the report. One of the funnels is bent as a result of the explosion.

"(Signed) W. Edwards.

The Manager, R.L. "21/1/97."

Mr. CHARLES GRIFFIN (Labourer) examined.

Mr. C. Griffin.

23 June 1903.

487. (*President.*) Have you been employed in the Lyddite Factory?—Yes.

488. For how long and up to what time?—For about three years, and till about three weeks ago.

489. Did you work principally in the filling room or elsewhere?—Mostly in the melting chamber, but part of the time in the filling room.

490. What was the work usually done the first thing in the morning in the filling room?—To remove the shell that had been filled on the previous day and fill up again with empty shell.

491. What was the first operation with regard to the removal of the filled shell?—To replace the plugs and screw them down. The shells are then taken to the rectifying room.

492. How were the plugs replaced?—By hand.

493. Was anything done to the threads of the bush before the plug was screwed in?—Yes, they were swept out with a brush.

494. Was a piece of rag ever used for that purpose, or always a brush?—Always a brush.

495. Were the shell removed as the plugs were being put in, or were all plugged before the shell were removed?—All shell were plugged before we started to wheel any work out of the room, and no shell were brought back during the plugging, so that the chamber was practically emptied.

496. Was any gauging of the shell carried out in the morning before the plugs were put in?—Not to my knowledge.

497. When were they gauged?—When they were in the rectifying shop.

498. Were they ever, to your knowledge, gauged in the filling room?—No, I have never seen them gauged there.

499. (*Lieut.-Col. Hadden.*) It is a custom to chalk some of the shell at times?—I have seen that done if there is one high to gauge.

500. How do they know they are high?—The overlooker gauges them.

501. When does he do that?—Possibly when the former is taken out.

502. The gauging is done by the overlooker only?—Yes, and he chalks it if he is doubtful.

503. (*President.*) Have you ever seen any tool used in the filling house?—No tool except those connected with the work there.

The witness then withdrew.

Royal Arsenal, Woolwich.

Thursday, 25th June 1903.

PRESENT:

REAR-ADMIRAL A. A. CHASE PARR (PRESIDENT).

Lieut.-Col. C. F. HADDEN, C.B., R.A.
Major F. L. NATHAN, R.A.

Captain J. H. THOMSON, His Majesty's Chief Inspector of Explosives.
Dr. A. DUPRÉ, F.R.S.

Captain J. G. M. WATSON, R.A., *Secretary.*

Major J. R. MALLINS, M.B., R.A.M.C., examined.

Major J. R. Mallins, M.B., R.A.M.C.

25 June 1903.

504. (*President.*) You are Senior Medical Officer, Royal Arsenal?—Yes.

505. Did you find any portions of articles or tools that were used in the filling rooms in the remains of the men who were killed?—No, not myself, but one of my men who was assisting me brought two pieces up to me.

506. Do you know in which bodies they were found?—My man told me that the broader piece (*identified as part of a copper shovel*) was found under a chest bone. The piece of metal shaped like a funnel (*the top of a former*) was brought up among some intestines.

507. Was there anything to show as to whom the remains belonged?—No, they were brought up in buckets, and there was nothing to indicate that.

508. Neither do you know then whether those remains were found in the buildings?—They were picked up by some of the men who were working there after the explosion and brought up to the mortuary.

509. (*Lieut.-Col. Hadden.*) Did all the remains come up together?—They were coming up all day, but the bodies of the men who were recognisable came up together. We have been getting some of the particles since.

510. Did anything come up with the intestines the funnel was in?—Yes, some other parts.

511. Do you know the names of the men who brought them up?—No, I was not there when they arrived, but I should think Major Barlow's people could tell you. It is quite likely they put them into the buckets.

512. (*Dr. Dupré.*) Were there any other pieces of metal found?—No.

513. How were they killed?—I think there were four or five bodies blown to fragments. The other cases had their legs blown off, and some had been struck by metal at a distance. All had multiple injuries.

514. (*President.*) Can you tell us who were actually blown to pieces and who were killed by the flying fragments?—There were four men in fragments, the others, although tremendously injured, could be recognised. I have here a list showing the bodies found, and also the condition of the same, which I will leave with you (*vide* Appendix No. XVIII.)

515. Has the portion of the body in which the large piece of copper was found been identified?—I cannot say.

516. (*Dr. Dupré.*) There were only two not identified?—When the coroner's court opened on Monday they were all identified except two, and these two have now been identified.

517. (*Lieut.-Col. Hadden.*) Of those bodies which were identified, was there any piece missing, such as the breast, in which this piece of metal was found?—No piece of breast was missing such as that in which the copper was found.

518. Apart from the four, there were twelve that were more or less complete, there was not a breast bone missing of those twelve?—No, I do not think so.

519. Then it must have been one of the four?—Yes.

520. And would the same apply to the funnel and to the intestines?—I cannot be so definite about that, as there were certain parts blown out altogether, and it might have been put together afterwards.

The witness then withdrew.

Mr. THOMAS CRITCHELL (Dresser) examined.

Mr. T. Critchell.

25 June 1903.

521. (*President.*) Will you please say what your work is in the Arsenal?—I am a dresser at the Royal Arsenal Surgery.

522. We have here two pieces of copper, which were found in the remains of the men killed, after the explosion; can you tell us where they were found?—The flat piece I took from the left side of a man's chest, under a portion of the vertebrae attached to the chest.

523. How large was the portion of the chest?—Nearly one-half of the left half attached to the backbone.

524. And what about the other piece of metal?—That came up in a bucket, with intestines and liver, which evidently had been scraped up with the funnel, and were mixed with earth and grass.

525. Could you say whether, if this piece had been blown against the stomach of a man, it would have taken the intestines with it, I mean, from a distance?—Yes, it is possible it would carry the intestines with it had it struck the man in the way indicated.

526. (*Dr. Dupré.*) Were the intestines injured in any way?—Yes, they were lacerated, and the contents escaping.

527. (*President.*) Do you know who brought up the intestines and that funnel?—No.

528. (*Lieut.-Col. Hadden.*) Did you receive the bucket?—Yes.

529. Was it a workman or a policeman who brought it?—I cannot say. Six or eight buckets came up on one stretcher.

530. The earth that was on this, was it adhering to the funnel?—Yes.

531. Was it tight on the funnel?—Yes, and there were portions of the flesh attached to the inside of the funnel.

532. Was there earth under them?—It was mixed up with it.

533. After the removal of the remains, was there still earth on the funnel?—Yes.

The witness then withdrew.

Dr. W. KELLNER, F.I.C. (War Department Chemist), examined.

Dr. W. Kellner, F.I.C

534. (*President.*) Have you examined or analysed the batch of picric acid that was being used in the filling room at the time of the explosion?—Yes, I examined the sample sent to me by Superintendent R. L., and which I believe to be from that batch.

535. Will you please give us the result?—The composition is well within the specification, unusually good, in fact. The result of the analysis is as follows:—

——	Specification.	Sample.
Melting point -	248° to 253° F. -	249° F.
Ash - -	Not above 0·3 per cent.	0·13 per cent.
Moisture - -	Not above 0·3 per cent.	0·07 per cent.
Insoluble in water -	Not above 0·2 per cent.	Trace.
Sulphuric acid (as SO_3).	Not above 0·2 per cent.	0·08 per cent.
Heat test - -	Above 30 minutes	Above 30 minutes.

536. Has it come to your knowledge at all that some batches of picric acid hold the "formers" more closely than others?—No. Difference in the degree of adhesion between former and lyddite, if they do occur, are more likely to be due to difference in the temperature of the melted picric acid at the time of filling the shell than to difference in composition.

537. Have any impurities in the acid come to your knowledge at all which necessitated the rejection of the acid?—Acceptance or rejection of the acid does not rest with me, but doubtless the results of my analysis are taken into account when sentencing a supply.

538. Have you had any knowledge of the impurities to any large extent?—I have never found samples of picric acid to contain impurities to any large extent, but the specification limits for impurities are occasionally exceeded, though not very much.

539. Were any of the impurities such as you would consider of a dangerous nature, or practically harmless?—I should say they were practically harmless. Picrate of lead would be considered a dangerous impurity, but the small amount of lead nearly always present in the picric acid is there as sulphate of lead, a harmless compound, which is not converted into picrate in the process of melting the acid. The metallic impurities do not melt at the temperature of melting picric acid, but settle to the bottom of the melting pot, and do not get into the shell.

540. What effect would soda have on the picric acid?—It would form picrate of soda.

541. Is that a substance liable to explosion?—Yes, all picrates are, but picrate of soda is one of the least sensitive.

542. As compared with picrate of iron?—Picrate of iron is much more sensitive to a blow than is the soda salt.

543. Can you throw any light on the cause of the explosion at all?—I have formed a theory, which, however, involves the assumption that a former was left in the shell over night. I do not know if there is any conclusive evidence against that assumption. I examined three formers sent to me by the Superintendent R. L. with the request to ascertain whether the solder, by means of which the tube is attached to the funnel part of the former, contains any lead, it should be tin. I found that the solder contained no lead, practically none. In order to remove the tube, the base of the funnel into which the tube is screwed was heated in a Bunsen flame to melt the solder. In the case of two out of the three formers, while this was being done something exploded inside the formers; in the third no explosion occurred. The screw-thread of the tube of the last-named former was well filled throughout its length with tin. In one of the two which exploded the tinning extended only a short distance, and in the other, which gave the more violent explosion, there was scarcely any tin. It had the appearance as if the tube had been screwed in without any tin, instead of being sweated in, and then secured by a little tin run round the edge. The unfilled screw-threads afforded lodgment for picric acid or picrate of soda which escaped removal by the washing process. Assuming the former used with the shell that exploded to have been in that condition and that it was left in the shell, and that an attempt was made the following morning to loosen it by turning it from right to left, or by a backward motion, the head of the former might have become unscrewed and the explosive in the screw fired by friction.

544. Supposing the former to have been filled with lyddite, the explosion (with screw) would have been sufficient, as far as you could judge, to ignite it?—The lyddite would be liable to be ignited by such an explosion.

545. Was the explosion of a decided nature?—In the one the noise was like the crack of a whip, in the other like the report from a rifle; smoke issued from the side holes in the tube, and from the funnel, but not from the joint.

546. In one instance the threads had not been tinned before screwing in?—No, apparently not.

547. (*Captain Thomson.*) Can you account for the scoring on the top of the upper portion of the former where it turns in the socket?—They are probably caused by tool marks, either in the socket, or on the former, or both.

548. We have had evidence that the former wears away till it cannot be used any longer; have you found any liability of the acid causing this?—Melted picric acid has no action upon the metal, nor does any action take place in the process of washing the formers,

Dr. W. Kellner, F.I.C.

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as this is done in a soda solution. An aqueous solution of picric acid does act upon the metal.

549. (*Lieut.-Col. Hadden.*) With regard to the sample that you received for the examination of the lot of picric acid, I suppose that is only a sample?—Yes, but if the sample is taken from the bulk after the latter had been sifted, it would be an average sample.

550. How much do you get?—About 5 or 6 ounces.

551. Does the temperature of melting vary at all between the different makes?—Very little; they are all within specification limits as regards melting point.

552. In the former in which there was no explosion, and which you unscrewed, did you trace any picric acid or picrate of soda?—There was none visible; there was no trace of yellow, and it appeared quite clean.

553. Did you examined the tin in the one that was tinned?—Yes; it was practically free from lead.

554. (*Dr. Dupré.*) Have you evidence that the explosion happened inside the threads?—No direct evidence, but I presume it must have been there. The screw, on unscrewing the tube from the funnel, appeared blackened.

555. Did your man see that it was cleaned inside?—The interior, as far as could be seen, was clean. The formers had evidently gone through the working process. If the tube is not screwed home, there might be additional space for picric acid to lodge; in that case, screwing the formers in the right direction might also lead to an explosion.

556. Have you tested the sensitiveness of this acid?—Not of this particular sample. It is difficult to get picric acid to go off by a falling weight; it requires a considerable blow.

The witness then withdrew.

Mr. William Wood (Leading Hand) examined (second time).

Mr. William Wood.

557. (*President.*) Part of the examination in the rectifying room consists in up-ending the shell; what is that for?—To knock out the loose lyddite which is in the cavity. This is done with a wooden mallet.

558. Have you ever found loose lyddite in the cavity before you have operated upon it at all?—Yes.

559. Will you tell us what is the routine when you begin to examine shell?—The first thing is to take out the plug, then the tapping tool is put into the bush to clear the lyddite, which falls into the cavity. The shell is then turned upside down by machinery and knocked with a mallet, which causes the loose lyddite to fall out. It is then placed on its base and gauged for depth, and another gauge is inserted, called a diameter gauge, to ascertain if it will take the exploder.

560. When the tap is screwed in, why should there be any loose lyddite fall to the bottom of the exploder hole?—A certain amount of lyddite works its way up into the bush, and the bush has to be free from this before the fuze can be inserted.

561. Then the plug which is screwed in in the filling room must than be screwed into lyddite if the thread is not clear before this operation with the tap takes place?—Yes.

562. Then, what is the object of wiping the thread of the fuze hole before the plug is put in in the filling room?—To clear the hole of loose lyddite.

563. But it does not clear the threads?—No.

564. The amount of lyddite which falls to the bottom from the threads can only be small?—That is so, you might find enough to cover a two shilling piece.

565. What is the largest amount you have found when up-ending shell?—Never more than enough to go on a two-shilling piece.

566. That would be considerable, taking into consideration that it comes out of the threads of the bush, and seeing that a plug had been screwed into it before?—The tool goes a little way into the lyddite, and you can feel where it has cut away the lyddite and left a small hollow cavity just below the bush of the shell.

567. You have never noticed any unusual amount of powdered lyddite coming out when you up-ended the shell?—Sometimes a little more than at others. There is also at times a kind of froth at the bottom of the cavity, and by the knocking it is broken up into a brownish coloured dust.

568. If the shell had been gauged in the filling room, would not that break up the crust?—Yes, and on turning up it would fall out.

569. (*Captain Thomson.*) Do you say that that which comes out is brownish in colour?—Yes.

570. Have you looked into the cavity?—There are no means for doing that.

571. What is the colour of the cavity?—Yellow.

572. Then what is this brown that you speak of?—The cavity is sometimes brown, and it may be acid which has come from near the bottom of the can.

573. The plug does not come to the top of the thread of the bush?—I believe it is just about the same length.

The witness then withdrew.

Mr. John B. Burall (Labourer) examined.

Mr. John B. Burall.

574. (*President.*) What is your position in the Arsenal?—I am in charge of the shifting house.

575. Are you always in the shifting house?—Yes.

576. What keys are kept there?—The keys of all the danger buildings.

577. Where are they kept?—When I lock up, the keys are put in the cupboard outside the shifting house. When the buildings are opened the keys are taken across on the "clean" side of the partition and hung up on the wall there.

578. Who has permission to remove any of these keys?—The overlookers. They take the keys from the board as they leave the building, and any more required are sent for afterwards by the overlooker.

579. So that a labourer bringing a message from an overlooker would receive any key he asked for?—Yes.

580. So really there would be no difficulty in a man getting a key if he wanted to—all that he would have to say would be that a certain overlooker wanted it, and he would have it?—Yes.

581. (*Captain Thomson.*) Does that apply to the key of the tool store?—Yes.

582. Was that taken on the morning of the accident?—I cannot say.

583. But anybody could have got it if they said they came from an overlooker?—Yes.

584. (*Lieut.-Col. Hadden.*) When an overlooker wants a key, does he ask you for it?—He may take the key himself, and in that case he generally calls out to me to tell me he has done so.

585. An overlooker would not take a key off the board without telling you he had done so?—No.

The witness then withdrew.

Mr. William Leverett (Leading Hand) examined.

Mr. William Leverett.

586. (*President.*) Where do you work in the Lyddite Factory?—In No. 16 building.

587. Were you at work there on the morning of the explosion?—Yes.

588. What work was being done in that building that morning?—Removing shell.

589. When had those shell been filled?—The day before.

590. What shell were they?—10-inch.

591. Had those shell been completely filled on the day before the accident, or had some of them been filled the day before that?—Some had been filled and some partly so on the day previous to the accident.

592. When was the filling on the previous day completed?—Between 11 and 12 o'clock.

593. When were the formers removed from those shells?—They were being removed up till 5.15 in the evening.

594. Was there any difficulty in removing the formers?—No special difficulty.

595. Were any of the exploder holes found to be improperly formed after the formers were removed?—There were one or two high to gauge.

596. That is the gauge did not go down far enough?—Yes.

597. What was done with the shell which were high to gauge?—They were chalked,

598. Were the formers replaced in any of these shell?—No.

599. Is the former ever replaced after it has once been withdrawn?—Never.

600. You do not try to replace it even if it were found that it had been taken out too soon?—We keep the time and, therefore, know when the formers should be removed.

601. But if is taken out and is found to move too easily and you, therefore, think it may have been removed too soon, do you re-insert it then?—A man may take it up a little way and put it back again, but it is never taken right out and replaced. As regards the time necessary, the temperature affects it, and it all depends upon what weather we have how long the former must remain in the shell.

602. You have never seen a former taken out and replaced?—No.

603. Have you seen the hole tested next morning with a former, to see if it were correct?—No.

604. You have never in any case seen a former entered into a shell next morning?—No, not in a completely filled shell.

605. Are the sides of the cavity ever tested in the filling room, or is it only the depth of the cavity?—Only the depth and never the sides.

606. What is the first operation in the morning before removing the shell?—Take away the bags and covers, brush out the bush, get the barrow and remove to trucks.

607. Do you screw the plugs in before beginning to remove?—Yes, we screw them in with our fingers.

608. (*Captain Thomson.*) Have you ever found the flat gauge fail to go down at all?—No.

609. (*Lieut.-Col. Hadden.*) When a former is jammed in the shell, what is the course pursued?—We call the overlooker's attention to it and he tells the foreman, and it is put into the oven after the jacket has been removed.

Mr. William Leverets.

25 June 1903.

610. Is it put in the chamber with the tray on?—Yes, with both the former and the tray on.

611. Have you ever known any of the heads come off the formers?—Yes, they unscrew.

612. During what operation does this happen?—If a man should be turning to the left instead of turning to the right. If, however, an overlooker is watching the movements of his men, he should see and prevent this.

613. Is this a common occurrence?—No.

614. Do they vary the direction in which a former is turned?—All formers are supposed to be turned to the right.

615. Sometimes they are turned the wrong way?—Yes. If a man forgets or, as is often the case, it may be easier to turn the reverse way.

616. Is it more likely to be turned to the left when using the spanners?—It is more often turned to the right then.

617. How many men use these spanners on a shell?—One man holds the socket with the spanner and another turns the former.

618. If one man cannot turn it, then a second man assists?—Yes, if it is very tight, but it is possible to loosen the former by unscrewing the socket.

619. If one man cannot loosen the former with a spanner, then two men endeavour to do so?—Yes, but first of all the overlooker's attention is drawn to it.

620. Have you ever known a former broken while being unscrewed by means of the spanners?—I have known them to break as the former comes up, and when the former is stopped in its progress. There is more strain on the head as the former is being withdrawn.

621. (*Dr. Dupré.*) In screwing in the plug, do you do it by hand?—Yes.

622. Supposing it sticks?—Then it is taken out and another inserted, sometimes there is a difference in the recesses of the bush.

623. You never use any force?—No.

624. (*President.*) Have you ever known a former removed in the morning?—No.

625. Have you ever tried to move a former in the morning that could not be moved the night before?—No, and I have never seen it tried.

626. The shell always go back to the oven in such a case?—Yes, the men that come in at 6 o'clock see to that before we come in.

627. Do the men who come in at the early hour have anything to do with the filling?—No, they are a different gang altogether, and would have nothing to do with the filling.

628. Nor do they have the removing of the filled shell, except in the case of those requiring special treatment?—No, their duty is to put the cans into the oven, and, at the same time, to put in the shells having fixed formers.

The witness then withdrew.

Mr. Frederick Cakebread (Labourer) examined.

629. (*President.*) Were you at work in No. 16 filling shop on the morning of the explosion?—Yes.

Mr. Frederick Cakebread.

630. What were you doing that morning?—I had just got in and was waiting to load up a truck with filled shell.

631. What is the first thing that you do in the morning?—Brush out the top of the shell and insert the plugs.

632. What are the other men in the shop doing?—Two go to the trucks and the other two get the shell near the door ready for loading up.

633. Are any of the shell moved before all the plugs are put in?—No.

634. Did you assist at the filling on the previous day in No. 16 building?—Yes.

635. Had all the formers been removed from the filled shell when you left on the evening before?—No.

636. How many were left in?—About eight or nine, and they were not ready to be taken out.

637. Did anybody remain to see after them?—Yes, there were three men, I believe.

638. You cannot say whether they were removed that evening or not?—No.

639. What would the routine be?—The men who remain would take them out.

640. What time of the day was the filling completed?—12 o'clock.

641. Had they all been filled then?—Yes.

642. What were you doing during the dinner hour?—Turning the formers.

643. How long are the formers allowed to remain in the 10-in. shell?—Five hours, and for the 9·2-in. shell 4½ hours.

Mr. Frederick Cakebread.

25 June 1903.

644. If all the shell were filled by 12 o'clock they would have had their full time by 5 o'clock?—Yes.

645. How long have you been working in the filling room?—Three months.

646. Have you ever seen a former re-entered into a shell after it has been taken out?—No.

647. Have you ever tried to put a former back to see if it would go in?—No, a clean one is sometimes inserted if a dirty one has been taken out.

648. Why is that done?—That is done if the lyddite is not properly set.

649. Then the clean former would remain in for some time longer?—Yes.

650. What time of the day have you seen that done?—In the evening, when the former has been in the five hours, and, on taking it out, the filling has not been properly set, then a clean one has been put in.

651. Have you seen the former re-entered in the morning to test the cavity?—It has not been placed in the shell, but it has been tried on the socket.

652. You mean when the lyddite is liquid, not after it has cooled?—Yes.

653. Have you seen the former entered after it has cooled, or attempted to be entered?—No.

654. (*Captain Thomson.*) There was a walking race on the eve of the accident; did you attend it?—No.

655. How was it organised?—I believe by somebody in the Cannon Cartridge Factory.

656. Did some of the lyddite people take part in it?—Yes.

657. Who won the race?—I do not know, but Usher came in third.

658. Was there much excitement about the race in he lyddite factory?—It was talked over very much, but there was not much excitement.

659. Did anyone get leave to go earlier on account of the race?—No.

660. (*Lieut.-Col. Hadden.*) Who were the men that were left in the chamber when you went out?—Leverett, Remington, and Edser.

661. You say that sometimes when a former has been removed you insert a clean former; how do you know the lyddite has not properly set?—It is known by the feel whether it is soft, and if too soft we put in a fresh former.

662. Have you known the head of a former to come off when being extracted?—There was one shell, which was left in the oven on the Wednesday morning, the top of which had come off. The shell was placed in the oven in order to remove the stalk.

663. Was that one of the shells from your own filling house?—Yes.

664. Did you see the head come off?—No, it was done after I left at night.

665. Who were in the building when that came off?—Remington, Leverett, and Edser. I left them in the chamber when I went home.

666. Have you had occasion to use the spanners to move these formers?—No, only to loosen the socket.

667. Never to loosen the former?—No.

668. When do you loosen the socket?—When the former has been tight, and on loosening the socket the former is easily extracted.

669. Do you know what time the walking race was?—I think it was 6.30 or 7. I am not certain which.

670. When was the last occasion that you know of a former being broken or the head unscrewed?—Last Tuesday week.

671. How did that happen?—By taking a former out of the shell. The man was standing up and extracting it by hand, after having loosened it with the spanners, and it broke at the filling hole in the tube.

672. What was done with that shell?—The attention of the overlooker was drawn to it and it was put on one side to go into the oven.

673. It had been removed when you arrived in the morning?—Yes.

674. Did you take any interest in the walking race?—No.

675. Were many of the lyddite factory men interested in it and connected with it?—They all had an interest in it.

676. You all knew that it was coming off that evening; did any men get leave to go away early on account of it?—Yes, one man went away early, I believe.

677. (*Captain Thomson.*) On the Wednesday night was there a former left in which could not be removed?—No.

678. (*Lieut.-Col. Hadden.*) Did any man from your shop attend the race?—I could not say for certain.

679. Where is the man employed who left early that evening?—In the examination room, No. 12.

680. (*Major Nathan.*) What time did you leave the chamber?—Half-past five.

681. Do the men ever turn out before?—No.

The witness then withdrew.

Major J. H. Mansell, R.A. (Proof Officer), examined.

Major J. H. Mansell, R.A.

682. (*President.*) Does the examination of the batches of lyddite come into your department before they are used for filling?—Yes.

683. Have you any report of the result of the examination of the batch which was used when the explosion occurred?—Yes.

684. Anything beyond what the chemist has given us and which was an analysis made after the explosion?—Yes, I have the analysis which was made before the explosion. (*See* Appendix XII.)

685. What form did the examination take?—There is a chemical analysis and a visual inspection, which consists of sieving a percentage of the acid which is delivered.

686. There was nothing unusual in this batch?—No.

687. Who makes the analysis?—Dr. Kellner.

The witness then withdrew.

Royal Arsenal, Woolwich.

Monday, 29th June 1903 (Morning).

PRESENT:

REAR-ADMIRAL A. A. CHASE PARR (PRESIDENT).

Lieut.-Col. C. F. HADDEN, C.B., R.A.

Major F. L. NATHAN, R.A.

Captain J. H. THOMSON, His Majesty's Chief Inspector of Explosives.

Dr. A. DUPRÉ, F.R.S.

Captain J. G. M. WATSON, R.A., *Secretary.*

Major F. F. MINCHIN, R.A. (Inspector of Laboratory Stores), examined.

Major F. F. Minchin, R.A.

29 June 1903.

688. (*President.*) Can you tell us with what material the bushes of the lyddite shell ought to be fixed?—Pettman cement.

689. Are the shell ever examined to ascertain whether this material has been used?—Yes, every shell that is taken for proof is examined for that purpose after it comes back from being fired at Shoeburyness, sometimes by a chemical analysis, but generally by visual inspection only.

690. The shells you speak of are those which are proved without being burst?—Yes.

691. Can you say whether this particular batch of 9·2-inch shell had been proved in that manner?—I do not know the batch referred to, but I may add that every invoice is so tested.

692. Does that proof take place before the shell are sent to be filled?—Yes, in every case. Of course, there is an extremely small quantity that can be subjected to analysis, and the chemist reports that he has found traces of some metal of the second group, but we have not been able to go any further than that. It is quite a trace.

693. Do you think it possible, when this cement is used, for it to form a protrusion into the shell beyond the bush?—No, in every case the cement is put on the threads of the plug of the bush, and the tendency is for it to be cleared away from the front threads as it is screwed in, and accumulate under the flange.

694. You do not find any surplusage to a large extent?—No, in every case where the bush has been taken out, the front threads have been found to be clean.

695. Who supplied these particular shell?—I cannot say positively, but I think they are E.O.C. manufacture, judging from the coarse cut on the outside.

696. (*Dr. Dupré.*) Have you ever found any of these bushes put in with red lead?—No.

697. The shell that have been proved are not issued to the Service?—No.

698. (*Captain Thomson.*) Can you tell us which of your men are mostly employed in the Lyddite Factory?—Potter is the man mostly employed there. As regards the inspection, the main point in which my men are concerned is the ganging of the cavities, and they have instructions to see what is going on, but have no check on the method of filling. They are responsible to me that the cavities are to Service dimensions. They also gauge the shell, and see they are properly marked, and though they do go into the filling room that is not one of their regular duties.

699. (*Lieut.-Col. Hadden.*) What date was the specification altered as regards the fixing of the bushes?—I cannot tell you from memory, but will refer to the specification, and let you know.

The witness then withdrew.

(*He subsequently showed the Court the specification for 6-inch lyddite shell, which had been altered in this respect in November* 1898. *The specification for 9·2-inch lyddite shell was approved in June* 1899, *and contained a clause directing that the bush should be fixed with Pettman cement.*)

Mr. WILLIAM POTTER (Inspection Department) examined (second time).

Mr. William Potter.

700. (*President.*) Has all your service in the Arsenal been in the Inspection Branch, or have you been employed in other departments as well?—The Inspection Department only, where I have been five years.

701. You told us that you had seen a rectifying tool used in the filling house in the morning; what tool was it, do you think?—Either a rimer or a trepanning tool.

702. It was the rimer you saw used in the filling room?—I think I have seen both, but I know I have seen the trepanning tool used there.

703. When was the last occasion that you saw that used?—I should say about two months back, but cannot say exactly.

704. In which filling house did you see it?—No. 9.

705. Have you ever seen the former re-inserted in the morning to ascertain whether the cavity was correct, or for any other purpose, when the shell was cold?—No, but I have seen them have a very great difficulty in removing the former.

706. At what time of the day?—About 5 p.m.

707. In what size shell?—5-inch, 6-inch, also 9·2-inch, and 10-inch.

708. Have you seen them try to get the former out in the morning?—Yes, but as a rule they put them in the oven.

709. Did you ever see them try without putting them in the oven?—Yes.

710. By putting the shell into the oven, does that delay the work of filling?—I do not see how it can do so.

711. Is the amount of acid that is melted lessened in consequence of putting a shell in the oven?—No.

712. Supposing an oven were used merely to warm a shell without putting any acid in it to melt, would that reduce the filling power?—Yes, that would delay the work, because there would be insufficient acid melted to fill the shell. There are only four ovens.

713. Have you known them run short of acid for the day's work?—Yes, I have known them put shell on one side and finish them next morning on account of the shortness of melted acid.

714. As far as you remember, you have never seen a former used as a rimer?—No.

Mr. William Potter.

29 June 1903.

715. (*Captain Thomson.*) What would be the object in trying to remove the former without putting it in the oven?—I suppose it would be to save time.

716. Have you seen them use spanners in the morning?—No, but I have seen them on several occasions use them in the afternoon.

717. You say you have seen them use a trepanning tool?—Yes.

718. What would be the object of that?—In order to take a little of the acid out, and I should say it would be with the object of getting the former into the shell again.

719. Why should they do this when the shell is going to be rectified?—They would want to get the former into the cavity to top up the shell. I cannot see any other object, unless it was that the walls had fallen in during the night.

720. What would be their object in doing it in the filling house instead of in the rectifying room?—I cannot say what object they would have.

721. How do they know if the walls have fallen in?—By the "former."

722. You think that the trepanning tool that you have seen used was used in a shell partially filled with the object of introducing a former into it in order to fill the remainder?—Yes. The reason I remember so well about this trepanning tool and noticed it particularly at the time was because the man took it from the rectifying room under cover of his shirt to prevent the foreman seeing it.

723. The trepanning tool was taken away from the rectifying room in a somewhat clandestine manner?—Yes.

724. (*Lieut.-Col. Hadden.*) You were in the rectifying room when this tool was fetched?—Yes.

725. Who came for it?—Morley, who was killed.

726. Have you seen any of the other men fetch tools out of the rectifying room?—No.

727. On the occasion when you saw him fetch the tool, did you see him use it?—No.

728. Have you ever been in the filling house while they have been using the tool?—No, not to my knowledge.

729. Have you ever seen them take a gauge away from the rectifying room?—No.

730. Have you ever been in the filling house in the morning when they have been plugging the shell?—No.

731. Have you ever seen a 9·2-inch shell with a former fixed put in the oven?—No, not a 9·2 shell.

732. Does the amount of work in the rectifying room vary much?—Yes, it does at intervals.

733. Have you ever known any complaint made by the men of the rectifying room of the amount of rectifying to be done?—Not to the foreman, but I have known them complain to each other, and a man once mentioned the fact to me.

734. What did he say to you?—He said the walls of the shell had fallen in a lot, causing a lot of rectifying or riming.

735. What particular nature of shell were those?—9·2-inch and 10-inch, but 9·2-inch specially.

736. When was that?—About six weeks back.

737. Was that before this tool was fetched from the rectifying room?—No, since then.

738. Had you been in No. 9 filling house on the morning of the accident?—No.

739. Had you been in the melting house?—No.

740. Had you been in the rectifying room on the morning of the accident?—No.

741. You had only been in the issuing store?—Yes.

742. When you saw this tool removed from the rectifying room, did you see it brought back?—I do not remember seeing it brought back.

743. How did they get on with the work in the rectifying room while it was away?—It was not required, as they were going through the other shell, inserting exploders, &c.

744. How many tools of each sort have they in the rectifying room?—One of each nature, a rimer and a trepanning tool.

The witness then withdrew.

Mr. Samuel McGowan (Inspection Department) examined (second time).

Mr. Samuel McGowan.

745. (*President.*)—How long have you been employed in the Arsenal?—Since November 1894.

746. Have you been in the Inspection Department all that time?—Yes.

747. You told us you had seen the formers removed, or attempted to be removed, in the morning when the shell was cold?—Yes.

748. Have you ever seen them replace the former in a cold shell or attempt to do so?—I have seen them examine the shell with the finger and then put in a short former and wait for the acid to come out to drop a little more in.

749. But not a long former as is used at first?—No.

750. Why would they try to remove one of these formers in the morning?—They always remove them if possible, and the shell are only put in the oven when they are unable to move the "former" in the filling house.

751. But if the former had been reported fixed the night before, what would happen then?—If they could not wrench it out there is nothing to do but to put it in the oven, but if they could remove it without this they did. I was three years in these buildings, and I do not think I saw many shells put in the oven for that purpose.

752. Did you ever see a 9·2-inch or 10-inch?—Never.

753. Were they filling that nature of shell then?—Yes, I believe so. They had filled M.L. 10-inch at that time I am sure, and they must have filled plenty of the other kind for Shoeburyness.

754. You never remember one of the larger natures put into the oven, do you remember any of the smaller natures being put in?—I have seen some 6-inch shell put in.

755. (*Captain Thomson.*) They would try to move the former over night?—Yes, unless the acid was not properly set.

756. You said that you had seen them rectifying shell in the filling house?—Yes, but that occurs very rarely.

757. What would be the object of that?—To save grumbling one to another.

758. They would not do it in order to put a former back?—No.

759. Have you seen it in the case of a half-filled shell?—No, I have never seen that done. The only time I have seen it was when they have found the cavity is too high.

760. (*Lieut.-Col. Hadden.*) Do you mean that it is a rule that if a former is fixed and left over night it was always tried in the morning?—Yes.

761. What length is this short former you refer to?—(*Witness measured off the distance on a long former.*)

762. It is called a short former?—Yes.

763. That is only used for filling up just under the bush?—Yes, I am not sure that it is not an actual former for another nature of shell.

764. Was there any difficulty in inserting this short former?—Yes, they might possibly have to try two or three before getting one in. Sometimes there is a difference in the fit of the socket.

765. Have you ever known of any shell being removed from the filling house in the morning by the oven gang before the filling gang came in?—That would be before I was in, so I could not say.

766. The largest shell you have ever seen put in the oven has been a 6-inch?—Yes.

The witness then withdrew.

(*The Court then adjourned to visit the scene of the explosion.*)

Royal Arsenal, Woolwich.

Monday, 29th June 1903 (Afternoon).

PRESENT:

REAR-ADMIRAL A. A. CHASE PARR (PRESIDENT).

Lieut.-Col. C. F. HADDEN, C.B., R.A. | Major F. L. NATHAN, R.A.

Captain J. G. M. WATSON, R.A., *Secretary.*

Mr. WILLIAM LEVERETT (Leading Hand) examined (second time).

Mr. William Leverett.

29 June 1903.

767. (*President.*) You told us in your previous evidence that you had known the heads of formers unscrewed, and you had known them broken as they came up; when was the last occasion that you knew the former to be broken?—Last Tuesday week, the 16th instant.

768. How was it broken?—In taking it up.

769. Where did it break?—At the two holes. That seems to be the weakest part of a former.

770. What was done with the shell?—I called the overlooker's attention, and he told the foreman, and the shell was sent to the oven in the morning.

771. Who removed the former eventually?—The overlooker.

772. Did the shell come back to the filling house?—Yes.

773. What was done then?—The former was taken out and another put in.

774. Was there any difficulty in getting another former into the cavity?—No.

775. Had the lyddite bulged in at all at the sides of the cavity?—No.

776. If the former were broken off at the holes, it would not have been filling the whole cavity?—You could only put the former into the cavity already made by the old one.

777. Did the new former go right to the bottom?—No.

778. What kind of former was put in? Was it a short former or the ordinary length?—The ordinary length.

779. But if it did not go down the full length, then the holes of the former would be above the socket?—Yes, that would be so.

780. In that case you would not be able to complete the filling of the shell?—No.

781. So that it would not have been much good unless it went right down?—No.

782. Was it necessary to put any more lyddite into it?—We did not put any more in.

783. You did not try to put any more in?—No.

784. Then why did you put another former into it?—To keep the cavity from coming up.

785. Was this because the lyddite was soft?—Yes.

786. Was it soft enough to allow the longer former to go right down?—Only to go down as far as where the other former came up to.

787. When was the previous occasion to that that a former was left in or broken?—It must have been a long time ago.

788. In fact you have no recollection of another being broken?—No.

789. But of a former being fixed in, and of a shell being heated to get it out?—I remember an occasion of that kind, but it is a long time ago.

790. What nature of shell was it?—A 10-inch shell.

791. On what date did this occur?—Last Tuesday week, the 16th instant.

792. Did you see this shell put into the oven?—No, it was put in by the overlooker.

793. Did you see the shell taken out?—Yes, it was in No. 2 oven; there are four compartments.

794. In which oven?—No. 2, that is in No. 16 building.

795. At what time was it taken out?—About 2.30 p.m.

796. Who put the shell in?—The overlooker. Edwards.

797. Did anybody assist him to put it in?—Yes, the men who came on to put the cans into the oven.

798. You are sure as to the date?—Yes.

799. Were you working in this same filling house on the previous days of the week?—Yes.

800. Were there any shell that had to be put into the oven from your filling room on any other day of the same week?—No.

801. If any had to be put in you would know?—Yes.

802. Who were the men that came in that morning?—I do not know.

803. Except for this shell was the oven empty, or were there cans of lyddite in it?—I believe there were some cans in it.

804. But you helped to take the shell out of the oven?—Yes, the overlooker and I took it out, but he actually removed it from the oven.

805. You cannot say whether there was anything else in the oven?—I believe there were some cans in, but I am not sure.

806. You did not actually go in to take out the shell yourself?—No.

807. What we want to know is whether there were any cans of lyddite in the oven with the shell or not?—I could not say positively.

808. (*Lieut.-Col. Hadden.*) Do you know who took the shell out of the oven?—Edwards, Widdowson, and Fletcher.

809. Who were the other two men that were working with you the evening the former broke?—Remington and Edser.

810. Edser said he was in the boiling-out house?—I wanted another hand, and sent to the overlooker for one, and Edser was sent.

811. (*Major Nathan.*) What did you have Edser in for?—To help turn the formers.

The witness then withdrew.

Mr. Thomas Beese.

29 June 1903.

returned I called his attention to it, and he admitted he forgot to mention the shell, but the total number of cans was the same. The log-book should read:—9 in No. 1, and 12 each in Nos. 2, 3, and 4.

926. Were there any shell in on Tuesday?—Not to my knowledge.

927. Do you know what was the matter with the shell that was in on Wednesday?—I should say the former was broken off.

928. If one had been in on the Tuesday you would have known?—Yes.

929. (*Major Nathan.*) Only shell with broken formers are put in the oven?—No, if a former is stuck it is put in to be loosened.

930. Have you known cases when shell with whole formers have been put in?—Yes, to loosen the formers so as to get them out.

931. (*President.*) Can you point to any instance of shell having been put into the oven and having been logged?—No, we have never made a record of it. The only remarks we make is a record of thunder storms, and the stopping of the motors.

932. (*Lieut-Col. Hadden.*) So that this record of what you had in the oven is really incorrect?—No, there were 45 cans.

933. Yes, but this is not a correct record, and never has been?—No, not in the case of shell.

934. But on some of the previous days I see you have got nine in one compartment, and12 in each of the others. Why is that?—Sometimes a chamber will not melt quite so well as the others, so we put the least number of cans into that chamber.

935. There is a record here of two cans in one and eight and seven in two others; why is that?—Perhaps it was because there were trays left in over night, or they had put extra trays of formers in.

936. So you can have cans, shells and trays of formers all in the same oven?—Yes.

937. And no record is kept, except in the case of cans?—No.

The witness then withdrew.

Royal Arsenal, Woolwich.

Tuesday, 30th June 1903.

PRESENT:

REAR-ADMIRAL A. A. CHASE PARR (PRESIDENT).

Lieut-Col. C. F. HADDEN, C.B., R.A.

Captain J. G. M. WATSON, R.A., *Secretary.*

Mr. JOHN MCCARTHY (Assistant Foreman) examined (third time).

Mr. John McCarthy.

30 June 1903.

938. (*President.*) You stated on a previous day that the last occasion when a shell having a fixed former was put into the oven for melting was on Tuesday morning,—are you sure of the day of the week?—No, I cannot say I am certain of the day, it might have been either the Tuesday or the Wednesday, but I know it was on the same day that a class of Naval officers went round. (*This has been proved to be Wednesday.*)

939. Did you put it in yourself?—I saw it put in.

940. What was the matter with it?—The former was broken.

941. From which filling house did it come?—No. 16.

942. You also stated that you were in the building after one o'clock on the day before the accident; do you refer to No. 9 building?—Yes.

943. You also stated that they were filling 9·2-inch shell?—Yes, when I passed through on one occasion they were filling through the funnel of former, that is, the former is put in at the first filling and after that has stood for very nearly four hours the second filling takes place through that former, and that was the operation which was taking place during the time of my visit there.

944. (*Lieut-Col. Hadden.*) Can you say whether any of the 9·2-inch were without plugs?—I cannot say for certain as to the 9·2-inch.

945. Have you ever seen shell being removed before they had completed the putting in of the plugs?—Yes, and at each time I have spoken to them about it, and instructed them to insert the plugs in all the shell before starting to remove any of the shell.

946. So that it has occurred?—Yes.

947. Did you notice when you went round if all the covers had been taken off?—The covers were not off, but they were removing them and the covers were all off the 9·2-inch shell.

948. You are quite sure?—Yes.

949. And you are quite certain that there was not a former in any of the shell?—I did not notice one, and I think that had there been a former there I should have noticed it.

950. But you are quite certain there were no covers?—No, there were no covers on those shells.

951. You observed sufficiently for that?—Yes.

952. But you cannot say for certain that there was not a former?—No, I could not say that for certain.

953. All that you can say for certain is that none of the covers were on the bodies of the shell?—Yes.

954. (*President.*) But you cannot say for certain whether there might not have been one or two shell with the covers folded up and lying on the head of the shell?—No, I could not say that for certain.

955. (*Lieut.-Col. Hadden.*) You said before that you had never seen a spanner struck for the purpose of removing a former from a shell; have you seen a spanner struck at all for any purpose?—No.

956. Have you ever known men to stay after time to complete the removal of the formers?—Yes, I have known men to stay till seven o'clock.

957. How often does that occur?—It has not occurred recently, but it did some considerable time ago.

958. Was that extra time booked?—Yes.

959. Would your time-book show the last occasion on which it occurred?—Yes, I might add that at one time we did not part fill shell, but we completely filled them and then stayed till the formers were withdrawn.

960. I understand from your previous answers that unless you consider it is worth while the men stopping late and being booked the extra time they do not stay?

—No, it is not on that account but sometimes we can remove a former five minutes sooner than at others. It does not always take 4½ hours for a cavity to be formed sufficiently to allow a former to be removed. I have known it to take ten minutes under that time, and I have known it to take five hours before a former could be withdrawn. If a former is removed too soon, we could not do anything further with that shell until the next morning, but in filling large natures of shell we never, if it is possible to avoid it, fill after a certain time of day, so as to leave sufficient time to finish off those in hand before leaving at night.

961. (*Lieut.-Col. Hadden.*) Can you say when was the last occasion when you had a fixed former—I do not mean a broken former?—I could not give you the exact time.

962. You have no record whatever of fixed formers?—No, we do not keep a record of shell placed in the oven.

963. It must have been some time ago?—Yes.

964. Have you been filling 9·2-inch and 10-inch shell for some time?—Yes.

965. How long has it been going on?—For two months.

966. And during those two months, has there ever been a case of a fixed former?—No, there was only the one instance, that of the 10-inch shell.

967. There has been no case of one having a jammed former?—No.

968. Can you give us any further particulars as to what these men were doing when you visited in the morning?—I think I said there were eight men in the building, but there were only five—Usher, Swords, Pinhorn, Marshall, and Herbert. They started work at 7 o'clock, and Usher, being the leading hand, was in charge. There was nobody else in the building at the time of my visit, and I saw two of them, Swords and Pinhorn, at the truck in the porch. Usher, Marshall, and Herbert were inside the building.

969. Where were the other three men?—They did not start until 8 o'clock, and so had not arrived.

970. What were their names?—Connor, Johnson, and Morley. They were presumably coming to work, and could hardly have got to the building, but they were seen inside the building before the explosion.

971. Do you know what the three men who were inside the building were doing when you were there?—They were getting ready for the removal of the shell, in fact, there was one man, I am not certain which, at the truck, or, rather, going towards the truck, to assist Swords and Pinhorn in getting the shell to the truck.

972. Had they actually got a shell outside the building?—They had a shell on the barrow, Swords and Pinhorn had the truck, and they were running the shell out of the building.

973. One man, you say, was going to assist them?—Yes, one man stands at the truck to help the shell up the plank.

974. What were the others doing?—Usher was giving instructions to the men in the building, and the others were clearing away the trays to be melted out. The trays are taken to the melting-out house.

Mr. John McCarthy.
30 June 1903.

975. Then one of those trays at the time of the explosion would have been taken away to the melting-out house?—Yes, but it could not have been removed there in this instance, as I did not see one in the melting-out house.

976. (*President.*) Who are the leading men?—The leading man was Burns, and the man who assisted him was Connor. Connor, through the firing at the butts taking place between the hours of 12 and 2, would not come in till 8 o'clock, and would have to take charge during those hours. Usher was in charge at the time until Connor arrived, when he would hand over his duties to him.

977. (*Lieut.-Col. Hadden.*) There was a notice put outside the entrance about the walking race?—Yes.

978. Were you at the race?—No.

979. I suppose all the men in the shops knew about the race?—I could not say, but, of course, they should have known about it, as the notice was there for everyone to see.

980. Did you hear any conversation about it?—Yes, frequently.

981. Was there ony rivalry between the lyddite and cannon cartridge people?—No.

982. We have had very decided evidence that formers have been taken out of shell in the morning, and we want to know whether that has ever come to your knowledge, or whether you have ever checked anyone for doing that?—It has never come to my knowledge that a former has been withdrawn in the morning without first going to the oven.

983. You have never known such a thing to be done?—No, not even at the time when I was in the shop as a workman.

984. Previous to the two months, have you filled any 9·2-inch and 10-inch shell?—Yes.

985. During the time you were filling them, what difficulties were experienced, if any?—We have found that the former has turned quite easily for the full time that we would allow the picric acid to solidify, but when the time arrived for the actual withdrawal of the former, it was found impossible to do so, although the former could still be turned round easily. The shell has then to be sent to the oven for the former to be melted out.

986. Did that often happen?—No.

987. In extracting the formers, have you ever known men turn them the wrong way to loosen them?—Yes. I have known them turned against the thread, and the tops turned off, leaving the stems in the shell.

988. In fact, you have known them turned in that way till they have actually unscrewed.—Yes.

989. There were cans of acid in the chamber in which the 10-inch shell was placed, sufficient stands being removed to make room for the shell?—Yes.

The witness then withdrew.

Mr. William G. Widdowson (Labourer) examined.

Mr. William G. Widdowson.

990. (*President.*) What is your work in the lyddite factory?—Principally to watch the acid in the chamber, and despatch it, when ready, to the filling house.

991. So that you always know what is in the heating chamber?—Yes.

992. Would you always know if a shell had been put into the heating chamber?—Yes.

993. When was the last occasion that you know of a shell having been put into the chamber?—I think it was about a fortnight ago when a 10-inch shell was put in.

994. How many days would that be previous to the accident?—I should say about four or five days.

995. Did you help to remove that shell from the oven?—No, that was done while I was away at dinner.

996. Did you see it?—Yes, I saw it after it was out.

997. Did you see what it had been put into the oven for?—It was owing to the former not having been extracted overnight.

998. Did you notice the former?—Yes, I noticed there was a former in the shell; I am not sure whether it was a whole former or not; I think it was.

999. (*Lieut.-Col. Hadden.*) Was the tray on the shell?—Yes, and the socket and funnel at the top of the former.

1000. Do you know when the last occasion was, previous to the one mentioned?—I cannot remember, but it is a long time ago.

1001. How many shells have you seen put into the oven?—About three or four into my oven.

1002. Have you been on the same oven all the time?—No.

1003. While you have worked there you have always been at an oven?—Yes.

1004. So that any shells that were put in you would see, and you have only seen about three?—Yes.

1005. (*President.*) Are you speaking now of only the large natures of shell, or smaller natures as well?—The large natures.

Mr. William G. Widdowson.
30 June 1903.

1006. Have you seen many smaller shell, 6-inch and below, put in?—I have not seen any of those.

1007. Are you always present when the acid or the shell are removed, except in the dinner hour?—Yes, I am there from 8 till 1, and from a quarter-past 2 till 20 minutes to 6.

1008. Then the oven would not be opened without your being there?—No.

The witness then withdrew.

Royal Arsenal, Woolwich.

Saturday, 4th July 1903.

PRESENT:

REAR-ADMIRAL A. A. CHASE PARR (PRESIDENT).

Lieut.-Col. C. F. HADDEN, C.B., R.A.

Major F. L. NATHAN, R.A.

Captain J. H. THOMSON, His Majesty's Chief Inspector of Explosives.

Dr. A. DUPRÉ, F.R.S.

Captain J. G. M. WATSON, R.A., *Secretary.*

Captain C. J. D. FREETH, R.A. (Danger-Building Officer) examined.

Capt. C. J. D. Freeth, R.A.
4 July 1903.

1009. (*President.*) When were you employed in the lyddite buildings, and for how long?—It would be rather difficult to say, as I have been associated with them, on-and-off, for the four years I have been here; but I should say my actual service there was about a year.

1010. At all events, you were there sufficiently long to enable you to be thoroughly cognisant with the instructions regarding those buildings?—Yes.

1011. Was it part of your duty to be constantly passing through the different shops?—Yes; until we got the Danger Building Visitors appointed, I used to visit every day.

1012. Who are the danger-building visitors?—They are two men who have been appointed to visit the danger buildings.

1013. When were they introduced?—About a year and a half ago, and before their appointment I always spent the afternoon in the shops.

1014. So that during that time you were often in the lyddite filling shops, and saw what was going on there?—Yes.

1015. Were you often present when they were removing formers?—Yes.

1016. Were they filling the larger natures of shell during the time you were there?—Yes, the 9·2-inch.

1017. Did they have more trouble with the larger natures of shell than they did with the smaller in removing the formers?—I do not know that they did; in fact, I think the larger natures would be easier, on account of their size.

1018. Would it have been reported to you when it was necessary to put any of those shell into the oven in order to remove the formers?—Not necessarily.

1019. Was it often that a shell was put in?—Very seldom.

1020. Did you know of any formers breaking?—No, not while I was there.

1021. Was it ever discussed as to whether some alteration could not be made in the former to enable them to be extracted more easily?—The present pattern is the one that was in use when I came, but of course there had been several experimental ones before the adoption of the one at present in use.

1022. Will you tell us what the orders are concerning the searching of men as they enter the buildings?—The man at the gate is responsible that when the men come in through the first gate they have nothing which they ought not to have. The men then come in and take off their clothes, and as they pass over the barrier they are searched again. After the men have gone to their work the man in charge of the shifting house searches all the clothes belonging to the men as they hang on the pegs.

1023. But who is responsible that the men take nothing in with them?—The shifting house man.

1024. Who is the shifting house man?—He is a man permanently in charge of the building in which the workmen change their clothes before going to the danger buildings. He is held responsible for the searching of the men, and for their conduct while in the shifting house, and he is liable to dismissal at once if the least thing goes wrong. He is generally an ex-policeman or something of that kind.

1025. What is the name of the present shifting house man?—Burall.

1026. From the evidence already given it appears that a number of men take it in turns to do the searching?—Yes, the shifting house man is assisted by the overlookers in this duty.

1027. There are two places where the men enter from the dirty to the "clean" side, so that it would be practically impossible for one man to search them all, and difficult for one man to be responsible?—It would be impossible for one man to search them in the time allowed, but one man may be responsible, in fact it should be made so.

1028. (*Captain Thomson.*) Have you seen them using the spanners on the formers?—Yes.

1029. Do you remember ever checking them for using too much force?—No, I do not think I have ever had occasion to do so.

1030. If you had seen two or three men using the spanners, would you have objected to it?—Yes, but I do not think you could get two or three men on them without breaking the former.

1031. Is it not the case that formers are sometimes broken?—I have only heard of one former being broken, and that was done, I believe, through a man not pulling straight.

1032. (*Lieut.-Col. Hadden.*) Are there any written instructions respecting your duties as Danger Building Officer?—There are now, but they have only been out since March this year. The chief thing that concerns me is that I should visit each building under my charge once a week. Before the Danger Building Visitors were appointed I had to visit every one of the buildings each day.

The witness then withdrew.

Mr. George Fletcher (Labourer) examined.

Mr. George Fletcher.

4 July 1903.

1033. (*President.*) Where are you employed in the Arsenal?—In the Cannon Cartridge Factory, but at the time of the accident I was employed in the Lyddite Establishment.

1034. In which shops have you worked?—I have worked in nearly all of them, except the rectifying room.

1035. You have been employed in filling of lyddite shell?—Yes, I was engaged principally on the filling of shell, and also the melting of the acid. At different times we had different jobs and were shifted about.

1036. Was there any great difficulty in extracting the formers?—Yes.

1037. When was the last time that you worked in the filling house?—I was working in No. 16 filling house at the time of the explosion.

1038. What caused the difficulty in extracting the former?—When the former has been extracted from the shell, I have noticed a quantity of lyddite around it and jammed between the socket and the former.

1039. You think it was that that made the difficulty?—Yes.

1040. When a former was found difficult to remove, what was done?—The socket was given half a turn by means of a spanner, and that would sometimes loosen the former sufficiently to allow it to be withdrawn.

1041. If one spanner was not enough, was a second used?—Yes, one to hold the socket, and the other to try to turn the "former."

1042. It was possible for two men to work on the spanners?—Yes.

1043. Did they exert the whole of their strength on them?—Yes, we have at times been tired of pulling at the formers.

1044. Supposing the lyddite was not properly set in the evening, when the time came for the removal of the former, was it left in till the morning?—Yes, if it was impossible to remove it that evening, but every endeavour was made to remove it in the evening before leaving.

1045. Have you tried to remove them in the morning?—Yes, and we have succeeded in removing them.

1046. Has that been, more or less, a common occurrence?—Yes, it has been frequently done in all the filling houses.

1047. Can you call to mind when was the last time?—I could not tell you the exact date, but I think it was about a fortnight before the accident.

1048. In which shop did it occur?—No. 16.

1049. Of course this was done when the overlooker was present?—Yes. In the case which occurred a fortnight ago, Paine was in charge, the overlooker being at the time engaged in searching the men. Paine was second in charge of the shop.

1050. Has this been done in the presence of some of the other overlookers, and who have actually seen it done?—Yes, it has been done while Burns has been present.

1051. Has it often happened that the shell had to be placed in the oven, because it was found impossible to remove the former?—Yes, we could not remove them all.

1052. Do you remember that happening?—Yes.

1053. How long ago?—I should think two or three days before the explosion.

1054. When was the time previous to that that you saw it done?—I could not exactly say. We have had so many at different times—on one occasion I remember nine 6-inch howitzer shells going in.

1055. Was that owing to any special reason?—No, simply because the formers became fixed, and we could not remove them and so had to melt them out.

1056. (*Lieut.-Col. Hadden.*) In extracting the formers with a spanner, has the spanner ever been struck?—No, I have never seen one struck, and I do not think anyone else has.

1057. When removing the shell in the morning, were they removed as they were plugged, that is, as soon as two or three shells had been plugged, were they removed while the others were being plugged?—Yes.

1058. It was not the custom to plug the whole of the shell first?—They were removed while the plugging was going on.

1059. What was the nature of the shell you speak of as becoming fixed two or three days before the accident?—I think it was a 10-inch shell.

1060. Was the former in that shell fixed or broken?—Broken off at the top.

1061. (*President.*) What time did you come to work on the morning of the explosion?—8 o'clock.

1062. Did you come in with the other men who were in No. 9?—I came in with Morley, one of the men who were killed.

1063. Did he mention whether they had to remove a former at all?—No, he did not mention the work.

1064. Can you say whether there was a former left in?—I could not say.

1065. (*Lieut.-Col. Hadden.*) When you have been removing a former in the morning, has either of the foremen been present?—No.

1066. Have you ever seen a former inserted in the shell in the morning for the purpose of gauging or rectifying the hole?—No, not after it has been once filled.

1067. They have never tried them with a former when ready for plugging?—No.

1068. Have you ever seen them filled up in the morning?—Yes, I have seen a short former used for that purpose.

1069. Was there any difficulty in getting those in?—No, they are about half the length of the ordinary former.

1070. When would that be done?—As soon as we got any acid out for the first filling, that would be about 11 o'clock.

1071. (*Major Nathan.*) When are you searched?—We are searched every time we cross the barrier from the "dirty" side to the "clean," and when we get to the workshop by the overlooker in charge.

1072. How are you searched while crossing the barrier?—We are then in our shirts, pants, and socks only, and are searched by a rubbing down.

1073. Then you put on your danger building clothes, and are searched by the overlooker?—Yes.

1074. How does he search you?—In a similar manner.

1075. (*President.*) Have you ever seen the tapping tool used in the filling house?—No.

1076. Do you think it would ever be necessary to use it in the filling house?—It might be necessary, but I have not seen it used there.

1077. Supposing you wanted to insert a short former to do the topping up, would it be necessary then to use the tapping tool in order to get the former in?—I have never seen it done.

1078. If there is lyddite in the threads sufficient to prevent the plug going in, what is done?—I have never seen any difficulty in putting in the plugs.

1079. (*Captain Thomson.*) Sometimes the plug does not go right down, and you would not notice whether it was right down. You are only allowed to screw it down finger-tight. What is done then?—We have a key in the filling room to screw them down with if it cannot be done by hand.

1080. Is the key ever used for putting plugs in the shells going out?—Yes, if we could not get the plug down with our hands.

The witness then withdrew.

Mr. William Hill.

4 July 1903.

Mr. WILLIAM HILL (Labourer) examined.

1081. (*President.*) How long have you been employed in the Lyddite Factory?—About seven years.

1082. In what part of the factory have you worked?—In the filling house boiling-out house, and drying house.

1083. How long have you worked in the filling houses?—About five years.

1084. During that time, have you seen difficulty in extracting formers from the shell?—Yes.

1085. Is it more difficult to extract the former from the larger natures, or the smaller?—They are all very hard to extract, but in the case of the 10-in. and 9·2-in., we have a better hold on account of their size. The smaller natures we have to get right on the ground to grip at. The difficulty also varies according to the time, the friction being greater towards the fifth hour.

1086. At the end of the time it is more difficult to turn than at the beginning?—Yes.

1087. Unless it is taken out before the acid is hard, it is very difficult to get out?—Yes.

1088. And if it is taken out too soon the cavity is not properly formed?—That is so.

1089. How many formers would one man have to keep turned?—A row of about 12.

1090. So that it is likely that a former has to be left a little time between the turns?—Yes, for three or four minutes at times, especially when there is a difficult case, as then the others must necessarily wait.

1091. If the former is very stiff in the evening and you cannot get it out, is it left till the morning?—Yes.

1092. And then do they try to get it out?—Yes.

1093. You have actually seen that done?—Yes.

1094. Have you seen it done recently?—Yes, about a fortnight or three weeks ago in No. 34, one of the shops not at present working.

1095. It has not been an unusual occurrence to remove the formers in the morning?—About once a month or six weeks.

1096. Have you known many cases in which it has been necessary to put the shell into the oven?—I have known cases of small shell, but not of large.

1097. When do you remember a former being stuck in a big shell?—I think there was one about three weeks ago.

1098. From your own knowledge you do not remember any large shell placed in the oven?—No.

1099. Have you ever known a case of a former being replaced after the shell has been filled?—No.

1100. Supposing you found when turning the former that the lyddite was not properly set to remove that former, would the former be left in for the night on that account?—No, they come out at the proper time, and if the walls fall in they are taken in the morning to the rectifying room to be rectified.

1101. We have had it in the evidence that there has been some complaint from the rectifying room about the number of shell sent to be rectified. To prevent that, would it be possible that the former should be left in because the lyddite was not sufficiently set?—No.

1102. It would only be left in because it was found impossible to remove it?—Yes.

1103. Have you worked with Connor at all?—Yes.

1104. Was he a good hand at extracting these formers?—We all used to do our share. I cannot say he was any better than the rest of us.

1105. And was Morley a good hand also?—Yes.

1106. Have you seen any of the overlookers present while formers have been extracted in the morning?—Yes. I have seen Burns there and Edser.

1107. (*Captain Thomson.*) Do you know from your own knowledge whether a former was left in on Wednesday night or not?—No.

1108. While the plugging of the shell was going on in the morning, were any of the shell removed?—Yes.

1109. Did you ever see the key used for putting in the plugs?—Yes, but they are generally put in by hand.

1110. If the key is used, is it because the plug will not go down?—Yes.

1111. You do not attempt to clear that out in the chamber?—No, that is done in the rectifying room.

1112. (*Dr. Dupré.*) When a former is fixed in the morning, do you always try to remove it by hand?—Yes.

1113. Did you ever know of a former being broken?—Only by two tools we used to use. Formerly we used a pair of tongs and two other instruments called wrenches, but we do not use the latter now.

1114. You do not use them now?—We use the tongs occasionally when the bell comes off the former.

1115. (*President.*) Are these tongs among the tools provided in the filling house now?—Yes, the tongs, but not the wrenches.

1116. What time did you come on the morning of the accident?—About 20 past 7.

1117. Did you see Connor or Morley that morning?—No.

1118. Nor any of the other men working in No. 9 building?—No.

1119. (*President.*) Have you worked with Connor in the filling room?—Yes.

1120. Have you known him engaged in extracting the formers?—Only in the usual way.

1121. You have not known him as specially engaged in the extraction of formers, as from the evidence he must have been a particularly strong man, and one likely to prove useful for that purpose?—Yes, he was a strong man about six feet high and of very good physique, but we all assisted each other in the removal of difficult formers.

1122. If one of the other men could not get a former out, would Connor assist?—Yes, sometimes. I have had a difficulty and have been assisted in that way.

1123. So that Connor would have been valuable in that way?—He was no more handy than the rest of us, as strong men are always secured for the filling rooms owing to heavy shell which have to be lifted.

The witness then withdrew.

Major H. W. W. Barlow, R.A.

Major H. W. W. BARLOW, R.A., Superintendent, Royal Laboratory, examined (second time).

1124. (*President.*) Before you became Superintendent of the Royal Laboratory, did your duties connect you at all with the Lyddite Factory?—I only dealt with the papers as they came through, but, of course, I had been there often and have had a fair working knowledge of it ever since it started.

1125. Was it ever reported to you that the formers were difficult to extract, and were any suggestions made as to moving them?—No.

1126. Have you got perfect confidence in Mr. Edwards, the foreman in charge?—Yes, absolute confidence. I have known Mr. Edwards do what very few foremen would have done, that is, put on canvas working clothes and go into the flues.

1127. I understand that the principal overlookers, &c. are taken from the labourers who have shown themselves best qualified?—That is so.

1128. Do you think that is the best way of selecting them?—If you retain the overlooker system, you cannot do much better, but I do not think it is a good plan.

1129. If a man has been through the whole of the work with the men, and has been accustomed to do

things which were contrary to the regulations, is it not likely he will continue to do those things when he becomes an overlooker, or do you think he will do otherwise?—I am afraid from the direct evidence I have received he keeps his sympathies with the working hands. Of course there are honourable exceptions, but the tendency is that way, I am afraid.

1130. (*Lieut.-Col. Hadden.*) Will you tell us on what system the men filling shells are paid?—On the fellowship system.

1131. What men working in the Lyddite Factory are paid on fellowship?—All, with the exception of the foreman, assistant foremen, principal overlookers, sweepers, shifting-house men and stokers.

1132. All the others are paid by shares?—Yes.

1133. How is the sum distributed arrived at?—By putting a price on to the completed shell made up, of course, of all the different operations, the number of shell filled per week forming the basis of the week's pay. The uncompleted work is paid for up to the stage it is in.

1134. What record is kept of the number of shell filled during the week?—The number is taken by the worktaker in conjunction with the foreman.

1135. Is any record kept by the foreman or overlookers?—Yes, the foreman keeps one, and the overlookers keep rough books of their output. This, however, is not for pay, but for issue purposes.

1136. If men have to stop after the usual hour for turning out, are they paid for that?—Yes, if a man stops after the usual hour, his share is increased accordingly.

1137. Who sanctions the man's stopping?—It would be sanctioned direct by the foreman, and be passed officially to me afterwards for final approval. I mean to say approval is given after the fact.

1138. Do you know whether there has been any stopping late recently?—I believe there have been no men kept back for over a year now.

1139. Are the buildings visited after the place is shut up?—There are no regulations laid down, but the police have entry, and the foreman and assistants make occasional surprise visits to see that the stokers are doing their work properly.

1140. You have seen the log-book?—Yes.

1141. What is that supposed to contain?—It is supposed to contain the time the filled cans are put into the ovens, the length of time they are in, and the rate of the working of the fans.

1142. Is the log-book supposed to contain a record of the shell that are put into the heating chamber?—Yes, that, I believe, was the original intention.

1143. So that if any shell were put in it should be noted in the log-book?—Yes, it should be presumably so noted.

1144. Is there any record in the log-book of a shell having been put in?—I did not look at it.

1145. Are the instructions which have been submitted to us the only instructions for the lyddite factory?—Yes, and they govern the manufacturing operations in each of the rooms. I am submitting copies of the other general regulations.

1146. Are they put up in each shop?—Yes, posted up on a board.

1147. As far as any instructions go, there is nothing to prevent the tools being taken to any of the shops?—No, there is nothing to prevent that.

1148. As far as you know, has anything been found while searching the men going in?—I have not heard of any case, but I think it is only right to say I have had to discharge three hands during my experience for having brought matches in by mistake.

1149. (*Captain Thomson.*) They can give them up at once without any notice being taken of it?—Yes.

1150. (*Lieut.-Col. Hadden.*) Is there any order as to putting up notices at the factory?—No, there is no regular order on the subject, the notices are generally posted in the shifting house.

1151. There was a notice put up at the entrance of the lyddite in connection with the walking race which was held on the eve of the accident?—I did not know of that.

1152. (*Major Nathan.*) There is no rule to prevent the posting of notices?—No, but no extraneous notices should be put up.

The witness then withdrew.

Mr. Frederick Smith (Labourer) examined.

Mr. Frederick Smith.

1153. (*President.*) How long have you been employed in the Lyddite Factory?—Three and a half years.

1154. Where have your duties occupied you?—For the greater part of the time in the filling room, and the other part in the observation room.

1155. On the day of the explosion, what were your duties?—I should have been in the observation room.

1156. Were you there at the time?—No. I was in the lavatory.

1157. You went straight to the lavatory on entering?—No. when I left the shifting house I went to No. 9 building to be searched.

1158. Who searched you there?—Usher.

1152. Did Connor and Morley come in with you?—Yes.

1160. Did they go to No. 9 building with you?—They went in just in front of me.

1161. So you went actually to No 9 building?—Yes.

1162. Was Usher in No. 9 building then?—Yes.

1163. And it was your duty to be searched by the overlooker?—Yes.

1164. Burns was the overlooker, but Usher was doing his work in his absence?—Yes.

1165. How long did that keep you at No. 9 building?—About a minute.

1166. Who did you see there?—Several of the men, some inside and one was outside with an empty barrow, waiting to go in.

1167. Had they a shell on a truck?—No, they had the plank on the truck.

1168. How long was it after that that the explosion occurred?—I had but just entered the lavatory when I heard the report.

1169. Are you sure there were no shell on the truck outside?—Yes.

1170. How many men were there altogether?—There were several, but I cannot tell you who they were. I remember seeing Connor, Morley, and Pinhorn, but there were a lot more than are usually there at that time in the morning.

1171. What were the other men in the building doing?—I could not say.

1172. What part of the building were they in?—Right inside.

1173. Where was Usher?—In the doorway.

1174. Were both the doors open?—Yes.

1175. Could you see whether one side of the building was clear of shell?—I could not say how many shell were there, but there was not a clear side. They were bringing the 9·2-inch from the further end.

1176. What part of the building was cleared for them to bring those shell down?—They usually have three single lines of shell, and the barrow was run up through the middle.

1177. You did not notice that one side was clear of shell?—No.

1178. Did you see a man using a mop?—No.

1179. Was there a bucket of water at the entrance—Yes. There always is a bucket of water there.

1180. Did you see a man using a dustpan?—No.

Mr. Frederick Smith.

4 July 1903.

1181. What was Connor doing?—He was in the middle of the shop, and I believe he was taking out his watch from underneath his jacket.

1182. What was Morley doing?—The last I saw of him he was bending down adjusting the bottoms of his trouser legs.

1183. Have you worked in No. 9 and No. 16 buildings?—Yes.

1184. Have you had difficulty in extracting formers? Yes, the greater part of them are difficult to extract.

1185. So that a great deal of force has to be used in getting them out?—Yes.

1186. Have you seen them taken out in the morning?—Yes.

1187. Why was that?—Because the men who were in the chamber the last thing before closing were unable to get them out.

1188. So that if the men left were not so strong as some of the others, when the stronger men came in in the morning they would have a turn at them?—Yes.

1189. When were you last employed in the filling house?—About a month ago.

1190. When was the last time you saw a former pulled out in the morning?—About a week, certainly not more than a fortnight before the explosion.

1191. Have you seen any of the overlookers there at the time when formers have been removed?—Yes, I have seen Connor, he was a very good hand at pulling out the formers in the morning. Leverett has also seen them.

1192. You have seen Connor actually taking them out in the morning, and that because he was a powerful man?—Yes, he and Morley were tall men and had more power over the formers.

1193. There was not any ill feeling at all amongst any of the men working in the Lyddite Factory, as far as you know?—No, a little chaffing went on among the men if they had a fixed former and had to send a shell to the oven.

1194. They very seldom went to the oven?—Yes.

1195. If a shell went to the oven it meant a reduction in the amount of lyddite melted?—Yes, they would leave cans out to make room for it, but I have seen them put the cans in afterwards.

1196. (*Captain Thomson.*) Did you lose pay on that account?—No, it made no difference to the pay at all.

1197. When you went to the building, did you see some shell waiting to be put on the truck?—Not outside.

1198. There were no shells on the truck?—No.

1199. (*Lieut.-Col. Hadden.*) Were the shells near the door inside the building plugged ready to go?—I could not say.

1200. Were you in this filling room the previous day? Yes.

1201. What time?—I was in charge from half-past one till ten minutes past two.

1202. Were you there after that?—No.

1203. Was any mention made by anybody working in the chamber that there was a former left in that night?—No.

1204. Was it a common occurrence to have to fill up the 9·2-in. in the morning?—Yes, they were filled up by means of a short former.

1205. While that was being done, those already filled were removed?—Yes.

1206. Was there any difficulty in getting the short former in?—Yes, at times.

1207. What was done then?—The shell is taken to the rectifying room, and rimed out.

1208. Did they ever bring the rectifiying tool to the shop and do it in the filling house?—I have seen that done.

1209. What tool did they use for that purpose?—A rimer, which would be obtained from the store.

1210. Have you ever been sent to get it?—No.

1211. Could a man always take a tool from the store without asking?—Yes, anybody could get a tool and take it back without it being known.

1212. When a former was left in to be taken out in the morning, was any report made of it?—No, the overlooker would not tell the foreman about it.

1213. (*President.*) When the former was left in at night, what was done with the shell?—It would be covered up with bags, or in some other way, so that the foreman should not see it.

1214. (*Lieut.-Col. Hadden.*) Have you known the formers unscrew?—Yes, I have seen the bell come right off, and in that case we got another head.

1215. Did you ever use the tongs for extracting the former?—Yes.

1216. Did you ever know any difficulty in getting the plugs in in the morning?—Yes, they used to stick up at times, and then we forced them down with a key.

1217. Was that in the filling room?—Yes.

1218. Is that the iron General Service key, or the little key for plugs?—It was a metal key.

1219. (*Captain Thomson.*) Have you seen an ignition take place in any of the buildings, or heard any report?—No.

The witness then withdrew.

Mr. William Edwards.

Mr. William Edwards (Foreman) examined (second time).

1220. (*President.*) Have you any further instructions respecting the working of the factory?—There are the instructions which are posted up in the filling rooms.

1221. You have no printed instructions as to the management of the buildings?—No.

1222. When was the last occasion that men were kept late to attend to the melting chambers or filling chambers?—We have not kept any men back for that purpose since June 1901.

1223. Do you keep a daily record of the shell filled?—We keep a record of the filling in a rough book. That is kept by the overlooker, but no official record is kept.

1224. Supposing so many shell are put into one of the filling chambers on one day, what means have you of knowing when those same shell are removed from that filling house?—We have no means.

1225. So that it is quite possible to leave shell there for some days without your knowledge?—Yes, unless a shell had been put out of its proper order or in some way was set on one side, in which case I should be sure to notice it as I passed through, and would ask the reason.

1226. As far as you know, there was no bad feeling at all amongst the men in the Lyddite Factory?—No, I think the men in that factory were rather more sociable than others.

1227. Have you ever had to complain of the way in which Burns did his work?—No.

1228. Was he in the habit of losing time in the morning?—I feel sure I can say off-hand that he is a good time-keeper.

1229. Can you say why he should have missed that particular morning on which the accident occurred?—I can only give his own reason, that he over-slept himself, being accustomed to come in at 8 o'clock.

1230. (*Lieut.-Col Hadden.*) Does the log-book contain a record of everything that is put into the oven?—It does not contain a record of the shell placed in it.

1231. So that it is useless as a record of what is in the oven?—With regard to the shell, certainly.

1232. You have no record at all of the shell put in?—None whatever.

1233. It is the foreman's duty to visit all the shops on closing?—In this particular establishment the foreman, Mr. McCarthy, did not do that duty as he was

allowed to leave a few minutes earlier, but another man, Cowell, was detailed to do it.

1234. Is it his duty, by inspection, to see that everything is correct?—That would hardly be possible for one man to do. He is assisted by certain overlookers who go round and try the doors, and he is left in charge of the factory to see it carried out.

1235. Who opens the shops in the morning?—Mr. McCarthy is present then, but each shop is opened by the leading hand in charge of the shop to be opened.

1236. Then none of the workmen go into the shops until the leading hand is there?—No, not in any case.

1237. Are there any instructions for the work in any particular shop?—Not exactly for the procedure of the work. There are instructions put up as to the amount of acid allowed in the sifting shops for instance, and there is a certain method adopted for the two men to carry out, but there are no printed instructions.

1238. There are no instructions put up in the shops other than the Instructions for the Guidance of Overlookers, No. 185, and the General Regulations for Danger Buildings?—That is so.

1239. The General Instructions are posted in every shop?—Yes.

Mr. William Edwards.

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1240. (*Major Nathan.*) Are these instructions ever read to the men and explained to them?—Yes, the General Regulations are read to every man every Monday morning.

1241. Are the Instructions, No. 185, for instance, ever read?—No, that would not be read. The General Regulations are the only regulations read out to the men.

1242. (*Lieut.-Col. Hadden.*) Is any work supposed to be disallowed that is not shown on here?—Certainly.

1243. I see there is nothing mentioned here about putting plugs in after filling?—It is an omission if it is not there.

1244. There is nothing mentioned about using the spanners on the formers?—No, but it is known by everyone that the spanner has been approved and recognised.

1245. But we have no guide as to what they may do. They may do other things to the shell besides what is contained in these directions?—That is so.

1246. So that the directions do not limit what they may do to the shell?—No.

The witness then withdrew.

Mr. William Wood (Labourer) examined (third time).

Mr. William Wood.

1247. (*President.*) You were asked whether you found any powdered lyddite in the shell before you began to work on them, and the answer you gave was in the affirmative. Can you explain that?—There has sometimes been a little loose stuff at the bottom which has been caused through probing them, before they came to my shop, to see if they were set at the bottom.

1248. When we examined some of the shell a few days ago, which you said had not been touched in the rectifying room, we found powdered lyddite in them. How can you account for that?—I cannot say for certain whether or not a man would take the tap while he was waiting, and commence tapping in order to give himself a job.

1249. But you told us that no work had been done on those shell that morning?—I am not sure of that.

1250. Then you cannot say whether those shell had been tapped?—No.

1251. It was perfectly clear they had been tapped, but it was not clear that this had been done in the rectifying room?—They could not have been done anywhere else.

1252. Why not?—They would have no tools in the other shop, but, of course, there are other tools in the store.

1253. Have you ever known shell brought to the rectifying room to be tapped in order that a short former could be inserted?—Yes.

1254. (*Lieut.-Col. Hadden.*) What nature of shell was brought over?—I do not remember one in particular.

1255. Did Marshall say anything to you when he brought the shell over?—Nothing about the work, only a little chaff.

1256. What was the chaff about?—About not being able to remove the shell from the barrow.

The witness then withdrew.

Mr. A. Burns (Leading Hand) examined (third time).

Mr. A. Burns.

1257. (*President.*) You said on a previous occasion that you gauged the shell in the morning; did it often happen that you gauged the shell at that time? If everything was right the night before, why should you have gauged them the next morning?—We gauged them for our own satisfaction. We usually gauged them in the morning.

1258. In the report of the inquest you are reported to have said that you know the men who were killed, and were chummy with them. Is this correct, as you told us you did not know whether any of them were interested in the walking race?—As regards what I said about being chummy with them, I meant on account of working with them, that is all.

1259. Knowing the men in that way, and seeing, as is evident from the evidence we have had, that they were all interested in the walking race, can you describe yourself as a chum to these men when you say that you did not know they were interested or taking any part in the race?—I only referred to my associations with them while at work.

1260. Have you ever seen a former removed from a shell in the morning?—No.

1261. We have very clear evidence that you have seen them removed then?—I have never seen one.

1262. You are quite sure of that?—Quite sure.

1263. The evidence we have received to the contrary is not true?—I cannot say about other evidence, the thing has not been done under my supervision.

1264. (*Captain Thomson.*) You have never heard of it being done elsewhere?—No.

1265. As far as your knowledge goes, whenever the former is left in the shell over night, the shell is put into the oven in the morning?—Yes.

1266. When was the last time that you know a shell went into the oven?—I hear there was one from the other chamber on the Tuesday before the accident.

1267. That was a case of a broken former; when was the time before that?—It is months since I had one. The one I had then was in No. 3 chamber.

1268. Have you known of one from other chambers?—No.

1269. Can you remember a distinct case of a shell with an unbroken former, merely a fixed former, being put into the oven?—I cannot say I can.

1270. They are not, as a rule, put in?—They would be if the former could not possibly be moved over night.

1271. (*Lieut.-Col. Hadden.*) How long have you been leading hand in the filling house?—Seven years.

1272. During that time have you always been present in the morning?—Yes, except on days when I have lost time.

1273. If during that time any formers had been extracted in the morning which had been left in over night, you would have known about it?—Yes.

Mr. A. Burns.

4 July 1903.

1274. If anybody said that such had been done, and that you were there at the time and saw it, it is untrue?—Yes, I deny that. It has not been done in my building, but I cannot say what has been done elsewhere. All I can say is that the fixed formers which could not be extracted over night were removed in the morning after they had been put in the oven.

1275. All the evidence we have had to the effect that formers have been removed in the morning in your presence is false?—Yes.

1276. You cannot give us an instance of a former being jammed in a 9·2-inch or a 10-inch shell that could not be taken out?—No, it has never occurred.

1277. Have you ever used the tongs to take a former out in the filling house?—No.

1278. What tool did you use for extracting a broken former?—The tongs.

1279. How do they insert the plugs in the shell?—By hand.

1280. Have you ever seen them use a key to insert the plug after filling?—Yes, sometimes.

1281. How long ago was the last occasion?—Three years.

1282. You have never seen a key used since?—No.

1283. So that if we have good evidence that keys have been used since, that is also false?—They have not been used recently.

1284. You say that the shells are always all plugged before any are taken away?—Yes.

1285. So that if we have evidence that shells are taken away while the others are being plugged, that again is false?—Yes.

The witness then withdrew.

Royal Arsenal, Woolwich.

Friday, 10th July 1903.

PRESENT:

REAR-ADMIRAL A. A. CHASE PARR (PRESIDENT).

Lieut.-Col. C. F. HADDEN, C.B., R.A.

Captain J. G. M. WATSON, R.A., *Secretary.*

Mr. William Murphy

10 July 1903.

Mr. WILLIAM MURPHY (Danger Building Visitor) examined.

1286. (*President.*) How long have you been occupied in the danger buildings?—Twelve months.

1287. What are your duties?—My duties are to go right through the danger buildings to see that no irregularities go on, and to see that the regulations are carried out.

1288. Which buildings are in your special department?—There are eight danger building establishments, and these are divided for us by the Danger Building Officer into two groups of four each, and are visited by me on alternate days, the other visitor visiting in the same way.

1289. So that the lyddite filling buildings come into your department on alternate days?—Yes.

1290. At what times do you visit these buildings?—At irregular times.

1291. What is the time that you enter the danger area?—At times at 6 in the morning to see the melting chamber, and at other times at 8 to see the searching done.

1292. The work in the lyddite buildings commences at 6?—Yes, that is the time the melting chamber starts, in order that the acid may be ready for the men to start work at 8.

1293. How often do you enter at 6?—Once a week, sometimes twice.

1294. How long do you spend in each building as you go round?—The whole place takes about half-an-hour.

1295. And you visit them two or three times a day?—Yes, two at least.

1296. Three times a day would take one and-a-half hours?—Yes.

1297. How is the rest of your time employed?—In visiting the other places on the beat. There are three other places. One set of buildings takes half-an-hour.

1298. So that the whole of your time is employed in going round the different buildings?—Yes.

1299. If any difficulty were experienced in any of the buildings, would it be the duty of the overlooker to report to you?—No, he would report to the foreman in charge.

1300. So that you would not be told of any difficulties that might occur?—No, on the contrary, that would be kept from me.

1301. Do you vary your beat considerably, or do you make the same round each time?—The intention is to vary it, so that the men would not know at what hour the visit would be made.

1302. Is there any private system of informing the men in the different shops when you are likely to be coming?—As a matter of fact, they can pretty well tell before I get to the shifting house, and therefore they are on the alert. This is the same when the Danger Building Officer makes his visit.

1303. Have you had occasion to report any irregularities that you have seen?—Not in the lyddite department.

1304. Have you noticed any difficulties in extracting formers or anything of that sort?—No.

1305. (*Lieut.-Col. Hadden.*) Have you ever been in the filling room the first thing in the morning, at 8 o'clock?—Yes.

1306. Have you seen them plugging the shell?—Yes.

1307. What were the other men doing while those who were plugging the shell were so engaged?—They remove the plugged shell to the door.

1308. So that while some of them are plugging, the others are removing the shell?—Yes.

1309. How do you know the work is correctly carried out?—We have printed instructions in each shop where the operations are carried on.

1310. Do you refer to the Instructions for the Guidance of Overlookers, No. 185.?—Yes.

1311. There is nothing in those instructions about the plugging of shell in the filling house?—No.

1312. Have you ever seen them using the spanners on the formers in the shell?—No, never.

1313. Have you ever seen them using the tongs for removing the broken formers?—No, I have never seen them being used, nor have I seen a broken former in a shell.

1314. The instructions to overlookers are the only instructions you have?—Yes.

1315. If you saw them doing anything that was not included in them, you would draw attention to it?—Most decidedly.

1316. (*President.*) Do you know of anything, from your own observation, which has happened which could at all account for the explosion?—No. I cannot account for it.

Mr William Murphy.

10 July 1903.

1317. There is nothing in the instructions to say whether the shell are to be removed while the plugging is going on, so that if you saw them taking shell away while they were plugging the other shell, you would not say anything to them?—No.

The witness then withdrew.

Mr. Edwin C. Coombs (Danger Building Visitor) examined.

Mr. Edwin C. Coombs.

1318. (*President.*) How long have you been employed in connection with the danger buildings?—Two years last January.

1319. What are your duties?—To see the general regulations are carried out as to the searching of the men and the use of the tools in the various operations and to bring to the notice of the Danger Building Officer anything which I think might require his consideration.

1320. What are the regulations that you go by?—The Instructions for the Guidance of Overlookers, and General Regulations, No. 64.

1321. With regard to the operations conducted in the buildings have you anything further than the instructions to overlookers to guide you?—No, those instructions are posted up in the various shops, and we refer to them and see they are followed.

1322. How many times do you visit the separate buildings?—The whole of the buildings are divided up for us into two groups, and the other visitor and I take the different groups on alternate days, visiting each group once a day at least, generally twice.

1323. What time do you spend in a building?—Sometimes a minute, at other times 10 minutes, while there are times when I merely pass through.

1324. What is the earliest time of the day that you pay a visit to the filling chambers?—About 6 o'clock in the morning, soon after they start work in order to see the cans put into the oven.

1325. Have you ever seen them putting a shell into the oven?—Yes, but I have not seen one put in for 18 months now. It is by no means a common occurrence.

1326. Did you ever see a difficulty in removing formers from a shell?—No, I have never seen one taken out.

1327. You have never seen them try to remove them for some time?—No.

1328. Have you ever visited the filling chambers between 5 and 5.30 in the afternoon?—Yes.

1329. Is not that the time when they would be removing the formers?—It never struck me that they had certain times for removing them, and if I saw them left in the shell, I should not have taken any notice of it.

1330. You have never taken any particular notice of the formers in any shape or form?—No, except to notice them steadily turning them.

1331. Have you ever seen them putting the plugs into the shell?—Yes.

1332. How do they do it?—I have seen one man with a handful of plugs putting them into the shell, while the others have been wiping the sockets with a sponge cloth.

1333. (*Lieut.-Col. Hadden.*) How do you know what are the proper tools to be used in a building?—There is a list of tools shown in the Instructions for the Guidance of Overlookers, No. 185.

1334. How do you know which are to be used in any particular shop?—I have always taken it they could be used for any operation for which they are intended, and that they could be taken from one shop to another.

1335. That is to say, that if a man was using a tool for its legitimate purpose, say, a rectifying tool in the filling room, you would not object to it?—Yes, I should object to that, as there is a proper rectifying room, and I should see that the shell was removed there.

1336. When you are visiting do you ever go back into a room by way of surprising them?—No, I did it once and there was some complaint about it.

1337. Who objected to it?—The foreman in charge of the Cap and Detonator Factory, Mr. Charlesworth. He thought I was trying to trip the men, and said the men would get frightened if they felt themselves watched in that way. (*See* Appendix X.)

1338. But the whole object of your visit is to see if anything is going wrong?—Yes, but I thought I would not visit in that way, nor so frequently, if it had the tendency to worry or frighten the men at their work.

1339. Did you report this to the Danger Building Officer?—No, this fact was told me by Major Eteson and was the outcome of a report made to him. The cause of the trouble was that the temperature was on the limit, and I visited the factory six or seven times to watch this temperature, and it was reported that I was visiting too frequently.

1340. Did Major Eteson tell you not to visit in that way?—He said if I suspected the men were getting worried that it would be a good thing not to visit so frequently, but to give them a good look up occasionally, but as a matter of fact it is impossible to find anything out unless you do go on them unexpectedly, as it is not possible to go to any of the factories without being seen.

The witness then withdrew.

Royal Arsenal, Woolwich.

Wednesday, 15th July 1903.

PRESENT:

REAR-ADMIRAL A. A. CHASE PARR, (PRESIDENT).

Lieut.-Colonel C. F. HADDEN, C.B., R.A.

Captain J. G. M. Watson, R.A., *Secretary.*

Mr. J. C. AYLAN (Manager) examined.

Mr. J. C. Aylan,

15 July 1903.

1341. (*President.*) What is your position in the Arsenal?—I am Manager of the East Laboratory.

1342. Do the danger buildings come under you?—Yes.

1343. How often do you visit the Lyddite Establishment?—I visit at irregular intervals, say once a week at least.

1344. How long have you been in charge?—I have been in charge of the Lyddite Establishment since the commencement, which is about seven-and a half years.

1345. Have you known of any occasion of a slight explosion or anything of that sort occurring?—There was a slight explosion in 1897 caused by a man dropping a funnel on some others, and there was a case of ignition on the exterior of a shell at Lydd, which subsequently resulted in the alteration of our paint.

1346. Those are the only incidents that have come to your knowledge?—Yes, except also a slight ignition in the flue in cleaning out, but this was when the air circulated, since then the air has been exhausted direct, without return.

1347. Has any defect with the formers, such as a difficulty of withdrawal, &c. come to your knowledge at all?—No specific difficulties have been brought to my knowledge.

1348. When was the present former adopted?—I do not remember the date, but I think we have been using the present former from four to five years.

1349. Why was a change made, and what was the change?—The object of the change was to do away, as far as possible, with the trepanning tool, or having to make room for the exploder by boring out the cavity.

1350. Previously, was the hole for the exploder trepanned out?—Yes.

1351. The present former was adopted to prevent the necessity of that, or to reduce the amount of trepanning?—Yes, and it has done so very considerably.

1352. Have you known of the threads of the bush in the shell becoming choked at all with melted lyddite, thus causing a difficulty in inserting the plugs?—There is always a possibility of a little acid getting into the lower threads, and this necessitates the cleaning of the threads before inserting the plug, but we never looked upon it as a marked difficulty at any time.

1353. Do you think that it was customary to screw the plug right home before the shell was removed to the rectifying house, or only as far home as it could be placed with the thumb and finger?—The latter is the intention.

1354. Was it the intention that the key should be used if it could not be got home in the filling house without?—No, we would have no intention of screwing it home with a tool in the filling house.

1355. Has anything come to your knowledge which would throw any light in any way on the cause of the explosion?—I have spent a great deal of time in following up in every possible way the probable cause, based upon my knowledge of the circumstances and the recognised mode of working, but beyond one hypothetical position there is nothing I can conclude as to the real cause. I must assume that something extraordinary, and very different to what we have experienced before, occurred to bring it about.

1356. (*Lieut.-Col. Hadden.*) You are very particular about having printed instructions for all the operations performed in the danger buildings?—Yes.

1357. What were the instructions governing the filling of lyddite shells?—They come under the Directions for the Guidance of Overlookers, No. 185.

1358. You say that it would be contrary to orders for anyone to use a fuze-key in the filling house for screwing home a plug?—Yes, in the filling house.

1359. Can you show me anything in the directions to overlookers as to how to insert the plugs, or against using the key?—No, I find there is no mention made of the insertion of plugs in the filling house, although I must admit I should have expected to find a paragraph as to where it was to be inserted, and how, but of course, supervision comes in in all these instances to supplement the printed instructions.

1360. So that, as far as those instructions go, the shells might never be plugged at all?—Yes, that is so.

1361. There is a list of tools at the end of the instructions, is there anything limiting those tools to the particular buildings?—They are not so localised in the list.

1362. So far as the instructions go there is nothing against using a rectifier in the filling house?—It does not specifically lay it down here, but of course it would be against all practice and approved common sense to do so. If, however, you take the printed instructions literally, there is nothing in them to prevent that being done.

1363. There is nothing against using any tool in any building?—No, logically you might say so as far as the printed instructions go, but if you carried that line to the end, then it would apply to almost any directions that are drawn up, and thus amplify these beyond their present extent, which would not be desirable.

1364. Supposing a man were to use, we will say a fuze key or rectifier for a fuze hole in the filling house, there is nothing in the instructions against it?—No, not definitely against it, but the tools provided, and which hang up in that particular shop, would not include such a tool.

1365. But the tool could be obtained from the store?—No, except as a breach of discipline, unless with the foreman's permission.

1366. But we have heard of instances of tools which have been taken from the store and used in the filling house?—The tools for use in the filling house are of a certain class, and beyond those tools no one would be justified, except under special circumstances (and those would receive a special sanction), in using a rectifier in the filling house.

1367. Who lays down what tools are actually taken into the filling house?—The foreman would really submit what tools should be used there, and those tools would have the approval of the Superintendent, visiting officers, and myself.

1368. Is that done in writing?—No.

1369. So there is nothing in writing as to what tools are authorised in the filling house, or any other danger building?—Not in writing as far as the Lyddite Establishment is concerned.

1370. Have you known any objection being raised by the foreman to the Danger Building Visitors?—I remember one instance in the Cap and Detonator Factory. The foreman in charge thought the Visitor very injudicious. To say the least he did not appear to realise that he might be doing more harm than good by too frequently interrupting the operator. There was also a case of a man dropping some detonators. A visitor called attention to the fact that a handful of detonators were taken up at one time, but that was outside the mark. On going into the matter I found three or four were being handled at the one time, and that was a safe number considering the nature of detonator the man was working upon. On the whole I cannot say that there has been any friction worth speaking about. When these visitors were first appointed the whole matter was discussed by the Superintendent, Danger Building Officer, and myself, and a perfect understanding was come to between us. I also spoke to my people about the matter, and pointed out that there should not be anyone more anxious than the foreman that things should go right, and that therefore we ought to welcome any help that could be given to obtain the end desired.

1371. Is the Danger Building Visitor in any way under the foreman or you?—No, he is under the Danger Building Officer.

1372. One of the foremen complained that the visitor did not report to him?—Supposing that to have occurred I should say the visitor had done wrong, because he is instructed to draw the attention of the foreman to anything he thinks is contrary to regulations, at the moment, and note the same for report to his officer, if he considers the circumstances to warrant it.

1373. Have you known the Danger Building Visitors find anything of any consequence?—No, not particularly. If there has been anything which has appeared wrong the Danger Building Officer has usually spoken to me about it, and the matter has been then looked into and put right.

The witness then withdrew.

APPENDICES.

APPENDIX I.

GENERAL REGULATIONS FOR DANGER BUILDINGS.

General Regulations.

1. The Foremen or Overlookers, and other responsible persons, are to be at their respective posts before the workmen and boys enter the buildings in which they are to be employed, and they will remain until all the workmen and boys have left the buildings.

2. The platforms are to be kept clean and free from waste material. They are to be swept not less than twice daily, before and after the dinner hour, and they are to be occasionally washed—men will be appointed for this work.

3. Great care is to be taken not to spill any gunpowder or other explosive on the tables or floors.

4. In hot weather the platforms and the floors of such buildings as are not ordered to be kept thoroughly dry are to be kept damp.

5. Everthing is to be in order when the men leave work in the evening.

6. No magazine, workshop, room, or store in which there are any explosive articles is, if unoccupied, to be left unlocked for any time, however short.

7. Every workshop, room, or store, in which workmen or boys are at work on explosive articles will, if practicable, have all the doors unbolted and free to open fully by a push from the inside.

8. During a thunderstorm near to buildings, workmen will withdraw to a safe distance from those containing any explosive articles, covering up the latter.

9. *No accumulation of empty packages, &c. is to be allowed in the buildings, on the platforms, or on the ground in the vicinity of the buildings. Principal foremen, and all concerned, are directed to give special attention to this, and report for Superintendent's information any delay in the removal of the same.*

10. During repairs to a danger building, the same is to be shut off from the clean platform by barriers specially provided for that purpose. All explosives to be removed, and the building is not to be again occupied for work until thoroughly cleaned and examined according to the class of repair executed.

The following, for example, would come under this rule, viz., repairs to roofs, flooring, doors, &c, including platforms, glazing lights, and any operation in which iron or steel tools are used. With regard to glazing of windows or lamps this rule will not apply, but special precautions must be taken to prevent the broken glass entering the building. Special arrangements to be made when electric lamps and connections are under repair.

Persons Employed upon Gunpowder or Explosive Work.

1. Every workman and boy employed upon gunpowder or other explosive work in any part of this department must be clothed in woollen garments while at work. They are to change their outer clothes, viz. coat, waistcoat, trousers, cap, and shoes, and to wear the suits specially provided for them. They must provide their own woollen shirt, and necktie of wool or silk. The outer garments, consisting of jacket, trousers, and cap, and the shoes will be provided by the Department. There must be no pockets in any part of their clothing, and no article is to be brought into the buildings without authority from the Foreman.

2. The change of clothes is to be effected in a shifting-house, where the ordinary clothing will be deposited, and it is strictly forbidden to cross the barrier before the clothing worn on either side is taken off, and on no account should either the private or the departmental clothing be hung on the wrong side of barrier. Five minutes are allowed for changing clothing. The people will be passed out of the shifting-house by an Overlooker.

3. The private clothing in the shifting-house is to be carefully examined by the man in charge during each call (and as soon as possible after the people have changed), and should a lucifer match or any other dangerous article, or any article connected with smoking be found, a report is to be immediately made to the Foreman. The man who discharges this duty will keep the shifting-house clean and properly ventilated; and will also have charge of the clothes when they are deposited in the building. He will see that no pockets are added to the clothing supplied by the Department.

4. Should any person inadvertently bring a lucifer match or any other dangerous article into the shifting-house, he should, before changing his clothing, deliver the same up to the man in charge of shifting-house, who is to immediately report the same to the foreman.

5. The foregoing is to be read in conjunction with Directions, No. 64, "General Regulations for Danger Buildings."

Visitors and Persons NOT *Employed upon Explosive Work.*

1. No one unconnected with the work is to be allowed to enter or pass through without special permission from the Superintendent of the Royal Laboratory.

2. All persons must, on entering these establishments, put on magazine shoes. All *workmen* not changing their clothes shall be searched for pipes, lucifer matches, and such like articles; their pockets being turned inside out. The attendant will ask all other persons whether they are in possession of lucifer matches or similar articles; if so, they must be given up before entering, and will be returned when leaving.

3. Persons wearing magazine shoes are strictly forbidden to step off the platforms. Ordinary boots or shoes are never, on any account, to be used or placed on the floors or platforms, where magazine shoes are ordered to be worn, and *vice versâ*, magazines shoes are never to be used where ordinary boots or shoes are allowed.

4. Whenever the loose bar of a barrier is removed to allow a truck to pass, it is to be immediately replaced.

Officers.

It is absolutely necessary that Officers, whether in uniform or not, should comply with these regulations.

By Order of
Royal Laboratory, Woolwich, 29th September 1899. The SUPERINTENDENT.

APPENDIX II.

DUTIES OF ASSISTANT SUPERINTENDENT AND DANGER BUILDING OFFICERS, IN CONNECTION WITH THOSE DANGER BUILDINGS WITH WHICH THEY ARE SPECIALLY CHARGED.

1. He will watch with the utmost care that work is carried on with the most scrupulous regard for the safety of all concerned, that the rules in existence are obeyed, and that steps are taken to bring to notice for alteration all such rules as may seem to him to have become obsolete or inefficient.

2. He will submit for Superintendent's approval all special Instructions, Directions for Overlookers, limits, &c., and he will not sanction any change in the same involving an *increase* of explosive or man limits without approval, except in cases of extreme urgency, when he may grant temporary increases, reporting immediately to Superintendent. He may, and should, however, reduce limits when found practicable.

3. He will visit every Danger Building under his charge as frequently as possible, but never less than once a week.

4. He will receive the weekly reports from Danger Building Visitors for the buildings under his charge.

5. He will personally satisfy himself, by inspecting them, that the arrangements for carrying out any experimental or dangerous work are the best possible as regards safety of the men employed on the work, and should refer to the Superintendent in any case of doubt.

6. He will inspect and pass as "clean" any building which has been under repair, or any new building, before it is taken into use for explosive work, signing the book kept by the Foreman for the purpose.

7. He will submit a report every Monday as to the performance of his duties.

In addition to the above, when on Duty in general Connection with the Danger Buildings.

8. He will not go, without leave, more than 1½ miles from the Main Gate (leaving his address with the Police), so long as any danger building, whether in his special charge or not, is at work.

9. He will visit, between 1 a.m. and 5 a.m., once during his tour of duty any Danger Building working night-shift.

10. He will add to his ordinary report, as at (7), a further statement as to his performance of the duties in (8) and (9).

NOTE.—He may exchange duties with another Officer without reference to the Superintendent, but will be responsible that such change has been notified to all concerned.

The tour of duty is one week, commencing at 8 a.m. on Monday.

(Signed) H. W. BARLOW,
Major, R.A.,
Superintendent,
28th April 1903. Royal Laboratory.

APPENDIX III.

RULES FOR DANGER BUILDING VISITORS.

They will be under Danger Building Officers, to whom they will report, and from whom they will receive instructions.

It is necessary that they should exercise their duties with tact and discretion; recollecting that the different Foremen are responsible for their charges, but, at the same time, recollecting that great strictness is necessary.

1. They are constantly to visit all Danger Buildings at which work is proceeding, at uncertain periods, to ascertain:—

(*a.*) That the work is being carried on in a satisfactory manner, and in strict accordance with the General and Special Rules and Regulations.

(*b.*) That the "limits" laid down for the amount of explosives, and the number of workmen, are being strictly adhered to.

(*c.*) That all the workmen are correctly dressed.

2. That the regulations as to shifting-houses and searching of people are thoroughly carried out.

3. They are occasionally to visit and examine all Danger Buildings, Houses, and shops not in actual use.

4. They are to check and examine the tools and implements in Buildings, and to see that no other than those authorised are in use.

5. They are also authorised to enquire the business of, and to search for matches and other combustibles, and pipes, all persons they may meet on their rounds who are not under the Foreman of Danger Buildings.

6. They will bring to the notice of Danger Building Officers any matter connected with buildings, appliances, fittings and lighting, which should be thought to require consideration or attention.

7. They will pay attention to the various fire-extinguishing appliances, and to the artificial lighting, and method of using same.

8. A diary will be kept in each Establishment, in which they will record the hour of their visit; and the fact of whether any report was necessary.

9. They will render a weekly report to Danger Building Officers on prescribed form.

10. They will specially, and at the moment, report, by telephone if necessary, to Danger Building Officers any unusual occurrence, and further bring to their notice any matter which they consider requires attention, either as regards buildings, appliances, &c.

11. In the case of any matter of discipline, or mode of work, &c., the Visitor will draw the *Foreman's personal* attention to it, and not give any instructions to workmen. This will in no way cancel his instructions of further reporting the matter to the Danger Building Officer, *vide* paragraphs 9 and 10.

12. They will be in possession of a complete set of the different regulations and instructions, corrected to date, and will keep permanent note of instructions given to them.

(Signed) H. ETESON,
Major, R.A.,
Assistant Superintendent R.L.
2nd January 1901.

APPENDIX IV.

DIRECTIONS FOR THE GUIDANCE OF OVERLOOKERS, No. 64.

General Regulations for Danger Buildings.

1. Men and boys employed in this factory must take off their outer clothes, viz.: coat, waistcoat, trousers, cap, and shoes, and they must provide themselves with woollen shirts and neckties of wool or silk.

2. The outer clothes taken off will be replaced by those supplied by the Department, and no pockets are allowed to be in, or to be attached to, the Departmental clothing, which is to be put on only after crossing the barrier. The jackets must be worn buttoned up, and trousers must not be worn turned up at the bottoms. Braces are provided for use with the Departmental clothing, and no waist straps or braces with buckles are allowed.

3. All clothing must be washed at least once in six months, and oftener if it requires it. Clothing must be kept clean.

4. No articles whatever are to be taken to the Danger Buildings without authority from the Foreman.

5. The change of clothes is to be effected in a shifting-house, where the ordinary clothing will be deposited, and it is strictly forbidden to cross the barrier before the clothing worn on either side is taken off, and on no account should either the private or the Departmental clothing be hung on the wrong side of the barrier. Men and boys will be searched after taking off their own clothes before passing the barrier to put on the Departmental clothing. Five minutes are allowed for changing clothing.

6. Men and boys must be out of the shifting-house as soon as possible after changing their clothes.

7. The Overlookers and man in charge of shifting-house will report to the foreman any misconduct or breach of regulations on the part of either men or boys.

8 The Overlookers are to admit the people to the different workshops under their respective charges, and they will be held responsible that every man and

boy employed under them is correctly clothed, and that no unauthorised article is brought into the shop.

9. Before commencing work the Overlooker in charge of the shop is to see that every door is unbolted and unlocked, and that each door is able to be freely and fully opened, and the removed bolts properly hung up.

10. The clothing in the shifting-house is to be carefully examined by the man in charge between each call, and as soon as possible after the people have changed, and should a lucifer match or any other dangerous article, or any article connected with smoking be found, a report is to be immediately made to the Foreman.

11. The man in charge of shifting-house will examine all workmen entering the Factory to repair buildings, plant, or for other purposes not connected with the manufacture. These men, as a rule, will not be required to change their clothing, but they must fully show the contents of their pockets; they must put overshoes on over their own, and if working for any considerable time on clean platforms, must change their own shoes for magazine shoes. These people are only to be allowed to enter the buildings in which they are employed. Overshoes are not to be further used if the stiffening at back has given way. Neither these nor magazine shoes are to be worn unless in reasonably good order.

12. During repairs to a Danger Building, the same is to be shut off from the "clean" platform. All explosives to be removed, and the building is not to be again occupied for work until thoroughly cleaned and examined according to the class of repair executed.

13. Men and boys are strictly cautioned against racing or sliding on the platforms, or playing in any way in the buildings or on the platforms. Overlookers are to report to the Foreman any person violating this order.

14. Persons using trucks on the platforms are to keep them under control, and under no circumstance are they to be moved faster than at a quick walk.

15. Doors and windows of Danger Buildings and covered porches attached, are to be closed when the difference between the wet and the dry bulb thermometer does not exceed 5°. During thunderstorms the people are to be sent to non-danger buildings, and all magazines and Danger Buildings are to be locked.

16. Should the platforms become slippery during frosty weather, they are to be covered with sawdust, care being taken that the sawdust is free from earthy or gritty matter before being placed on the platform.

17. The platforms are to be swept at least twice daily and washed once a week; the men employed are also to erect barriers where it is necessary to carry bricks, earth, or any other gritty matter over platforms for repairs to buildings, &c.

18. The buildings are to be washed out once a week, with the exception of those used for time fuze work, magazines, and drying houses; these are to be washed out as frequently as possible, but only with the sanction and under the directions of the Foreman in charge. All parts of buildings or fittings where dust can lodge are to be carefully swept at least twice a week.

19 The throwing of paper, or any article whatever, about the grass or platforms is strictly forbidden, and all persons are to avoid spitting on to the platforms or floors of buildings.

20. Strict attention is to be observed in reference to fire buckets and hand engines, that they are not removed from the positions assigned to them, or used for any other purpose.

21. All breakages in electric or gas lamps, or windows, are to be immediately reported to the Foreman by the Overlooker in charge; also any concentration of the sun's rays by passing through electric lamps, or defective windows, is to be reported.

22. Workmen are not allowed to take their meals in the workshops. The Overlooker in charge will see that the buildings are safely locked, and the keys deposited in the proper place.

23. Should the Factory require to be opened at any time beyond the ordinary working hours for repairs, &c., a man must always be appointed to see that the regulations are strictly adhered to.

24. The lights are not to be turned out at any building until the Overlooker in charge has seen that every other person has left the building, and that all is correct.

25. To prevent any persons being left in the buildings after the place is closed, the men in charge of shifting-houses are to see that no private clothing is left remaining. Should such be found, he is at once to report the same to his Foreman, who will take immediate steps to find the person to whom such clothing belongs.

26. The larger notice of General Regulations for Magazines, Cartridge, and Composition Establishments, is to be read in conjunction with the foregoing, and in the case of new hands being entered for work, they are to be personally instructed in the foregoing by the Foreman in charge.

By Order of
Royal Laboratory, Woolwich, The SUPERINTENDENT,
16th July 1902.

APPENDIX V.

DIRECTIONS FOR THE GUIDANCE OF OVERLOOKERS, No. 185.

Sifting Picric Acid, Filling Shells with Lyddite, inserting Exploders, Fuzes, &c.

Each overlooker will be held responsible for the whole of the operations carried on under his supervision.

1. When shells are received for the purpose of being filled, before being taken to the filling building they are to be brushed on the outside to free them from any grit, the fuze-hole plugs removed and cleaned, the bush and recess cleaned, and the interior thoroughly searched to ascertain if dry, clean, and varnished. An electric searchlight must be used for the latter operation.

2. All shells are to be gauged, and, if necessary, returned to be rectified, examined, and fitted with plugs before they are removed to the filling building.

3. The shells will then be removed to the building for filling, set out in rows, plugs removed, fitted with canvas jackets and metal trays (for protection against splashes of melted picric acid). A metal socket is then to be screwed into the fuze-hole. A metal funnel is to be inserted in the metal socket for shells above 4-inch, and a metal former in socket for 4-inch shells.

4. All sockets, funnels, and formers must be fitted to the shell before filling, to ensure that they work without undue friction. The top of socket is to be protected by one or more asbestos washers when inserting the funnel or former.

4*a*. Great care must be taken in examining formers, to detect roughness in the surface which will cause the former to be very difficult to turn in the lyddite. Emery paper, if necessary, should be lightly used to smoothen formers, so as not to reduce the diameter; this is to be done in the tool store only, and all tools upon which emery paper has been used must be thoroughly washed before being taken into use. All tools must be frequently examined to detect any cavities which may be formed in the surface, tools with the same being put on one side. All cans must be examined daily for pin holes and thinning of the metal.

5. The picric acid is to be brought to the Lyddite Establishment by the Royal Arsenal Railway in quantities, as required, and must be at once deposited in the magazine. All packages must be brushed and examined before they are taken into the magazine. The picric acid must be brought from the magazine in powder cases or powder barrels, as required.

Sifting.

6. Only picric acid which is in accordance with Specification No. $\frac{P}{92}$, and has been passed by P.O., to

be used. It must be sifted through a 10-mesh sieve before being used. In sifting, the sieve must be suspended above a wood hopper, through which the acid is to be discharged into a barrel. The hopper is provided with a papier mâché cover. The residue must be removed from the sieve, very carefully examined, and any foreign matter removed. The coarser grains of acid may be used and will be placed with the acid which has passed through the sieve. The greatest care must be exercised in carrying out the above operations. Any discoloration or unusual appearance or odour of the acid, or appearance of foreign matter, is to be immediately reported and the operation stopped.

7. Not more than 150 lb. of picric acid must be in the sifting-room at any one time.

8. When sifted, the acid, contained in a powder barrel, is to be removed to a store building and transferred from the barrel into metal cans, containing about 30 lb. each. It is then ready for melting. The cans are provided with a papier mâché cover lined with asbestos during transit of the acid to the melting chamber. Not more than 1,500 lb. of acid is allowed in this building at any one time.

Melting.

9. The cans containing the acid are removed to the melting chambers, not more than 1,500 lb. at any one time, placed in the chambers on metal stands (which are to be protected with a covering of asbestos), and the covers of the cans removed. The doors of the chambers are to be securely closed, and the temperature then raised to keep as near as possible to, but not to exceed, 290° F., and maintained at that temperature until the acid is quite melted. The temperature is regulated in the "Observation Room" above the chambers, and is indicated by thermometers which reach the level of the cans in the chambers below. The temperature is also to be checked by maximum thermometers every few hours. A log will be kept for recording all observations of temperature three times daily.

10. During the time the melting operation is in progress, the chamber doors must not be opened unless the person in charge is present, or someone appointed by him. The acid, while melting, is to be watched from the "Observation Room," and should anything unusual be observed, the heat inlet doors of chamber are to be at once closed, and the Foreman's attention immediately drawn to the same.

11. When the acid is melted, known by its appearance and testing with a copper rod, the cans containing the same, before removal from the chamber, must be carefully covered up and carried by hand to the filling building, as required.

12. In removing the melted acid from the chambers, the cans on the stand nearest chamber door are to be removed first. When the stand is empty it must be removed from the chamber before taking any acid from the next stand. Great care is to be taken in removing the stands from the chamber to prevent them touching the walls or doors. On no account whatever may any person make use of a metal stand by standing up on it to remove melted acid from a chamber.

Filling.

13. *For shells above 4-inch.*—The melted acid is to be poured from the cans into the shells through the metal funnel until it reaches a height of about 2 inches below the bottom of the bush of the shell. The height is to be ascertained by means of a copper-wire gauge.

14. The filling funnel is then to be withdrawn and the "former" (which is itself fitted with a small supplementary funnel) inserted through the metal socket, and frequently turned round to keep it from becoming set in the lyddite as the latter solidifies.

15. When the shrinking of the lyddite, which is known by the "former" holding slightly in the shell, has ceased, the filling of the latter must be completed through the "former," the melted acid being allowed to come up into the funnel of same. The "former" is to be frequently turned round until the lyddite has solidified and the recess for the exploder is formed. The time taken to solidify varies with the size of shell and the surrounding temperature. The "former" will then be withdrawn. Gloves must be worn when turning formers or handling shell containing molten lyddite.

16. *For 4-inch shells.*—The melted acid is to be poured into the "former," allowing it to come up into the funnel, and proceed as in paragraph 15.

17. If, on examination after the "former" is withdrawn from the shell, it is found that the shell is not quite filled up to the bush, a short metal "former" fitted with a funnel is to be inserted, and the filling completed through this. The filled shell will then be allowed to stand and cool for as long as possible, before being removed to the rectifying room.

18. The quantity of lyddite in filled shells in the filling building at any one time must not exceed 1,500 lb.

19. In removing funnels, "formers," and sockets, care must be taken that no unnecessary force is used. Should the "former" become fixed, the shell must be placed in a melting chamber for such a time as will enable the "former" to be easily removed. The shell will then be removed to the filling chamber and the "former" withdrawn. This must be done under the personal supervision of the person in charge.

Gauging Cavity and Rectifying.

20. The filled shells must next be removed to the rectifying room, and when perfectly cooled, the recess for exploders will be gauged both for depth and diameter, and if necessary, rectified.

21. The thread in bush of shell must then be carefully cleared of lyddite by screwing in a metal tap, and afterwards carefully wiped out with a piece of silk cloth or serge cutting not previously used for any other cleaning purpose.

22. When gauging recess, the depth gauge must be inserted first, and if the recess be not deep enough the trepanning tool must be introduced, and the lyddite cut to the required depth. To remove this a wood rod is placed in the trepanning tool, the loose lyddite pressed into a pellet within it, and the tool afterwards withdrawn. If the recess be too deep so much crushed lyddite is to be put in as will bring the recess to the correct depth, the crushed lyddite to be pressed firmly down by a metal rod.

23. After correct depth of recess has been obtained, the diameter gauge must be inserted to ascertain if the recess is correct to diameter. The recess, if necessary, will be rectified by inserting a metal rimer and turning it round several times gently to clear the recess of any small projections of lyddite which may remain on the walls after the removal of the "former." All shells not actually under operation are to have their plugs inserted.

24. The quantity of lyddite in filled shells in this building at any one time must not exceed 2250 lb.

Inserting Exploders and Primers.

25. After being rectified, the shells must have, (*a*) an exploder in shalloon bag; or (*b*) an exploder and primer ½ oz. R.F.G.[2] each in separate shalloon bag, and both contained in a waterproofed paper cylinder; or (*c*) an exploder in shalloon bag in waterproofed paper cylinder, inserted in recess already formed, as may be necessary; (*a*) is inserted choked end first, (*b*) and (*c*) are placed in recess tapered end first. The filled exploders and primers must be kept in a covered box or case, and removed only one at a time, as required for insertion in the shell. The quantity of explosives in made-up exploders and primers must not exceed: picric powder 16 lb., gunpowder R.F.G.[2] 5 lb.

Plugging and Fuzing.

26. After the exploder is inserted, the shell is to be taken to a separate building or compartment, to be plugged or fuzed, as may be required.

27. Before inserting the plug or fuze, special care must be taken that sufficient space is left for fuze or plug as necessary. This is ascertained by inserting wood gauge (without compression) into the fuze hole; the fuze hole and recess must be free from picric powder or lyddite dust, and perfectly clean. The leather washer must be lubricated. The threads of plug or fuze must be lubricated with Mark III. luting, thinned, care being taken that it does not extend over the bottom. To ensure this the bottom of the fuze or plug must be wiped clean on a piece of silk cloth or serge cutting. The plug or fuze must be screwed home firmly into the shell by the G.S. key, so as to ensure that the leather washer under the flange of plug makes

a watertight joint. The Mark II. plug F.H. special, must be further secured by three indents, made by stabbing with a centre punch and wood mallet, the lip of flange of plug into the top of recess of fuze hole, care being taken that the stabbing is just sufficient to prevent the plug turning in transit. The plug or fuze must not be removed subsequently while its shell is on the premises, except in the Fuzing Room, and then only when required for inspection by I.L.S.

28. Not more than two filled shells and 20 fuzes are to be allowed in the building or compartment at one time, the fuzes to be kept in a wood box with leather cover.

Securing Kit Plaister.

29. All shells filled with lyddite (except those fitted with Mark II. plugs F. H. special for Land Service) must be fitted with kitted plaister, large for shells 9-inch and upwards, and small for shells below 9-inch. This must be done in a separate building, and the shells fitted with a canvas jacket to prevent the kit composition running over the sides of shell. The composition must be broken into small pieces and put into a copper heated by steam, to melt. When melted, the patch held by the braid loops, is immersed into the hot liquid until completely saturated, then placed on nose of shell as quickly as possible, and pressed down by hand until it is firmly secured to the shell, sawdust being used to prevent the kit sticking to the operator's hands. Any kit composition which, while hot, may have run off the patch on to the shell must, when cooled down, be scraped off with a metal knife.

Painting and Finishing.

30. Fuzed shell must have the kit plaister painted *red;* on plugged shell the plaister is unpainted.

31. Particular care must be taken that the entire exterior of each shell, especially the driving band, is thoroughly cleaned before being issued.

32. The shells must be painted with the special *yellow* paint where necessary; a *red* ring of vermilion to denote "filled" round nose, ½ inch below kit plaister, or 1½ inches below the tip, if the shell is not fitted with kit plaister; then stencilled with monogram of station where filled, date, "with — oz. exploder," with *black* paint. When fuzed, the word "fuzed" is stencilled with *red* paint beneath the red ring. A *red* disc 1 inch diameter following the date, when shell is fitted with a gunpowder primer. If the exploder is contained in a waterproofed paper cylinder, the shell must be stencilled on the back with a rectangular figure, 1 inch wide and 6 inches in length, in *red* paint, and if the exploder be of "dry mixed" picric powder, the letters D.M. must be stencilled inside the rectangle, also in *red* paint. Shells fitted with Mark II. plugs must have a coat of paint of the same colour as the tip of the shell, applied over the junction of the plug and shell.

33. Paint without any admixture of lead, other than sulphate, must be used for shells filled with lyddite, and in all buildings where these shells are treated care must be taken to prevent the formation of rust on iron walls, fittings, &c. Places where rust is forming are to be immediately and freely painted with the special paint.

Packing and Recording.

34. When shells are packed in boxes, the boxes must be stencilled with the nature of contents, gross weight, date, monogram of station, number of package, and must be labelled inside, with packer's name and date and outside, with explosive, group and division labels.

35. In order to ascertain that the weight of lyddite is being kept correct, 10 per cent. of all shells are to be weighed, both before filling and after filling, and rectifying for exploder, is completed. A record of the same is to be kept.

36. A record of the number of shells filled must be kept, by whom examined, filled, exploder inserted, plugged or fuzed, and packed, also the No. of thousand of fuze used.

37. All tools, after use, must be thoroughly cleaned before being taken into use again. Empty cans, funnels, sockets, and trays must be completely immersed in boiling water in which has been dissolved soda crystals (not caustic), and the liquid kept boiling until they are clean. "Formers" are to be placed in metal trays, and have the lyddite melted from them in the melting chambers, the "formers" are removed from the trays, placed in others and allowed to cool before being subjected to boiling process. The lyddite, so obtained, must at once be poured into cans of molten picric acid and used again for filling shells. Lyddite obtained from wire gauges removed by hand is placed in cans, melted, and used again for filling shells. Finally all tools must be rinsed with clean hot water. On no account must any of the tools be scraped with a knife, the wood scraper alone being used where necessary.

38. The impregnated wash-water must be filtered through fine copper-wire gauze, the solid matter will be retained and finally destroyed in accordance with Directions for Overlookers, No. 183, and the filtrate passed into the drain.

39. Refuse, sweepings, &c., must be placed under water and afterwards destroyed with the solid matter mentioned in preceding paragraph.

40. Not less than three buckets filled with water are to be in each building. Floors, tables, &c., to be kept clean.

41. The melting chambers must be swept out and the doors washed once a day, and the whole of the chambers and flues flushed and cleaned once a week, and afterwards carefully examined by the Foreman in charge or the person acting for him. The stove and all joints of same must be most carefully examined for any defect that will allow any fire to pass through.

42. The Foreman, or an Overlooker appointed by him, will give the necessary orders to ensure the regulation of the speed of the fan, and the kind of fire required in stove—coke only.

43. Overlookers or leading hands must on each Monday morning, before commencing work, read to the men in their respective shops Directions for Overlookers, No. 64.

Also Overlookers must, at irregular hours, once each call, make inspections of the various shops under their charge, and search workmen's drawers, boxes, &c., for any forbidden articles.

44. Tools, &c, allowed for use are as follows. (Metal tools may be of gunmetal, bronze, or copper, as convenient):—

Adze, coopers', metal.
Aprons, leather.
Apparatus, sifting picric acid.
Barrows, projectile.
Boxes, wood.
Braces and bits.
Brooms, bass and hair.
Brushes, scrubbing and cleaning.
Brushes, tool.
Cans, metal.
Cases, M.L., special.
Covers, asbestos, for cans.
,, canvas ,,
,, ,, ,, shells.
,, leather, for boxes.
,, papier mâché, for hoppers.
Cushions, leather.
Cuttings, serge or silk cloth.
Drivers, coopers', metal.
Driver, screw, ,,
Formers, metal.
Funnels, metal.
Gauges, iron, shell.
,, metal, depth and diameter of cavity for exploder.
Gauges, metal, ½ oz. primer.
,, wood, ½ oz. primer, plug or fuze.
,, wire.
Gloves, silk cloth, leather, and serge.
Hammers, metal.
,, steel.
Holders, shell, metal.
Hoppers, wood.
Keys, cases, M.L.
,, iron, fuze and plug, G.S.
,, lever, for plugs.
Knives, metal, large and small.
Lights, search, electric.
Mallets, wood.
Mops.
Pincers, shrapnel primers, extracting exploder.
Punches, centre, metal, with steel points.
Pots, paint.
,, grease.
Rimers, metal, rectifying.
Rods, metal.
,, wood.

Scales and weights.
Scissors, metal.
Scoops, copper.
Shovels ,,
Sieves, copper-wire.
Sockets, metal.
Spanners ,,
Stamps, steel.
Stands, metal.
Stencil plates, paper.
Taps, metal, clearing bush.
Thermometers.
Tongs, metal, removing formers.
Trays, metal.
Trepanning tool, metal.
Washers, asbestos.

45. Directions for Overlookers, No. 157, must be observed in unheading barrels received containing picric acid.

All the usual precautions for Danger Buildings must be observed.

By Order of
Royal Laboratory, Woolwich, The SUPERINTENDENT.
17th October 1900.

APPENDIX VI.

DIRECTIONS FOR THE GUIDANCE OF OVERLOOKERS, No. 186.

During Thunderstorms; Lyddite Establishment.

1. On the approach of a thunderstorm the bell at Shifting-house is to be rung, all the Magazines and Danger Buildings will at once be closed, and everyone employed will go to the Shifting-house and remain there until the storm is over (with the exception given in paragraph 5).

2. Should the process of *melting* picric acid be in operation when the bell is rung: before leaving, the person in charge of Observation Room must close the heat-inlet doors of the melting chambers.

3. The stoker is to stop the electric motor driving the fan, and close the dampers and ash-pit door, and fully open the furnace door.

4. Should the process of *filling* with molten acid be in operation, this must be immediately stopped and the acid returned to the chamber.

5. Any shells filled, and which have the "former" inserted, but the cavity for exploder not formed, must be attended to if necessary, during the progress of the storm, to prevent them becoming set in the lyddite. No more persons must be present during this period than are absolutely necessary.

6. The Foreman, or person in charge, will see that the foregoing instructions are strictly carried out in every particular.

By Order of
The SUPERINTENDENT.

Royal Laboratory, Woolwich,
2nd June 1897.

APPENDIX VII.

DIRECTIONS FOR THE GUIDANCE OF OVERLOOKERS, No. 48.

Sweepings from Compositions, &c.

Each Overlooker will be held responsible for the whole of the operations carried on under his supervision.

* * * * *

7. The sweepings and waste picric acid are to be kept in a bucket or barrel containing water, and destroyed in accordance with Directions No. 183.

8. The sweepings and waste picric powder are to be kept in a bucket containing water, and destroyed in the same manner as picric acid.

By Order of
Royal Laboratory, Woolwich, The SUPERINTENDENT.
24th November 1897.

APPENDIX VIII.

GENERAL DIRECTIONS FOR OBSERVANCE IN DANGER BUILDINGS.

Copy of Memorandum issued to Principal Foremen on 25th January 1900.

Please arrange for each "Overlooker" or "Leading Hand" in Danger Buildings to read to the men in his shop, "Directions for Overlookers, No. 64" on first commencing work on Monday mornings.

Having in view the numerous new entries lately, it is considered quite necessary that the above should be done, as there can then be no excuse for any person to say they were not made acquainted with the "*Rules and Regulations.*"

25th January 1900. (Id.) J. C. A.

APPENDIX IX.

MISCELLANEOUS NOTICES.

A.

Any workman employed in Danger Buildings who may discover that he has inadvertently brought a lucifer match or other dangerous article, or any article connected with smoking, into the Arsenal, should immediately deliver it up to his Foreman, or to the man in charge of the shifting-house.

By Order of
Royal Laboratory, Woolwich, The SUPERINTENDENT.
27th May 1898.

B.

Special attention is called to paragraph 2 of General Regulations, dated 12th July 1892, concerning the searching, &c., of "visitors" and "persons" not employed upon gunpowder or composition work. *This Regulation is to be rigidly carried out.*

By Order of
Royal Laboratory, Woolwich, The SUPERINTENDENT.
24th July 1893.

C.

Occasionally the electric lights suddenly fail. At any such time it is strictly directed that every person in the workshop remain stationary, *i.e.*, seated or otherwise. The person authorised will at once make use of the "portable light" provided specially, and await further orders.

By Order of
Royal Laboratory, Woolwich, The SUPERINTENDENT.
29th January 1901.

D.

LYDDITE ESTABLISHMENT.

Explosives Limit.

Building No. 9, Filling House.

The quantity of explosives allowed in this building at any one time is not to exceed the following:—
1,500 lb. (fifteen hundred), including shells filled lyddite.

By Order of
Royal Laboratory, Woolwich. The SUPERINTENDENT.

E.

LYDDITE ESTABLISHMENT.

Building No. 9, Filling Chamber.

The total number of workmen allowed in this building is not to exceed 12 (twelve).

Colonel,
SUPERINTENDENT, R.L.

APPENDIX X.

CAP AND DETONATOR FACTORY.

Diary.

(Visitor, Danger Buildings.)

Remarks entered in above by D.B.V. Coombes, 15th March 1901.

Two workmen in No. 11 Building removing from moulds and brushing detonators, dropping the detonators instead of placing them gently, in the box provided.
No spatula used for stirring composition in pan and overseer states it is sufficient to renew the water.

(Id.) E. C.

18th March 1901.

Action by Foreman.

SIR,

THE box used for depositing the detonators in being 1¾-inch deep, and is opened by the same hand that contains the detonator, with the fingers bent, allows the operator to place the detonator in the pan inside of box. Occasionally one drops, but it cannot do so more than one inch. The men have been cautioned, but the overlookers and men on this work in particular complain that, through being constantly watched, they get very agitated and confused, that their attention is taken off their work, and thereby cannot give their proper attention to it through the extra supervision, and especially in the presence of the inspector (who complains). The same complaint is made by the man engaged in filling fulminate detonators.

With regard to the use of a spatula for stirring the water, this was discontinued some years ago, it being unnecessary seeing the water in the pan is frequently changed.

(Signed) R. CHARLESWORTH.
18th March 1901.

Misc. 246/12.

D.B.V. Report re method of removing Detonators No. 9 from box.

Manager E.L.

Cap and Detonator Factory, No. 3 building.

D.B.V. reports that he saw the overlooker of above removing detonators No. 9 from a box for purpose of repacking in cylinders by handful at a time.

Detonators should be handled with care and one at a time. Please report on above facts. This occurred at 5 p.m. 30th instant. ×|
31st August 1901. (Id.) H. E.

MR. CHARLESWORTH.

PLEASE furnish a separate report as early as possible.
2nd September 1901. (Id.) S. J. M.

SIR,

WITH respect to the attached report regarding the method of handling No. 9 detonators the Overlooker, Leppard, R. No. 12383, who is complained of, has been on this work for 18 or 19 years, and is one of the most careful workers at this factory. He denies handling the detonators in any other than the most careful manner, well knowing the danger and liability to accident. He has packed quite 200,000 detonators at this factory and I have never had occasion to complain. The handful complained of by D.B.V. Coombes consisted of four which the man is in the habit of taking at one time from the box. The greatest of care and supervision is specially given to this nature of work.

I respectfully beg to call your attention to the Rules for Danger Building Visitors, paragraph 11, which states that the foreman's personal attention should be called to any complaint of this nature, and personally I consider this a most frivolous report to make, especially direct to Assistant Superintendent.

D.B.V. Coombes was at this factory quite three hours on the 30th and signed the book three times "*All correct.*"

3rd September 1901, (Sd.) R. CHARLESWORTH.
Assistant Manager,
Composition Establishment.

MR. MORLEY,

I am quite prepared to agree with you, and will so write, but I should like to know your view of × | ; my own is that it depends rather on the nature of detonator referred to, *e.g.*, we would naturally deal with torpedo detonators *one* at a time.

4th September 1901. (Id.) J. C. A.

MR. CHARLESWORTH,
Your early remarks, please.
5th September 1901. (Id.) A. H. G.,
for Assistant Manager.

SIR,
YES, that is so, 38 and 76 grain torpedo detonators are only handled *one* at a time.
5th September 1901. (Id.) R. C.

APPENDIX XI.

EXPERIMENT FOR COURT OF INQUIRY ON LYDDITE EXPLOSION IN THE ROYAL ARSENAL ON THE 18TH JUNE 1903.

War Office Authority, 50/Gen. No. /1181.

Programme.

To be carried out at Shoeburyness. The following stores will be required:—

Shells. B.L., 9-inch common, lyddite, filled	14
Exploders for " " -	3
Tubes, electric - - - -	3
Fuzes to R.L. design, No. 10,690 - -	5
Bags, primer, 7 drams - - -	6
Detonators, electric - - -	3

1. Five shells to be placed on their bases as shown on the sketch, Nos. 2, 3, 4, and 5, to be plugged without exploders.

No. 1 to have a primer, 7 drams, inserted in the cavity, the primer being supported by a wire so as to be about 8 inches below the nose of the shell. The primer to be ignited by means of an electric tube lowered on to it.

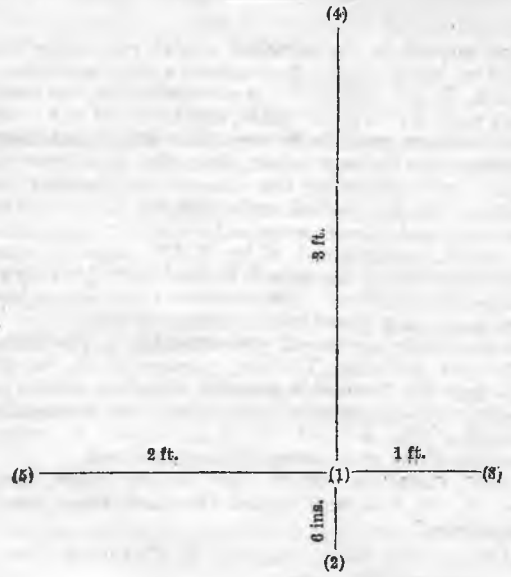
If No. 1 shell merely burns out or explodes without detonating, the experiment to be repeated twice.

2. The shells to be arranged as in (1). No. 1 shell to have a primer as in (1), but to be ignited by means of a fuze to design R.L. No. 10,690, in order to represent the ignition of a plugged shell.

If no detonation takes place, the experiment will be repeated twice.

3. If (1) and (2) fail to detonate No. 1 shell, this will be carried out as follows:—

Shell arranged as in (1). No. 1 shell will have an exploder inserted, and will be detonated by means of an electric detonator in order to ascertain how far the detonation will spread.



8th June 1903. J. G. M. WATSON,
Captain R.A.,
Secretary, Court of Inquiry.

Report of Experiments as carried out.

Rd. 1. Series 1.

Five 9·2-inch B.L. f.s. lyddite common shells, Mark III., filled lyddite, but without exploders, were placed standing on a 9-feet by 9-feet 2-inch target, lying flat on the sands, at about 2,000 yards from the shore, as shown on the sketch attached to programme. Nos. 2, 3, 4, 5 were plugged. In No. 1 shell a 7-dram R.F.G.[2] primer was inserted in the cavity formed for the exploder, supported by a piece of wire so as to be about 8 inches below the nose, and ignited by a V.S. electric "P" tube, Mark VII., resting on the top of the primer.

Result.

The first smoke that appeared was yellow, then a dense cloud of black was visible, mixed with a great deal of yellow, most yellow being in the direction of No. 3 shell. Combining the smoke observations with the appearance of the crater, it is believed that No. 1 shell detonated partially, No. 2 detonated completely, and No. 3 was broken up by fragments from Nos. 1 and 2. The head of No. 3 shell was recovered 120 yards from the crater, with a large quantity of unconsumed lyddite in it, and the sands in the same direction were covered with large and small pieces of lyddite. The fragments of No. 3 shell recovered show hardly any signs of explosion. No. 4 shell was found 20 yards from crater, badly cut about by fragments. No. 5 shell was found 60 yards from crater and more damaged than No. 4, the walls being apparently cracked through in one place.

Rd. 2 (not in programme).

One shell (No. 6) standing on its base on the sands, without exploder or primer. A V.S. electric "P" tube was placed in the fuze-hole, the head of the tube level with the top of the fuze-hole, tube pointing into the shell. The tube was fired and no explosion occurred. Examination showed the exploder cavity blackened by powder, and there was a faint smell of burnt lyddite, but as far as could be seen there was no fusing of the lyddite.

Rd. 3 (not in programme).

The same shell (No. 6) was fitted with a 7-dram primer and electric tube, exactly as in Rd. 1, but standing on the sands. The tube was fired and the shell was judged to have detonated completely, although there was a considerable quantity of yellow in the smoke. There was no sign of yellow in the crater and the pieces recovered in the crater show unmistakable detonation, and the yellow seen was probably from shell No. 3 of Rd. 1, which was scattered all over the sands.

Rd. 4 (not in programme).

One shell (No. 7) standing on its base on the sands was fitted with an electric tube from which the powder had been removed and eight strands of quickmatch inserted. The strands of quickmatch were about five inches longer than the exploder cavity, and were doubled up to enable the top of the tube to be placed level with the top of the shell, hence there was more quickmatch at the bottom of the exploder cavity than at the top. The tube was fired and the shell detonated completely.

The remaining 3 shell were then taken out. One was laid alongside No. 5, and another on top of the pair, and the third shell was laid alongside No. 4. Three slabs (1 lb. 12 oz.) guncotton were arranged on the first pile with two 7-dram primers and detonators, and the detonators were fired. Detonation was complete. The crater was six yards in diameter and four yards deep. The other 2 shell were exploded in the same manner and detonation was judged to be complete though the crater was not examined.

The 10 shell expended for this trial were those belonging to the lot which exploded at Woolwich.

(Signed) A. J. NIXON, Colonel,
Shoeburyness, Superintendent of Experiments.
21st July 1903.

APPENDIX XII.

The following analysis of Messrs. Read, Holliday and Son's picric acid was handed in by Major J. H. Mansell, R.A., Proof Officer, on 25th June 1903:—

Invoice Number -	17,329.	17,330.	463.	Specification Limits.
Melting - -	248	248	249·5	248 to 253.
Ash - -	0·25	0·24	0·16	Not to exceed 0·3 per cent.
Moisture - -	0·18	0·15	0·17	Not to exceed 0·3 per cent.
Insoluble -	Trace	Trace	Trace	Not to exceed 0·2 per cent.
Sulphuric acid -	Large trace.	0·07	Large trace.	Not to exceed 0·2 per cent.
Heat test - -	Over 30 minutes.	Over 30 minutes.	Over 30 minutes.	30 minutes at 160° F.
Visual - -	Clean.	Clean	Clean	—

APPENDIX XIII.

REPORT ON MATERIAL FROM SHELL-FILLING HOUSES, WOOLWICH.

The material, which was taken from fillet slips under joists, and from between boards of filling building No. 34, was separated by picking and sieving into the following portions, which were examined:—

(*a.*) Hair, 1½ per cent. This consists of the animal hairs which have become detached from brooms.

(*b.*) Wood, 20 per cent. Mostly in the form of fine chips, 3 mm. in length.

(*c.*) Small flints, 1½ per cent. Two 5 mm. long.

(*d.*) Scales of metallic iron, 3 per cent. From 2 to 7 mm. long, and some carbonate of lime.

(*e.*) 74½ per cent. of fine powder passing through 40-mesh sieve, consisting of—

Organic matter - -	25 per cent.
Silica sand, &c. - - -	29 „
Metallic iron - - -	37 „
Oxides of iron and alumina -	4 „
Carbonate of lime - - -	5 „
Copper - - - -	Trace.

Besides the above, the material was found to contain picric acid and picrate, 1·5 per cent. The picrate, which on examination turned out to be picrate of calcium, was present to the extent of about 0·5 per cent. No other picrates were found.

(Signed) R. ROBERTSON,
Chemist.

Waltham Abbey,
3rd July 1903.

APPENDIX XIV.

Experiments on sensitiveness to blow of various explosives.

A thin layer of dry powdered substance between two hardened steel surfaces. Blow in foot-pounds per square inch required to detonate or fire the substance.

Sample.	Result.	Remarks.
Picrate of lead, 1st sample (from lead acetate and ammonium picrate).	Fired; about 5	Very sharp, narrow range.
Picrate of lead, 2nd sample (from white lead and picric acid).	Fired; about 16	„ „
Picrate of iron -	Fired; about 45	Faint, narrow range.
Picrate of copper -	Fired; about 150	Sharp, narrow range.
Picrate of sodium -	Fired; about 930	Faint, narrow range.
Lyddite - -	Not fired at 940	Firing point probably considerably over.
Picrate of calcium -	„ „	„ „
Cordite, Mark I. -	Fired; about 10	Moderately sharp, range wide.
Cordite, M.D. -	Fired; about 20	Moderately sharp, range very wide.
Smoke producing composition for shrapnel (magnesium 1 part, antimony sulphide, 2½ parts).	Fired; about 88	Faint spark, narrow range.

(Signed) W. KELLNER,
Chemist, W.D.

15th July 1903.

APPENDIX XV.

DESCRIPTION OF FORMERS FOR LYDDITE SHELL.

Cast from the following alloy:—

Copper	90 parts
Tin	9 ,,
Phosphor tin	1 ,,
Zinc	2 ,,

The formers (*vide* Diagram) are cast in two pieces, viz., funnel and stem. These are machined all over and screwed together, and the joint further secured by running in pure tin. After this they are polished, gauged and examined.

APPENDIX XVI.

EXPERIMENTS WITH "FORMERS" CARRIED OUT BY WAR DEPARTMENT CHEMISTS.

(*a.*)

On unscrewing six used lyddite formers which had been cleaned by R.L. in the usual manner, it was found that five of them had only the first screw thread filled with tin, and one had three threads filled with tin. The other threads of the last looked clean and new.

All six were fixed in a vice and violently screwed up and unscrewed several times by means of a spanner, but no explosion occurred.

Two (A) of the six had a considerable amount of brownish black powder in the screw threads, three (B) a small quantity only.

From the former two (A) a very small quantity of the powder (less than 0·1 grain) was heated in a porcelain crucible over a small flame, in both cases the powder exploded very sharply. It left a residue of oxide of copper, and was either oxide and picrate of copper, or oxide of copper and picric acid, the copper, of course, coming from gunmetal "former."

The three (B) "formers" were heated at the screw portion in a gas burner, two of them exploded with very loud reports when heated to about the melting point of tin. The report given by one was quite as loud as that of a rifle shot, the second one not so loud. The third did not explode at all.

Judging from the above the two (A) formers will certainly explode on heating.

(Signed) W. H. DEERING,
30th July 1903. pro Chemist W.D.

(*b.*)

The screw threads of one "former" were filled with lyddite by melting picric acid into them and screwing the parts together before the lyddite had set. In another "former" the threads were filled with picrate of soda by rubbing the moistened salt into them, screwing the parts together and warming to dry.

The tubular part of the "formers" were then firmly clamped in a vice and, by means of a long-handled spanner, the funnel end suddenly turned. This was repeated a number of times with both "formers." No explosion occurred.

(Signed) W. KELLNER,
31st July 1903. Chemist, W.D.

APPENDIX XVII.

REPORTS BY DR. DUPRÉ, F.R.S., ON EXPERIMENTS CARRIED OUT BY HIM.

A.

Picric Acid.

A sample of the same acid as that used for filling the shells that exploded gave the following results on analysis:—

		Specification Limits.
Melting point	249° F.	248°–253° F.
Ash	0·19 per cent.	Not above 0·3 per cent.
Moisture	0·3 ,,	Not above 0·3 per cent.
Sulphuric acid	Trace	Not above 0·2 per cent.
Lead oxide	0·08 per cent.	—
Heat test	No action in 30 minutes.	Above 30 minutes.

With the exception of the oxide of lead, not mentioned in the specification, the acid is therefore well within the specification, and in other respects also it was of good quality.

As regards the oxide of lead, experiments of mine have shown that the admixture of 2 per cent. of the oxide raises the sensitiveness of the acid to percussion but very slightly, while 4 per cent. has a decided effect in this direction. If, then, the lead oxide found remains fairly evenly distributed in the melted acid, it may safely be concluded that it would exercise no practical effect on the sensitiveness of the acid. Should it happen, however, that during the melting the oxide in the form of picrate of lead settles to the bottom of the cans, the last portions poured out might possibly contain enough lead to increase the sensitiveness sufficiently to render the use of this portion of the acid dangerous.

Paint.

The paint scraped from some of the shells in the filling house in which the explosion occurred contained:—

Carbonate of lime	16·6 per cent.
Oxide of lead	0·86 ,,

The carbonate of lime is derived from the ochre used.

Substance scraped from the Iron Work of one of the Barrows used for moving the Shell, and Material adhering to Strap of Barrow against which the Shell rests.

The substance scraped from the iron work of the barrow proved to be pure oxide of iron free from any trace of picric acid.

The material on the strap was paint rubbed from the shells, with the exception of one small stain, which proved to be vermilion. Nothing in this has any bearing on the explosion.

Material taken from the Joints of the Floor in No. 34 Filling House.

This consisted of undyed cotton fibres, wool dyed yellow by picric acid, some bristles, some bits of wood,

a large proportion of rusty iron flakes apparently detached from a surface which had been painted white, and a few small pebbles and flints with very slight traces of picrate of calcium. No other picrate could be detected. The material is neither inflammable nor explosive.

Experiments.

The surface of a small steel anvil (2·5 inches square) was thoroughly cleaned and some picric acid placed on it; this was then moistened and allowed to stand over night. The next morning the water had evaporated and the surface slightly blackened, but on testing with a hammer, no increase of sensitiveness above that of picric acid itself could be noticed; this experiment was twice repeated, with the same result. The anvil was then warmed on a water bath, and some picric acid and water put on; when the water had evaporated a fresh portion was put on, and this repeated three times. The dry residue was not more sensitive than the picric acid itself, and especially no tendency whatever of the explosion to spread could be noticed. This experiment was repeated, with a similar negative result, using cast iron in place of steel. It appears evident that specially favourable conditions, as regards moisture, surface, &c. are required for contact between iron and picric acid to lead to any dangerous production of picrate of iron.

The surface of the anvil was then covered with two coats of the paint used for painting the shell. When this was dry the anvil was heated to the melting point of picric acid, and some of the acid put on the paint. After cooling, the solid acid resting on the paint was tested with a hammer, but no increase in sensitiveness above that of picric acid alone could be noticed, and, more especially, no tendency whatever towards ignition or spreading of the explosion could be noticed. The experiment was repeated three times with similar results.

A fresh coat of paint having been put on the anvil and allowed to dry, moist picric acid was then put on and also allowed to dry; in this case, however, it appeared that the oil of the paint prevented all action between the acid and the mineral matter of the paint. The experiment was repeated three times with the same negative results, using, however, weights of cast iron instead of steel.

Experiments to ascertain whether a flash from the outside was likely to ignite any picric acid contained in the screw threads of the bush and plug.

The screw threads of a bush, as well as those of a plug, were filled with finely powdered picric acid and the plug carefully screwed into the bush all but four threads. The annular space left between the top of the bush and the plug was then filled with guncotton and the latter fired; none of the picric acid ignited. The experiment was repeated twice, both bush and plug being cleaned and charged with fresh acid, but the screw plug was screwed in two threads more, so as to slightly confine the guncotton in the annular space mentioned, which resulted in a far sharper explosion of the guncotton, but still no flash passed. It was then ascertained, however, that guncotton did not ignite picric acid, even when the latter was placed on the guncotton direct, and the above experiments were, therefore, repeated with mealed powder, but still with no result. In no case did the effect go beyond the first thread of the screw plug. Finally, the plug and bush having been thoroughly cleaned, and the three threads filled with picric acid, the plug was put in a little more than half its length (only about one and a half threads had actually taken hold), some powdered picric acid was put round the plug and the annular space filled with a Bengal fire composition, consisting of potassium chlorate, strontium nitrate, shellac, and stearine, which was then set on fire with no results. The experiment was repeated twice with similar negative results. In all the above experiments the bush was placed over a tuft of guncotton, which was in no case ignited.

Experiments with "former."

A "former" with its funnel removed was heated to a little above the melting point of picric acid, some of which was put on the lower half and allowed to cool. The socket was then slipped over the other end, and being too small to pass over the solidified acid on the lower half was forcibly pushed down by hand. No explosion or ignition took place. The experiment was twice repeated, forcing the socket down by a blow from a head hammer in place of pushing it down by hand, with similar negative results. The experiment was then three times repeated, sand having been spread on the acid so as to form a rough surface, nevertheless, when the socket was forced over the acid and sand by a blow from the hammer, no explosion or ignition resulted. The "former" was then again coated with melted acid and the hot socket pushed over so as to give a layer of melted acid between "former" and socket. When everything was cold the firmly fixed socket was forced from its place by a blow from the hammer with no result. This experiment was twice repeated with similar negative results. Once more acid was melted on the hot "former," covered with sand, and the hot socket pushed over. When cold the socket was moved by a blow from the hammer, again with no result. This was twice repeated with similar negative results. Lastly, the "former" was once more heated and partly covered with melted acid to which litharge had been added, the hot socket pushed over and when cold forcibly moved by a blow from the hammer, still with no result. The experiment was twice repeated with similar negative results. Between every experiment the "former" and socket were carefully cleaned

(Signed) A. Dupré.

23rd July 1903.

B.

Analysis of Contents of Screw Threads of "Formers."

Dark powder, consisting essentially of picrate of copper and picric acid in about equal proportions, with traces of picrate of zinc.

When heated the powder explodes with moderate violence; it acts, however, as an exploder to any picric acid in contact with it.

(*a.*)* *Analysis of the Residue from No.* 1 *Melting Can after having been in oven from* 3.15 *a.m. until* 1.45 *p.m. (three hours over and above the time after being melted ready for use).*

Dark-looking crystalline substance, partly in coarse powder, partly in flat cakes, one surface of which is smooth, the other rough. The smooth surface, and about half the cake above it, is much darker than the remainder. An average sample of the whole gave—

Mineral matter (ash) - 2·350 per cent.

This ash consists mainly of sulphate of lead, with a little picrate of iron and some grit.

(*b.*)* *Analysis of residue from No.* 8 *Can.* (¾*-inch from bottoms of* 3 *to* 8 *were poured into* 8 *and again melted* 3 *hours.*)

Irregular lumps partly yellow, partly very dark, but many of the lumps are entirely dark, and the dark and yellow portions are more readily detached from each other than in sample 2. The black parts yielded on analysis—

Mineral matter or ash	-	11·44 per cent.
The ash consists of:—		
Sulphate of lead - -	6·98	,,
Oxide of iron - -	0·90	,,
Grit (fine sand) - -	3·56	,,
	11·44	,,

Both portions, but especially the black, when heated in a tube, show a distinctly greater tendency to explode than does pure picric acid.

I have not been able to detect any distinct difference in sensitiveness to percussion between either the dark or yellow portions and pure picric acid.

(Signed) A. Dupré.

7th August 1903.

* Eight cans of acid were melted and the contents allowed to settle. The acid was then poured off, a small quantity (about ¾ inch) at the bottom being retained. The analysis of this residue is shown in (*a*). The residue from six cans was poured into one can, and, after further melting the clear acid was poured off and the residue analysed (*b*).

APPENDIX XVIII.

LIST SHOWING MEN WHO WERE KILLED OR INJURED, &c. IN THE LYDDITE EXPLOSION ON 18TH JUNE 1903 AT WOOLWICH ARSENAL.

Name.	Age.	Whether Married or Single.	Service in R.L.
Killed.			Years.
Usher, J.	38	Married	7
Greenless, A.	40	"	$3\frac{8}{12}$
Curran, F.	47	"	$4\frac{6}{12}$
Pinhorn, E. F.	36	"	$3\frac{2}{12}$
Edwards, W.	29	"	$11\frac{4}{12}$
Case, G.	52	"	$7\frac{4}{12}$
Adams, C.	36	"	7
Newton, E.	30	"	7
Swords, J.	28	Single	$14\frac{8}{12}$
Remington, A.	32	Married	$3\frac{3}{12}$
Herbert, M. W.	26	"	$3\frac{6}{12}$
Marshall, T.	38	Single	$3\frac{1}{12}$
Connor, P.	27	Married	$6\frac{4}{12}$
Morley, F.	35	"	$3\frac{5}{12}$
Johnson, S.	31	"	$3\frac{5}{12}$
Larkin, J. P.	31	"	$7\frac{1}{12}$
Severely Injured.			
Stevens, A.	38	"	$24\frac{11}{12}$
Stevens, F.	33	"	$10\frac{4}{12}$
Goldsmith, A.	25	"	3
Webb, J.	48	"	$3\frac{5}{12}$
Slightly Injured.			
Crofts, G.	21	"	$7\frac{4}{12}$
Saunders, A.	25	"	$6\frac{7}{12}$
Smith, F.	28	"	$14\frac{5}{12}$
Wood, W.	53	"	$14\frac{4}{12}$
Gaurd, D.	29	"	$15\frac{7}{12}$
Stevenson, E.	30	"	$3\frac{1}{12}$
Smealy, A.	37	"	$3\frac{6}{12}$
Howell, E.	41	"	$2\frac{7}{12}$
Hammond, C.	38	"	16
Lindsey, A. J.	29	"	$15\frac{7}{12}$

REMARKS ON BODIES BROUGHT TO THE MEDICAL DEPARTMENT, 18TH JUNE 1903.

1. Greenless, A. — Chest, abdomen, face and neck, right side, blown out; bowels protruding; both legs broken, stained yellow. (Body.)
2. Adams, C. — Compound comminuted fracture, right thigh; abdomen open; leg almost blown away; left thigh fractured. Died on arrival at hospital 8.40 a.m.
3. Newton, E. — Crush of left arm; right chest in pulp; laceration of lungs, &c.
4. Pinhorn, E. — Compound fracture, right leg; compound comminuted fracture of left side of head; chest and back extensively injured.
5. Curran, F. — Compound fracture right leg and foot; left knee lacerated; thighs fractured.
6. Case, G. — Chest eviscerated; left leg fractured; right leg missing below knee; right arm fractured.
7. Usher, J. — Pelvis and both legs missing; everything blown away; both arms fractured; skull in fragments.
8. Edwards, W. — Skull and brain blown away; chest and abdomen opened, and in pieces; right leg and thigh, right arm, and left arm fractured.
9. Swords, J. — Neck, both sides, chest and abdomen opened; compound fracture left arm; both legs and feet fractured; fractured right thigh, and severe laceration of left thigh.
10. Remington, A. — Right thigh blown off; left leg broken; left thigh lacerated; skull fractured; laceration left shoulder, and wound of abdomen. Died in hospital 9.15 a.m.
11. Herbert, M. W. — Spine and ribs. Rest pulp. (Identified by shirt).
12. Larkin, J. P. — Comminuted fracture right thigh; severe fracture of leg, with extensive destruction of soft tissues and skin; comminuted fracture left leg; extensive laceration of parts; knee joint opened, and bones forming part reduced to pulp; femur comminuted, also scalp wound and wound of abdomen. Died in hospital 10.50 a.m.
13. Marshall, T. — Fragments. Recognised by tattoo marks on arms.
14. Johnson, S. — Fragments. Identified by evidence.
15. Morley F. — Fragments. Identified by evidence.
16. Connor, P. — Fragments. Identified by evidence, and false teeth.

(Signed) J. R. MALLINS, M.B.,
Major. R.A.M.C.,
S.M.O.

APPENDIX XIX.

STATEMENT OF DAMAGE CAUSED TO BUILDINGS BY THE LYDDITE EXPLOSION ON THE 18TH JUNE 1903.

	Yards.
Radius within which serious structural damage was effected by the force of explosion	23
Radius within which minor structural damage was effected, *i.e.*, breakages of doors, window-sashes, &c.	125

Description.	Distance from centre of No. 9 building. Yards.
Lyddite Establishment.	
No. 12 building, Examining Room, N.W. angle:—Sashes and glass broken; door blown off	42
No. 13 and 13a, Washing-out House:—Sashes and doors broken; framing and roof damaged	20
Urinal and latrine under bank:—Wall blown down, framing and roof damaged.	23
Fence near river bank blown down and damaged	20
Fuel shed:—Brickwork and roof damaged	21
No. 17 building, Melting House:—Glass broken &c.	98
No. 19 Washing-out House; sashes &c. broken	70
No. 16 Filling House:—Roof damaged	53
No. 7 Melting House:—Brickwork roof and glass damaged	19

Description.	Distance from centre of No. 9 building.
	Yards.
No. 8 Stove House :—Brickwork and roof damaged	21
No. 9 Filling Chamber and covered way blown up and platform destroyed	—
No. 10 building (portion of old Proof Butts Buildings.) Doors broken, sashes and glass	23
No. 1 building, Receiving House, N.W. angle :—Doors and roof damaged, glass broken	66
No. 27 building, near traverse :—Doors broken, brickwork damaged, glass broken, &c	34
No. 3 Shifting-House :—Glass broken	55
No. 15 Ablution House :—Brickwork and roof damaged, all glass broken	46
No. 4 building, 12 feet by 12 feet brick :—Brickwork damaged, sashes broken	35
No. 5 building, 12 feet by 12 feet brick :—Brickwork much damaged, also doors, sashes, &c.	27
No. 6 building, 12 feet by 12 feet brick :—Front wall blown in and roof damaged.	22
No. 24 and 24a Office and Stores (Tool) :—Brickwork much damaged, doors and roof ditto.	23 & 42
Nos. 21, 22, and 23 wood buildings :—Weather boarding perforated in places	51, 63 & 75
Assistant manager's office :—Sash blown in	113
No. 41 building 15-ft. by 15-ft., wood :—Glass broken ; slates damaged	67
No. 35 Melting House :—Brickwork damaged, handrail and staircase broken, corrugated iron on both sides of building dislodged, roof perforated, also roof of stove house	40
Covered way roof perforated and Changing House damaged	43
No. 34 Filling Building :—Doors and slating damaged	48
No. 39 Boiling-out House :—Brickwork damaged ; sashes broken and roof damaged	34
No. 1 building, Empty Shell Store :—Sashes broken ; slating damaged	70
Cap and Detonator Factory.	
Old latrine :—Brickwork and roof damaged	63
New latrine :—Brickwork and roof damaged	65
No. 10 Cap Pressing House :—One pane of glass	104
Office :—Roof damaged	68
Boiler house :—Glass broken in skylight	89
No. 3 Cartridge Factory.	
No. 16 building :—Sash broken	125
Rolling Stock Shed.	
Roof trusses slightly moved, louvres, broken and dislodged, gables displaced, door damaged and sash broken.	106

APPENDIX XX.

COPY OF ORDNANCE COMMITTEE MINUTE ON THE SUBJECT OF IGNITION OF PAINT ON LYDDITE SHELL.

Minute 41,437.

Experimental Officer, Lydd, 6th April 1896, forwards the following Report from Mr. Berry, Magazine Foreman :—

"On Saturday, 4th April 1896, I was at the shell store unloading a trolley carrying 5-inch B.L. howitzer shell, filled with lyddite and with exploders of 4½ oz. picric powder. I carried in a shell and placed it on the edge of the base on the wooden floor, and raised the point to get it fair on the base. As I did so the edge of the base touched another similar shell and immediately sparks came from the base of the shell I was handling, and something commenced to burn in a streak up the side of the shell from just above the driving band for a distance of about 8 inches towards the head, where it went out. It took some seconds to burn, long enough for me to make two attempts to extinguish it, and to call out to my son, who was outside, to get away. The burning was like that of a fuze, I have on previous occasions noticed, in some cases, streaks of what appeared to be melted picric acid on the outsides of shell."

The Experimental Officer states that he has examined the shell in question. There is a black mark, apparently due to burning, along the side of the shell about ¾ inch wide and 8 inches long, extending from immediately above the driving band towards the point of the shell. The shell is marked as follows :—

O.C. Rª. 5125 C. Design 7707. R.L.W. ⩚ 3.96, Lyddite. Exploder 4½ oz.
Gross weight, 15 lb. 2½ oz. 21.
Also stamped on driving band 21.

He has examined a good many of the other 5-inch shells, but cannot find any streaks of lyddite outside, though there may be such under the yellow paint, which is itself somewhat streaky.

D.G.O.F., 20th April 1896, states that on hearing of the occurrence at Lydd, he sent down to have all the shell scraped and cleaned, and this has now been done. In filling these shells some liquid picric acid splashed over the shell, and although they are cleaned prior to issue and repainted, it appears this is an insufficient precaution. Apparently the molten picric, running over the lead paint, combines with the lead, and lodges in the recesses of the driving band, and the ignition occurred by the rubbing of one band against the other. To prevent this for the future, he has altered his system of filling, so that no molten acid can get on the exterior of the shell. He has also done away with lead paint, and is using a yellow ochre, for which he is asking I.G.O.'s approval.

In conjunction with Chemist, W.D., he carried out the following experiments :—

A piece of iron was painted with the yellow *lead* paint, and, when dry, dusted with picric acid and then put into an oven to melt the acid ; another coat of paint was then put on. By hammering on this they exactly reproduced the ignition as described by Experimental Officer, Lydd ; the experiment was repeated, using yellow ochre paint, and it was not possible to ignite the surface either by a hammer or a light.

The Committee's action was as follows :—

"The Committee consider that the precautions which the D.G.O.F. states will in future be taken will meet the case."

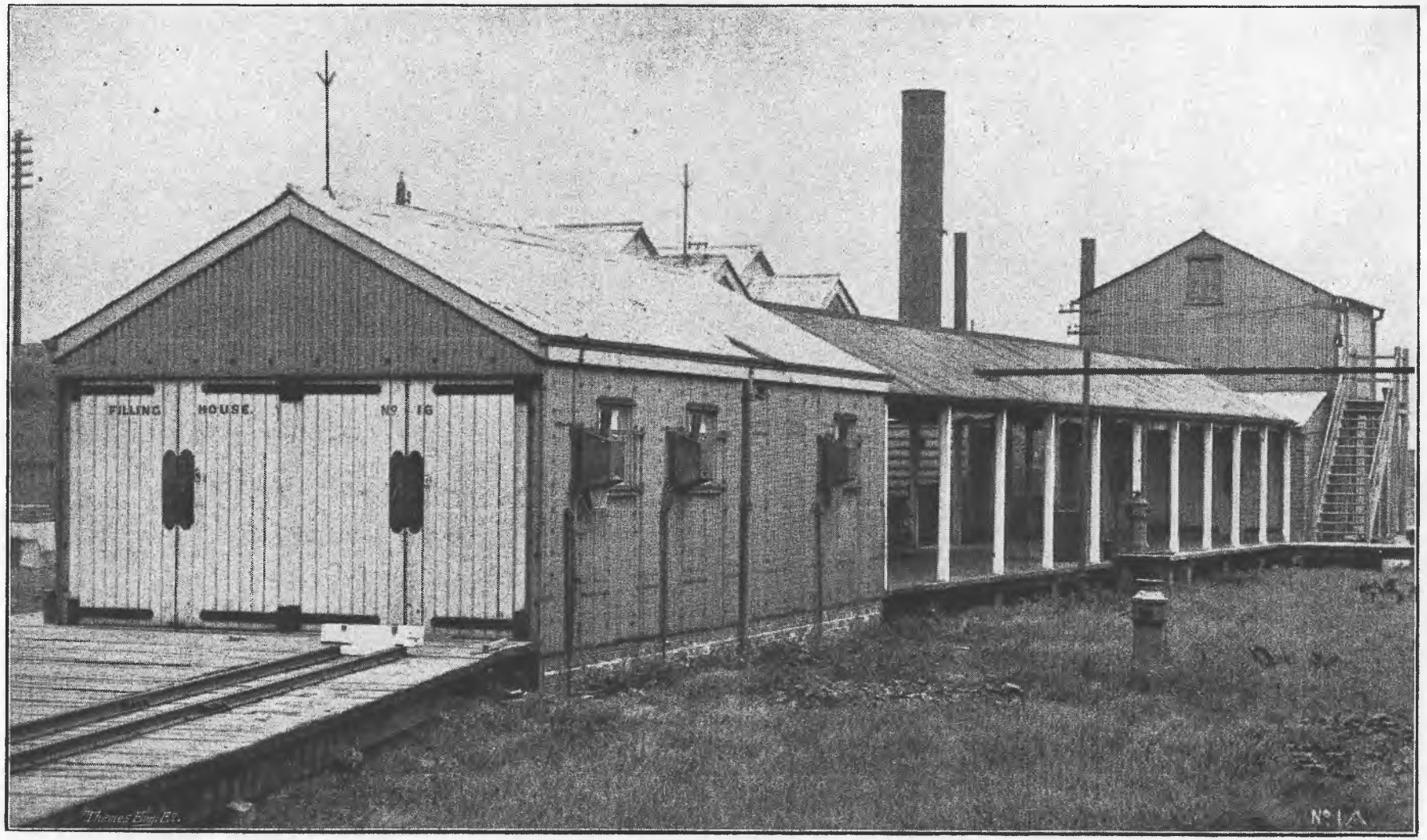
APPENDIX XXI.

PREVIOUS ACCIDENTS by FIRE or EXPLOSIONS with PICRIC ACID.

(Extracted from Special Report No. CXXXIX., by H.M. Chief Inspector of Explosives, Home Office.)

No.	Date.	Place.	Quantity involved.	Description of Accident.
1	About 1861	Lowe's Works, Reddish	About 1 cwt.	Burnt away without explosion. (Special Report, No. LXXXI., p. 18.)
2	About 1879	Longshaw's Works, Warrington.	5 or 6 cwt.	The picric acid packed in a cask became involved in a fire, and burnt away without explosion. (Special Report, No LXXXI., p. 18.)
3	—	Do.	?	Burnt away without explosion. (Special Report, No. LXXXI., p. 19)
4	—	Heron Chemical Works, Lancaster.	4 or 5 cwt.	Burnt away without explosion. (Special Report, No. LXXXI., p. 20)
5		Corbett & Co.'s Works	?	Stove burnt out without explosion. Special Report, No. LXXXI., p. 18.)
6	—	Calvert & Co.'s Works, Bradford, near Manchester.	4 or 5 cwt.	Burnt away without explosion. (Special Report, No. LXXXI., p. 18.)
7	—	Roberts, Dale & Co.'s Works, Cornbrook, Manchester.	8 cwt. ?	In two instances the stove burnt out without explosion. (Special Report, No. LXXXI., p. 19.)
8	7th June 1882	Heron Chemical Works, Lancaster.	1,500 lbs.	A fire broke out in a picric acid stove, which was in two storeys. After 15 minutes a small explosion occurred, and about two minutes later a much more violent explosion, which wrecked the whole building. It is not stated whether the roof had previously fallen in, but such was probably the case. The explosion was at the time attributed to the bursting of steam pipes, but there is little doubt now that it closely resembled the present one. Undoubtedly, lime, in the form of mortar and plaster, was present in this conflagration. (Annual Report, 1882, p. 44; and Special Report, No. LXXXI., p. 20.)
9	22nd June 1887	Roberts, Dale & Co.'s Works, Cornbrook, near Manchester.	13 or 14 cwt.	A fire broke out in or near the stove, having been caused, in all probability, by a man who was smoking. This spread to some casks of picric acid outside. After five or six minutes an explosion of a moderate character occurred, followed, after the lapse of about a minute, by a second and far more destructive explosion. Litharge was present in the conflagration, and there is little or no doubt that the second explosion was caused by the formation of picrate of lead, which served to detonate the whole of the picric acid present. (Special Report, No. LXXXI.)
10	24th August 1887	Glover and Sons' Works, Bradford.	Small	Some picric acid had been put in a barrel with sweepings. The contents of the barrel were shovelled into a furnace, with the result that the explosive deflagrated so suddenly that a man was fatally injured. There was no explosion in the usual sense of the word. (Annual Report, 1887, p. 43.)
11	10th February 1890	Lowe's Works, Reddish	Very small	A small quantity of picric acid ignited in a building in which sulphuric acid is recovered. The cause was not ascertained. (Accident No. 14, 1890.)
12	27th June 1890	Rheinau, near Mannheim	10,000 lbs. in several buildings.	A fire originated in the stove and spread to the packing house. After it had been burning for about 25 minutes, about 1,400 lbs. of dry picric acid exploded somewhat feebly. After about eight minutes, a second and more violent explosion occurred in the nitrating house, involving about 1,800 lbs. of moist acid, loosely packed in casks. After a further interval of about five minutes, a third explosion occurred of great violence, which completely destroyed the picric acid department. This last explosion involved about 1,300 lbs. of moist acid in casks. It was suggested that in the last explosion the picric acid was detonated by an explosion of picric acid vapour and air. This may have been the case, but it appears more probable, as mortar was present, that the determining cause was the formation of picrate of lime. Previous to the first explosion, about 5,500 lbs. of acid on trays in the stove had burnt away harmlessly. (Annual Report, 1890, p. 48.)
13	About November 1899.	Read, Holliday & Sons' Factory, Huddersfield.	Very small	A man was working in the stove when his foot slipped on the floor and caused an ignition, which was readily extinguished with water. The heel of his boot was shod with iron. The stove was warm at the time, but no quantity of dry picric acid was present. (This accident was not reported at the time.)

No.	Date.	Place.	Quantity involved.	Description of Accident.
14	4th December 1899	Low Moor Chemical Co.'s Factory, Low Moor, near Bradford.	Very small -	Whilst a steam pipe was being repaired in the stove, and a man was removing a brick with his hand, something caught fire and burnt him. The accident was attributed at the time to gas accumulated behind the brick, as the man was working with a lighted lamp; but it seems not improbable that picrate of lime may have been the substance which ignited (*See also* the case mentioned by Mr. Graesser, where brickwork had become soaked with picric acid, and the picrate of lime which had formed took fire and exploded with great force. (Special Report, No. LXXXI., p. 11.)
15	3rd May 1900 -	Do. - - -	1,400 lbs. -	A fire occurred in the stove, caused apparently by the friction of a tin tray containing picric acid on an iron pipe. The contents of the stove burnt away without explosion. (Accident No. 108, 1900.)
16	30th May 1900 -	Read, Holliday & Sons' Factory, Huddersfield.	10,000 lbs. in three rooms.	While repairing a steam pipe leading into a stove containing 2,700 lbs. of picric acid, a workman caused the ignition of some picrate of iron which had been formed on the pipe. The flash passed along the pipe into the stove igniting the contents, which burnt furiously for about eight minutes without explosion. The roof then fell in, and half a minute later the contents of a packing room, and of a centrifugal room (under the same roof) containing together about 7,300 lbs. exploded. (Accident, No. 124, 1900.)

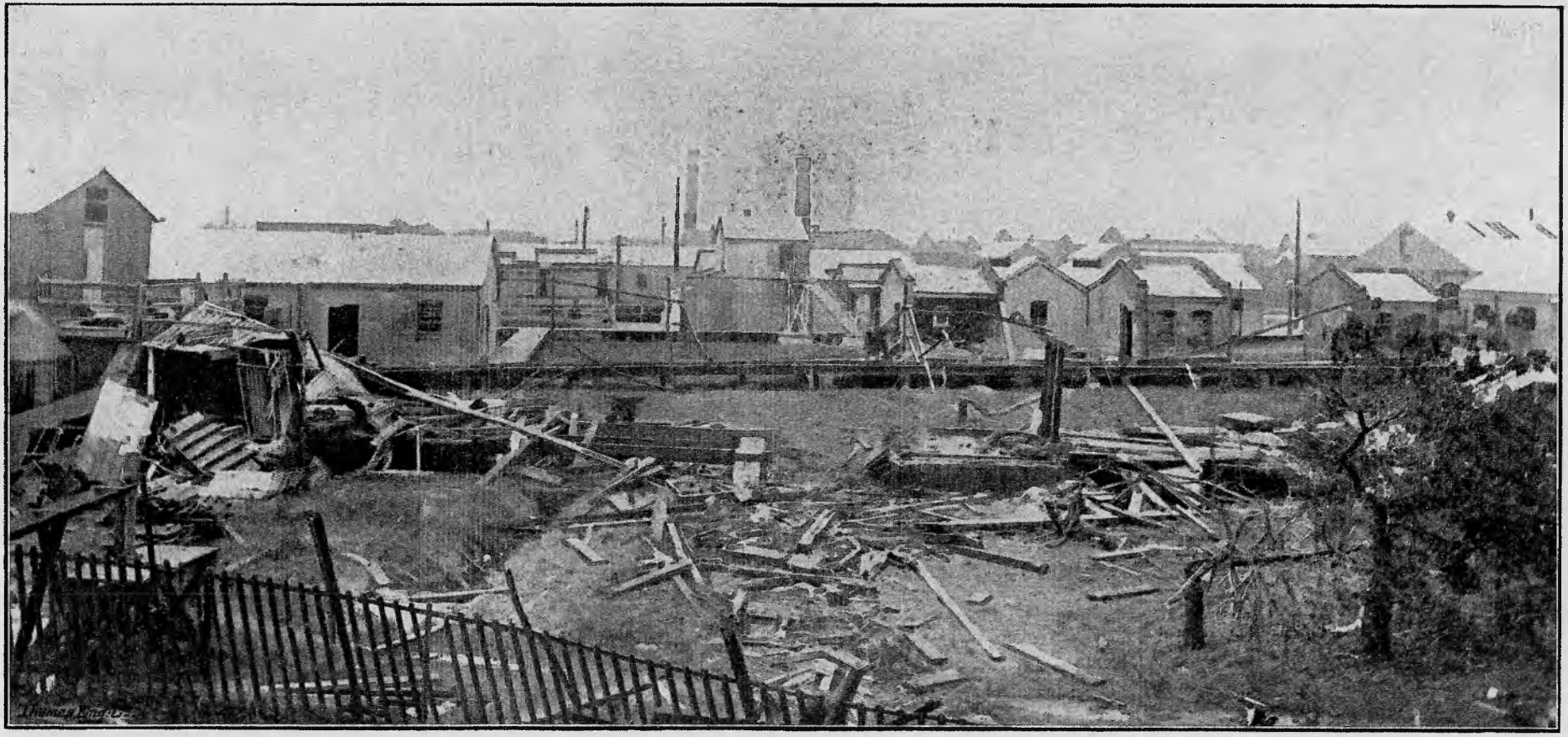


No. 16 Filling House.

(No. 9 Filling House was similar to this, but had a light porch over the door.)

VIEW OF SCENE OF EXPLOSION FROM THE SOUTH.

APPENDIX XXIII.



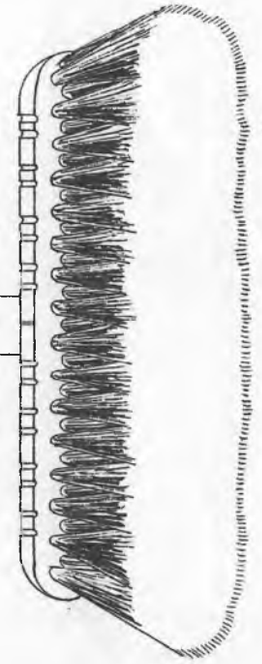
VIEW OF SCENE OF EXPLOSION FROM THE NORTH-WEST.

TOOLS ETC. USED IN FILLING CHAMBERS.

Appendix XXVII.
(d)

Lyddite Establishment.

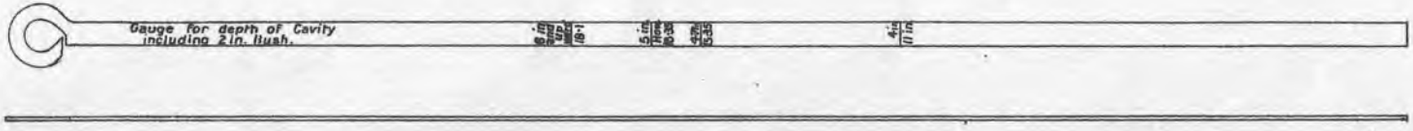
ches - 1 foot.



Hair Broom.

Mop.

Gauges.

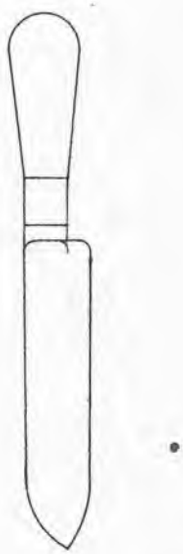


TOOLS ETC. USED IN FILLING CHAMBERS.

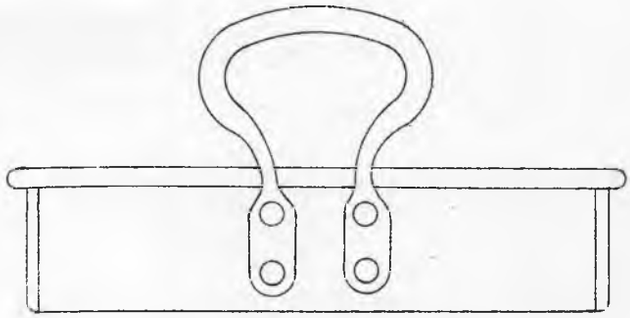
(c)

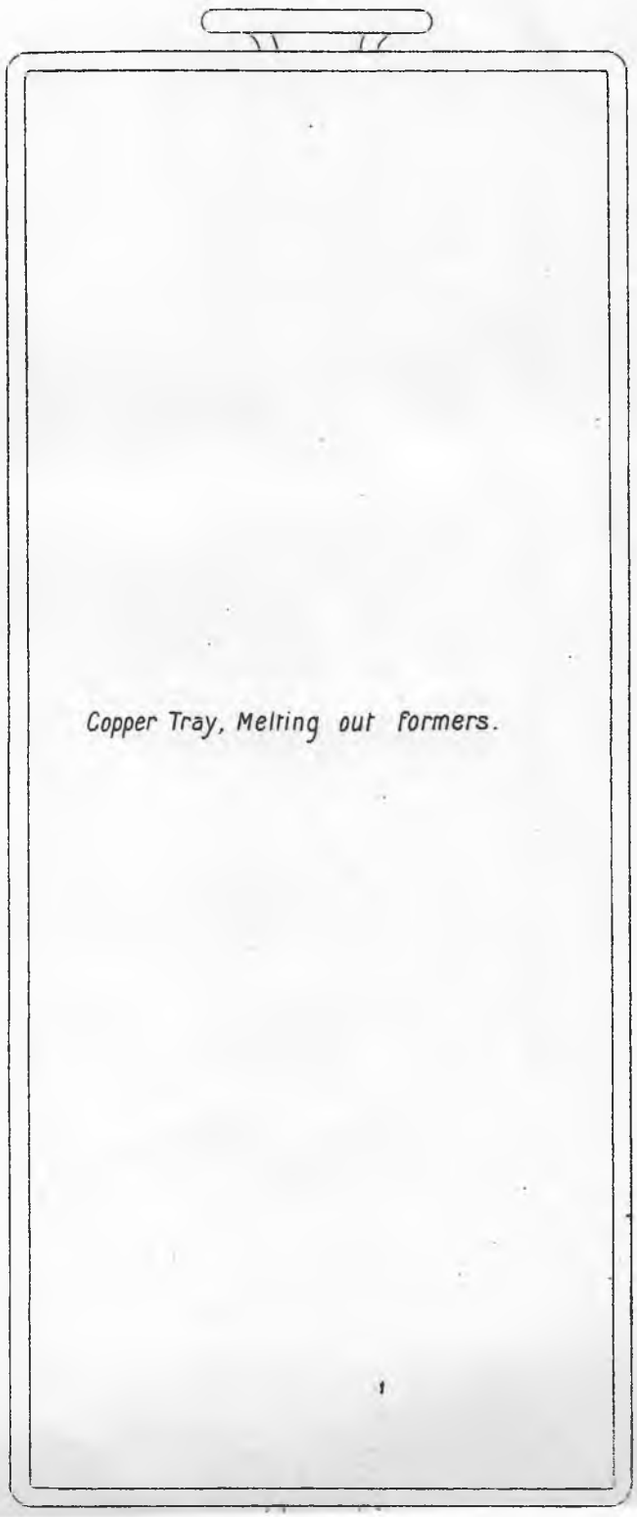
Lyddite Establishment.

Scale 3 in. = 1 foot.



Knife, Phosphor Bronze.

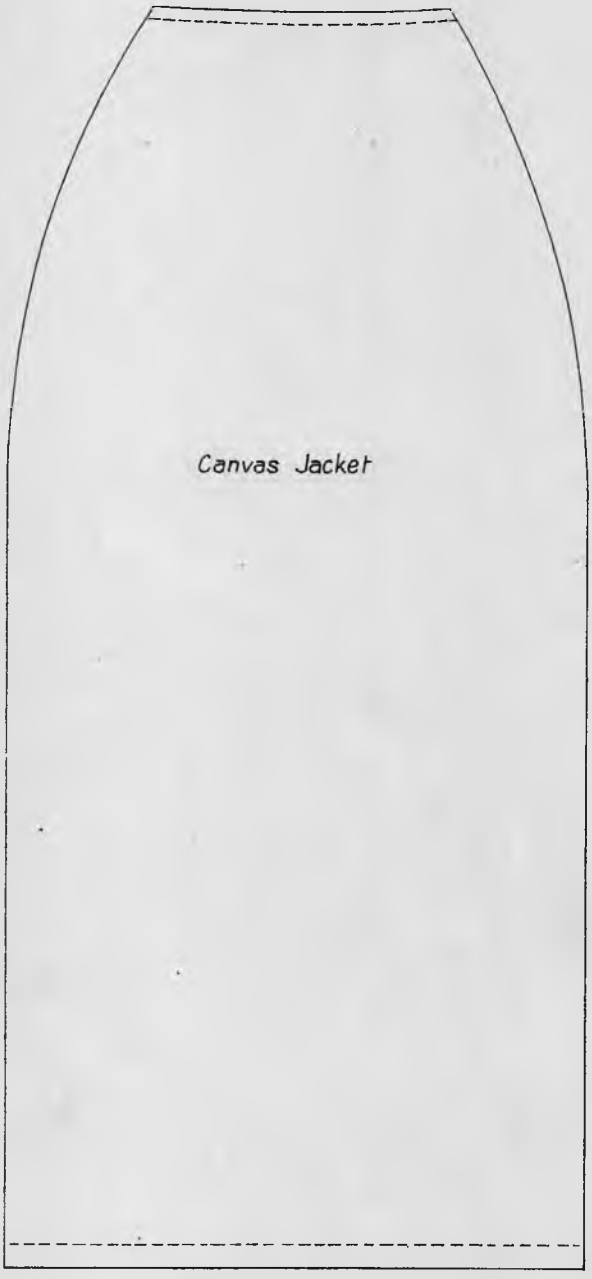


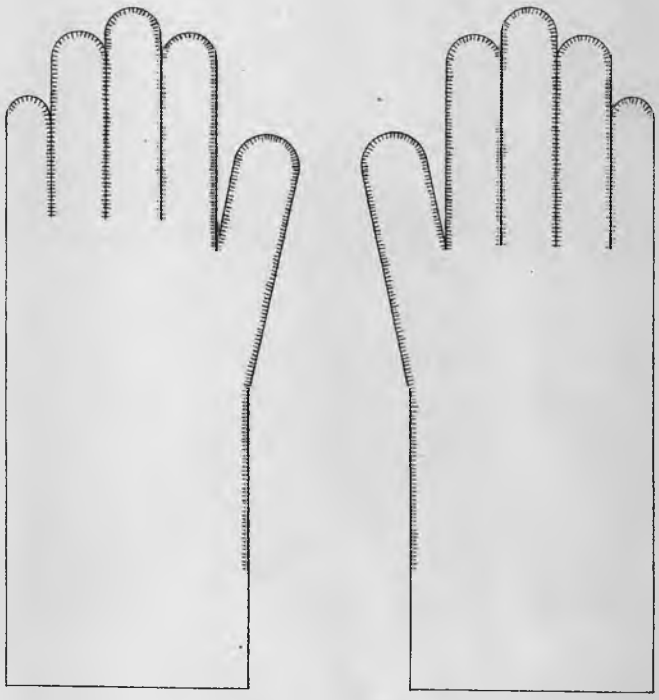


Copper Tray, Melting out formers.

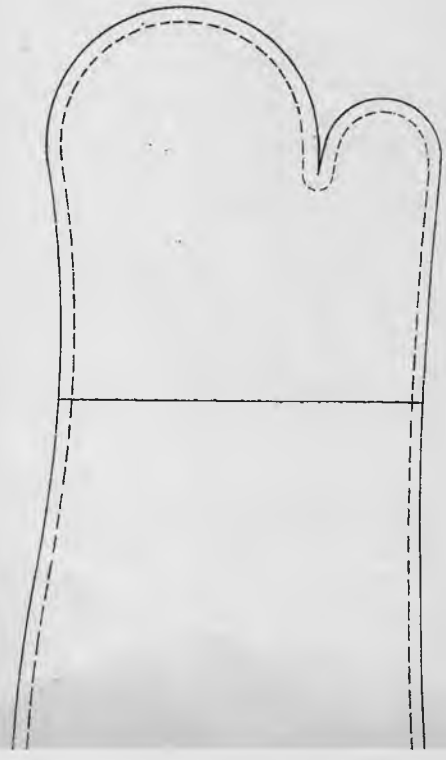
Brush.

Scale 3 inches = 1 foot.

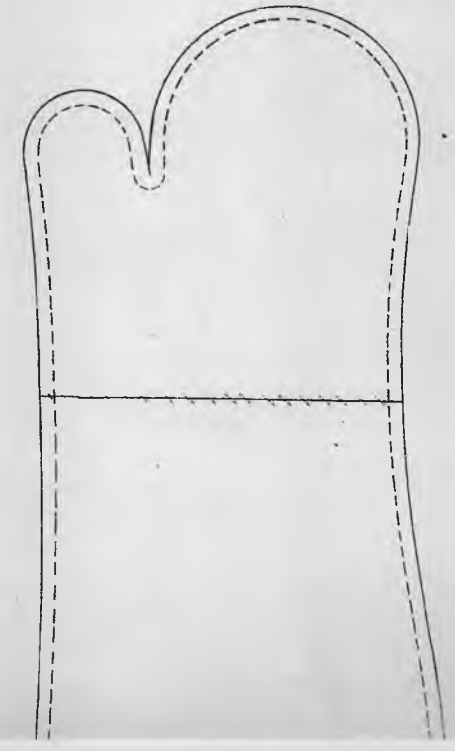




Chamois Gloves.



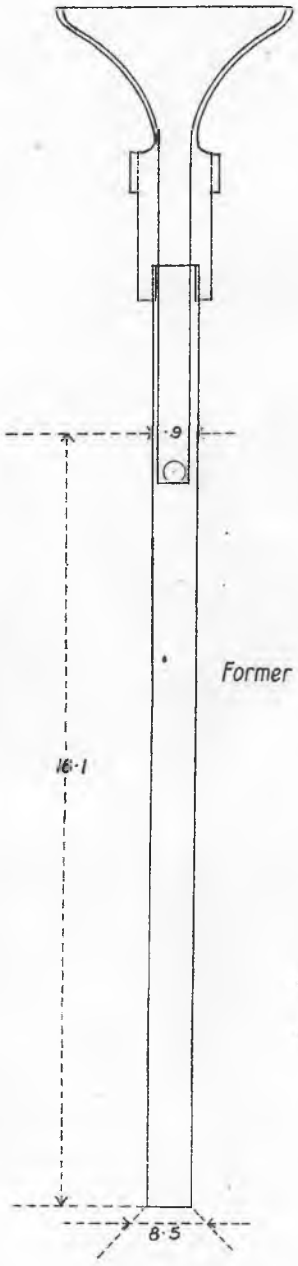
Mittens.



TOOLS USED IN FILLING CHAMBERS.

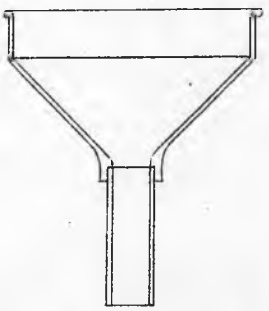
Lyddite Establishment.

Scale, 3 in. = 1 foot.



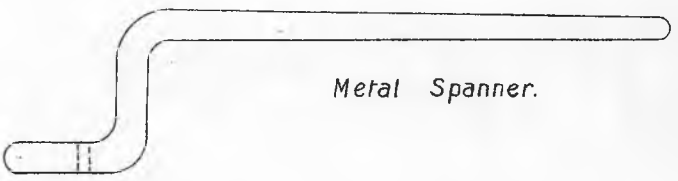
Former

Tongs.

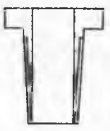


Funnel.

Asbestos Washer.



Metal Spanner.



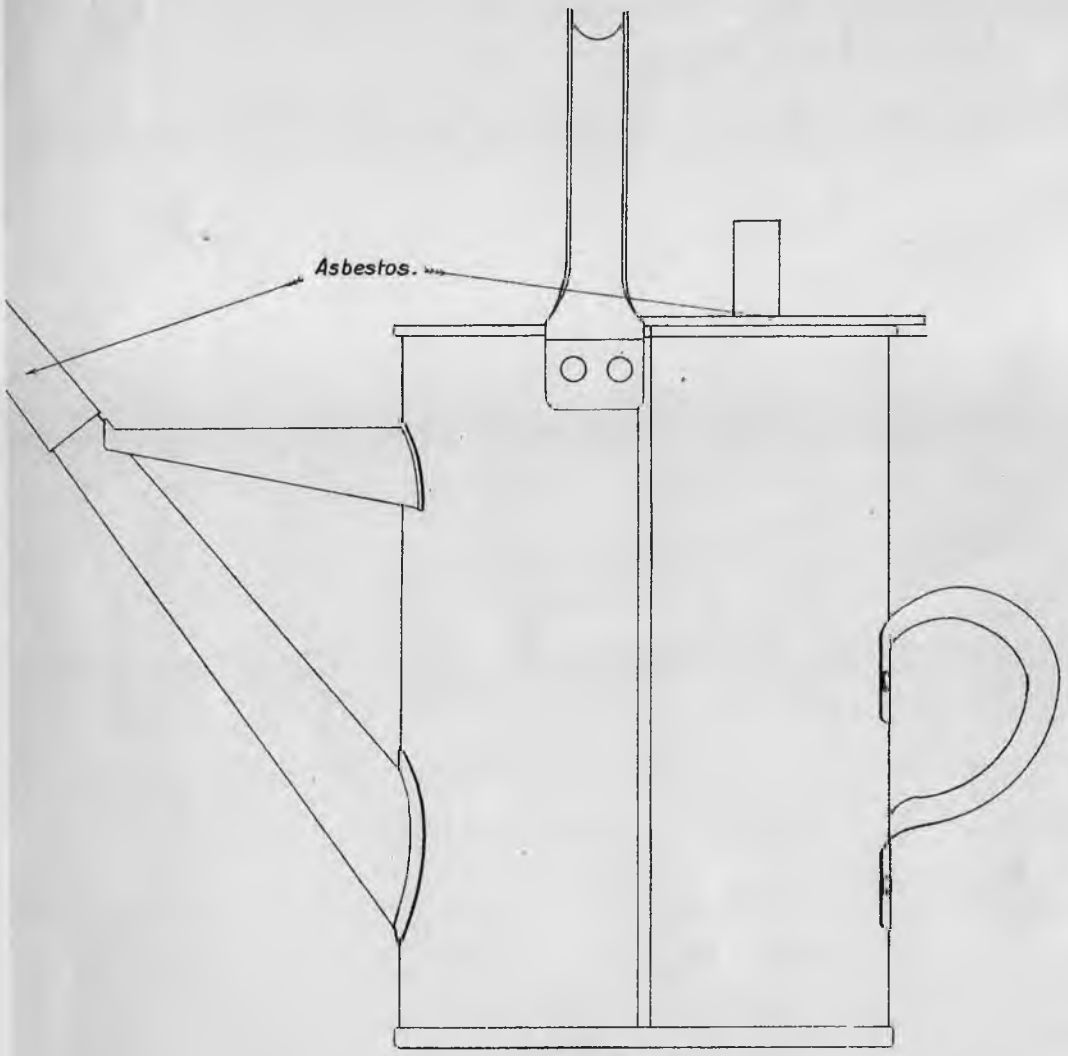
Gun-Metal Bush.

Circular Copper Tray

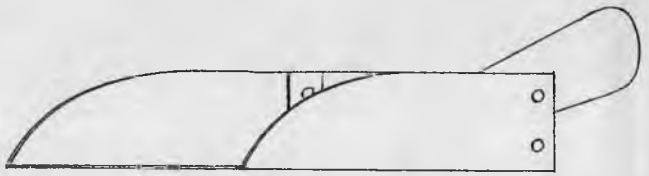
TOOLS USED IN FILLING CHAMBERS.

Lyddite Establishment.

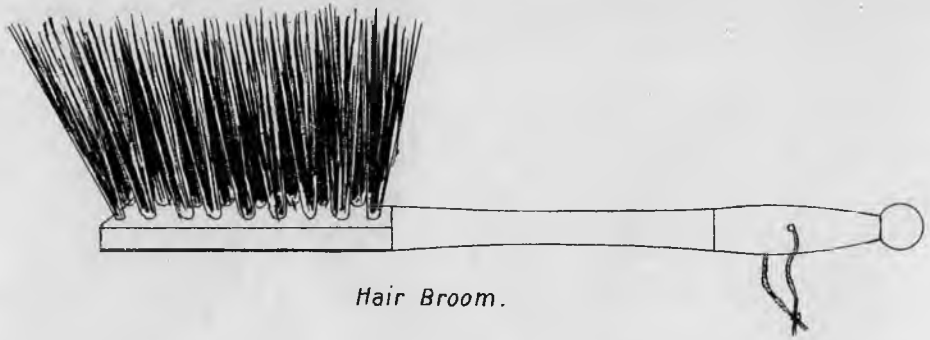
Scale 3 inches = 1 foot.



Melting Can.



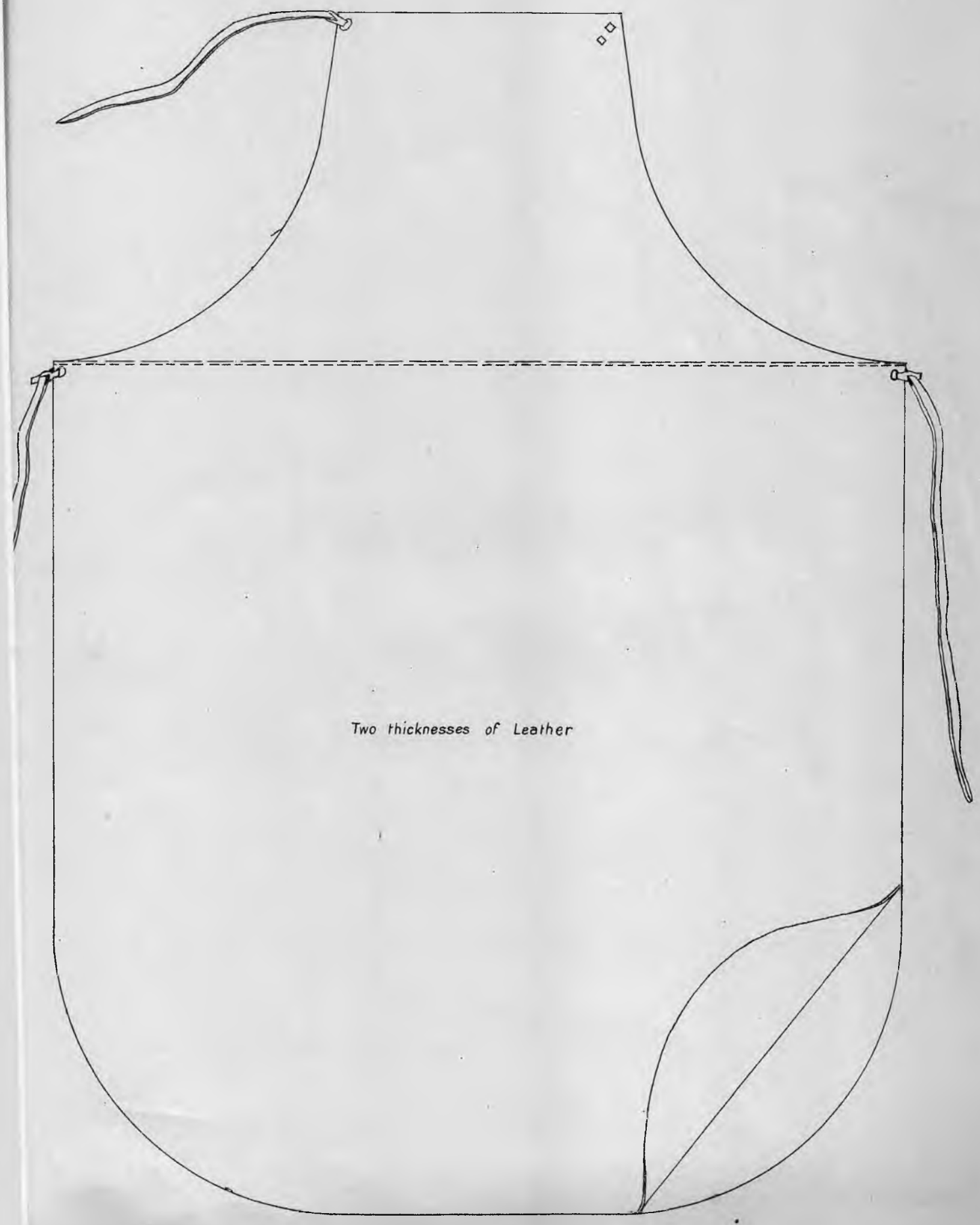
Copper Shovel.



Hair Broom.

Lyddite Establishment.

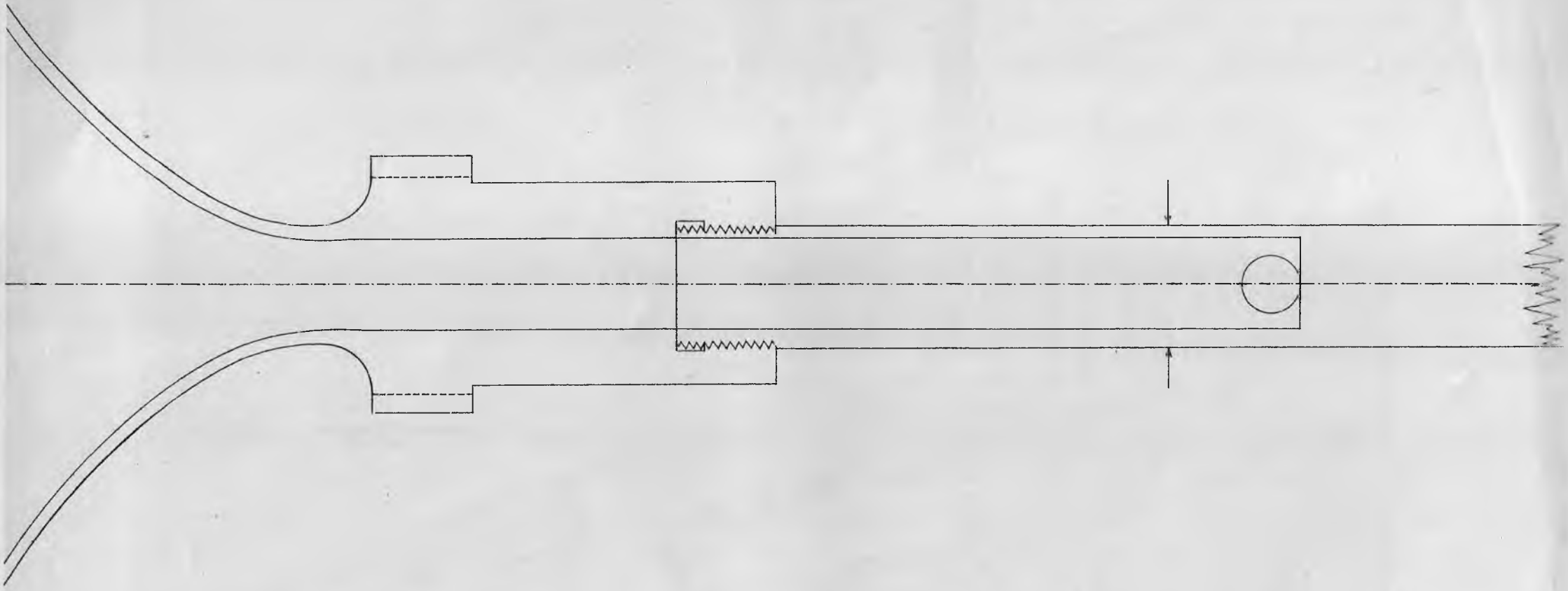
ale 3 inches = 1 foot.



Leather Apron.

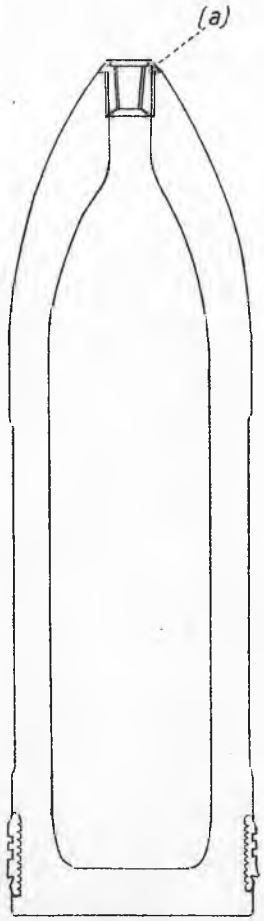
FORMER FOR MAKING RECESS FOR EXPLODER IN LYDDITE SHELLS.

Shewing Joint at Head.

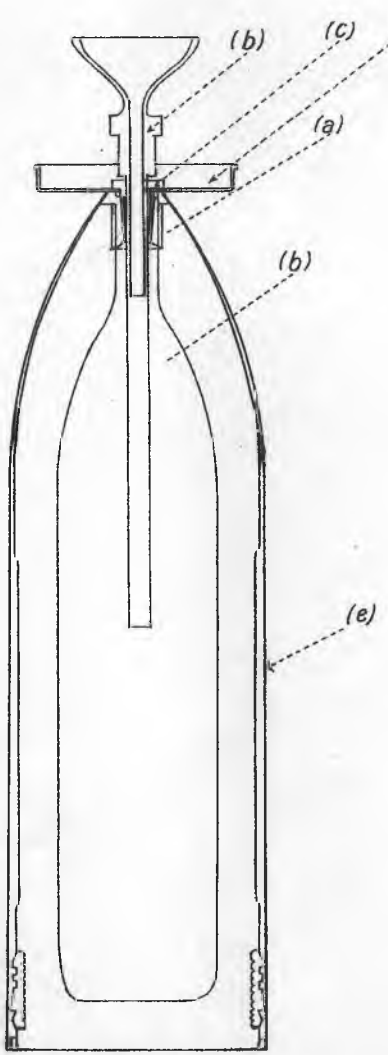


SHELL B.L. COMMON LYDDITE 10 INCH

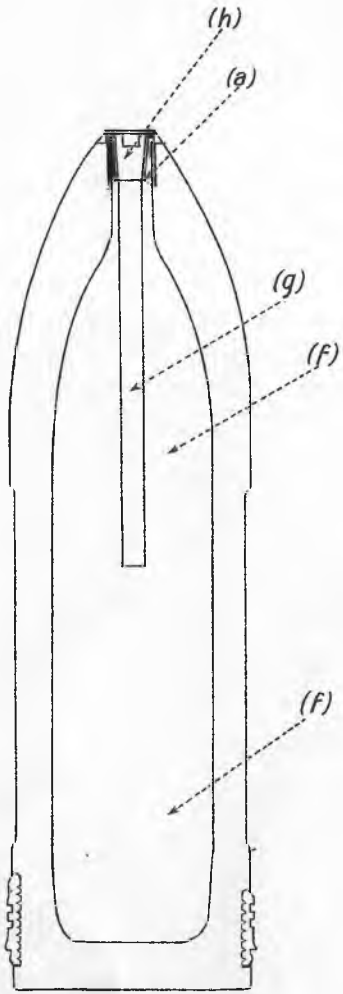
1½ in = 1 Foot.



EMPTY.



READY FOR FILLING.

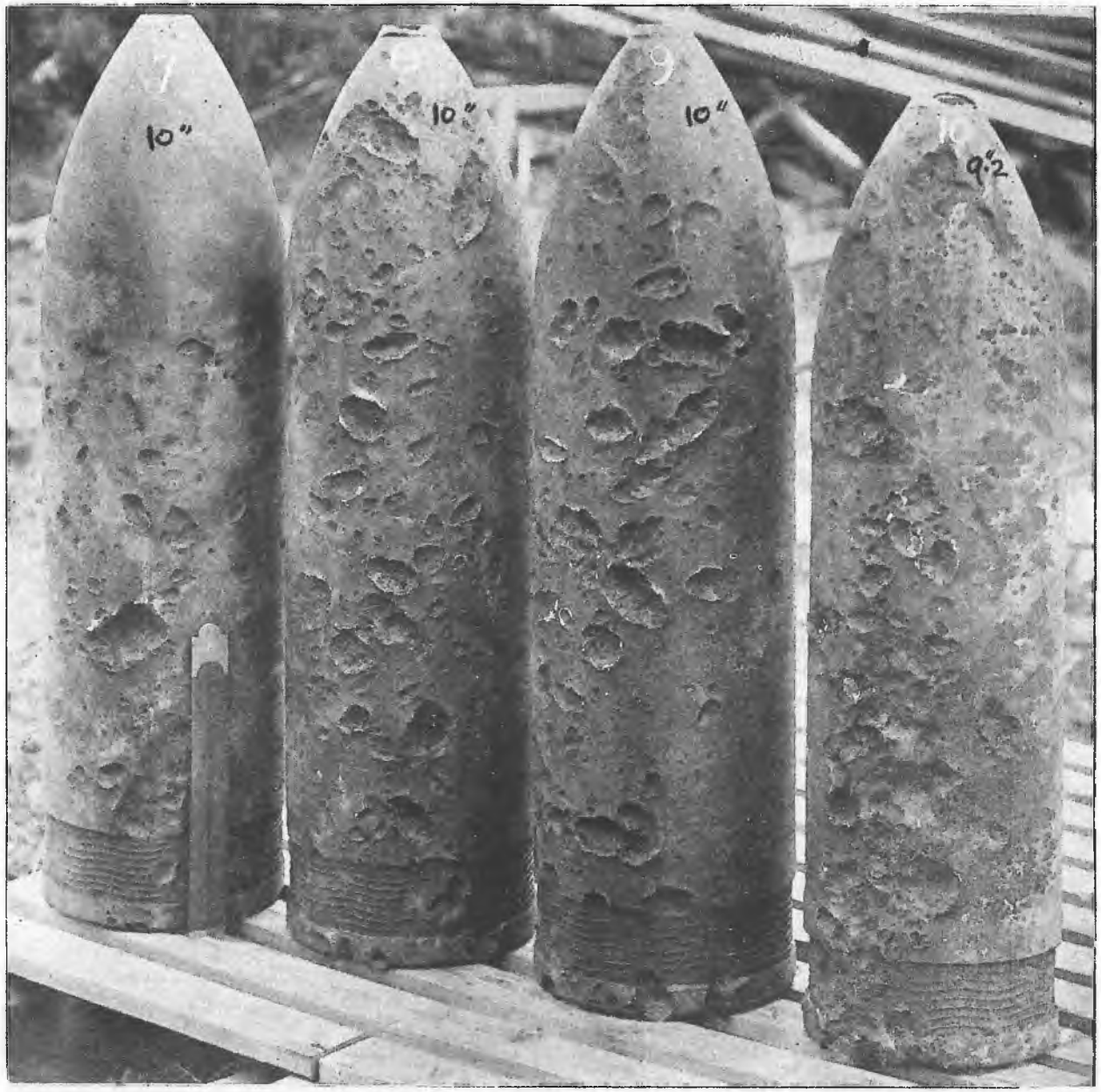


FILLED.

(a) Fuze hole bus
(b) Former.
(c) Socket.
(d) Tray.
(e) Canvas jacket
(f) Lyddite.
(g) Exploder cav
(h) Fuze hole plu


14.
10"
15
10"

APPENDIX XXV. (a).




11
10"
12
10"
13
10"

APPENDIX XXV. (*d*).

* NOTE.—This paint was scraped off, for analysis, after the explosion.