

FINAL REPORT
OF THE
COMMITTEE ON EXPLOSIVE SUBSTANCES.

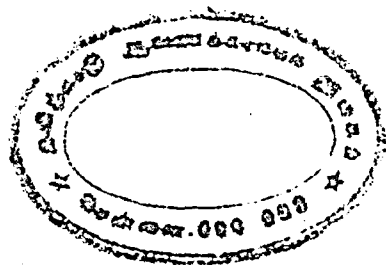
WITH APPENDICES.

1881.

CALCUTTA:

MILITARY DEPARTMENT PRESS.

1882.



Committee on Explosive Substances.

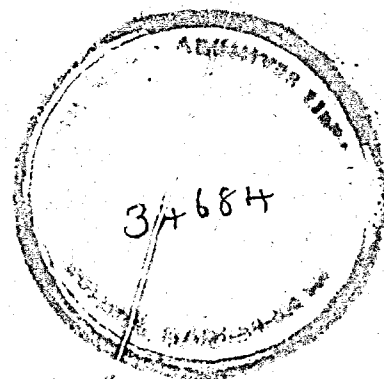
President.

Date of appointment.

Colonel R. J. HAY, R.A. May 1880.

Members.

Brevet-Colonel D. MACFARLAN, R.A., Ordnance Consulting Officer for India November 1879.
Colonel C. B. BRACKENBURY, R.A., Superintendent R.G.P.F. July 1880.
Captain C. BRIDGE, R.N. June 1878.
Lieutenant-Colonel F. LYON, R.A., Superintendent R.L. April 1880.
Lieutenant-Colonel E. MAITLAND, R.A., Superintendent R.G.F. May 1880.
Captain E. BAINBRIDGE, R.A., Acting Secretary .. April 1879.
Captain A. NOBLE, F.R.S., C.E., late R.A... .. May 1869.
F. A. ABEL, Esq., C.B., F.R.S., Chemist to War Department May 1869.



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Final Report of the Committee on Explosive Substances.



IN compliance with instructions received, 1-3-81, the Committee have the honor to submit their final report.

The following experiments and investigations have been carried out by the Committee on explosives since the date of their progress report, 30th April 1880:—

1. Experiments with 17·72-inch R. M. L. 100-ton gun.
2. Experiments with 16-inch R. M. L. 80-ton gun.
3. Experiments with 12·5-inch R. M. L. chambered gun of 38 tons.
4. Trial of gunpowder for heavy guns.
5. Trial of gunpowder for field and siege guns.
6. Trial of small-arm powders.
7. Methods of improving the keeping qualities of gunpowder.
8. Gunpowder of Indian manufacture.
9. Guncotton as a bursting charge for shells.
10. Foreign gunpowder.
11. Miscellaneous subjects.

SECTION I.

1.—EXPERIMENTS WITH 17·72-INCH R. M. L. GUN OF 100 TONS.

The Committee were directed, 10-1-81, to carry out experiments to determine the charge for the 100-ton gun.

These were carried out at the Proof Butts, 16, 18, and 24-2-81. The

results are given in Appendix A. It having been decided on

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that 15 tons was the highest pressure in the chamber allowable, it is impossible to increase the charge beyond 450 lb. of prismatic powder. With the Westphalian powder used for these trials, this will give to a 2,000 lb. projectile a mean muzzle velocity of 1548 f.s., with a mean pressure at the bottom of the bore of 15·3 tons, and on the base of the projectile of 12·8 tons.

SECTION II.

2.—TRIALS OF 16-INCH R.M.L. GUN OF 80 TONS.

The experiments with this gun have been threefold,—viz., (1) to ascertain the force of the blast when these guns are fired; (2) to determine the charge of prismatic powder most suitable for these guns, and (3) the trial in them of foreign and experimental prismatic powders.

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Gen. No.
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1. To ascertain the force of blast.

The Committee, 30-4-80, were directed to carry out experiments in this direction, and two gauges were ordered at a cost of 50l. each.

Trials were carried out and the results are given in Appendix B. It was decided, 16-2-81, that, as the only available 80-ton guns were all on board the *Inflexible*, that the carrying out of further trials should be left to the Admiralty.

- 2 and 3 To determine the charge, and for the trial of foreign and experimental prismatic gunpowders.

The details of these trials are given under Section IV, "Trial of Gunpowder for Heavy Guns." The question of a prismatic powder with prisms of an increased size has been under the consideration of the Committee, and the results have been so far satisfactory, that it is anticipated that this description of powder may be introduced for the largest natures of guns; but until the conclusion of their trials, the Committee were unable to make a definite recommendation on this head. They therefore, as a temporary measure, recommended, 23-9-80, that the charge should be 450 lb. of prismatic powder (with a $\pm$ limit of 2 lb.) according to specification drawn up to guide supply of prismatic powder from abroad (see pp. 20 and 21), the charge to be made up in four equal cartridges without a choke, the whole charge to have a density of $\frac{32.34}{857}$.

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SECTION III.

3.—EXPERIMENTS WITH 12.5-INCH CHAMBERED GUN OF 38. TONS.

The experiments with this gun have been —

1. To determine the charge.
2. For trial of W. A. and Foreign prismatic gunpowder.

1. To determine the charge.

It being found (see p. 4 of Progress Report, 1880), that there was great difficulty in ramming the 200 lb. P² cartridge made up with sticks into the 40.1-inch powder chamber, experiments were made with cartridges having hollow cylindrical zinc internal tubes. These, however, were found to buckle up under the rammer and were abandoned, and the Committee, 25-5-80, recommended that prismatic powder should be adopted for the charges for these guns, and that they should be chambered to a diameter of 14 inches and a length of 40.1 inches, and after trials, the results of which are given in Appendix D to Section IV, they recommended that the charge should be 210 lb. of prismatic powder $\pm \frac{1}{2}$ per cent. to allow of the cartridges being made up in complete tiers of prisms, the charge to be made up in two cartridges.

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It being pointed out in a Minute, 18-1-81, by Superintendent R. L., that there was a difficulty in making equal half charges to this weight with complete layers of prisms, the Committee, 11-2-81, reported that it was advisable that the half charges should be interchangeable, and recommended that each half charge should be made of 21 layers having 54 prisms in each layer, i.e., the centre prism of each layer being omitted. This would make the weight of the whole charge 210 lb. and its length 41.6 inches.

2. The trial of W. A. and Foreign prismatic powder.
(For results of these trials, see Section IV.)

The 12.5-inch 38-ton Proof Guns.

The Superintendent R. G. F., 26-5-80, reported that No. 415 gun was no longer serviceable. The Committee recommended that the gun should be re-tubed, and also that another gun should be chambered and pierced for crusher-gauges.

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The Admiralty having, 30-4-80, enquired whether the form of chamber was a source of weakness, the Committee recommended that the new proof gun should be fitted for a crusher-gauge No. 3 at the neck of the chamber to determine this point. This was approved, 23 6 80, and the Committee, 10-9-80, forwarded the results of trials, and reported that there was no increase of pressure at this point. (For results, see Appendix C.)

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The re-tubing of No. 415 gun for proof purposes was approved, 10-11-80.

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The Committee were informed, 11-2-81, that No. 1 gun had become unserviceable through the cracking of the tube, and that No. 98 was to be taken into use for proof of powder and marked Expl. No. 451.

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SECTION IV.

4.—TRIAL OF GUNPOWDER FOR HEAVY GUNS. FOREIGN PRISMATIC POWDERS.

The Committee in their former progress report, April 1880, informed that 9,000 lb. of 1-hole powder and 1,000 lb. of 7-hole had been procured from the Rottweil Company Hamburg, and 10,000 lb. from the Westphalian Powder Company at Cologne, and the results of trials of this powder up to 30-4-80 are given in Appendix O. to that report. This powder may be termed the 1st Supply.

The following additional orders have since been given to these firms:—
6,000 lb. of Rottweil 1-hole powder, 3,000 lb. for 38-ton gun, and 3,000 lb. for 80-ton gun were ordered, 4-4-80, and notice of delivery was given, 2-11-80.

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100,000 lb. of Westphalian 1-hole powder were ordered, 24-7-80, and notice of delivery was given, 2-11-80. This is termed the 2nd Supply.

An additional order was given to the Westphalian Powder Company for 150,000 lb. of 1-hole powder, 5-10-80. This will be termed the 3rd Supply.

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A further order for 40,000 lb. of 1-hole prismatic was given to each of the above Companies, 10-2-81. This will be termed the 4th Supply.

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The trial of the 2nd Supply is given in Appendix D.

The Rottweil powder, 6,000 lb., being for experimental purposes, was ordered to fulfil the following conditions:—

1. 3,000 lb. of powder, which the Rottweil Hamburg Company consider suitable for a R.M.L. gun of 12.5-inch calibre, having a powder chamber 14 inches in diameter and 40.1 inches long, and firing a charge of from 200 to 212 lb. weight, with a projectile weighing 800 lb.

39,164

The powder must not give a mean pressure in powder chamber of more than 18 tons per square inch, as indicated by compression of copper cylinders.

2. 3,000 lb. of powder, suitable for a 16-inch R.M.L. gun having a chamber of 18 inches diameter and 60 inches long, firing a charge of from 425 to 450 lb. of powder, and projectile of 1,700 lb. weight.

The powder must not give a pressure at the bottom of the bore of more than 19 per square inch.

The Westphalian powder being for supply was ordered to come up to the terms of specification (see Appendix D).

At the first trial of this powder all the lots passed except 7 and 8. On the recommendation of the Committee the proof was repeated, and all the lots were then passed.

The 3rd Supply was sent in, and samples proved, 19-3-81. (For results see Appendix D.) The whole of the lots failed to pass.

For the 4th Supply the specification was slightly modified (see Appendix D.)

WALTHAM ABBEY SAMPLES OF PRISMATIC POWDER.

The manufacture of samples of prismatic powder has been continued with success.

The result of trial of samples 1 to 11 are given in Appendix O. of progress report, 1880.

These samples were all of about the same size as the foreign prismatic powder that has been supplied to this country, viz., height 24.8 mm.; diameter of sides 3.7 mm.; diameter of hole 10 mm.; average weight from 10 to 11 to the lb.

Trials have since been made with prisms of an increased size, and with varying sizes of central hole. These results have been so far satisfactory that the Committee, 16-2-81, recommended that the machine ordered for Waltham Abbey should be constructed in the first instance for the manufacture of prisms of about the following dimensions—height 2 inches; diameter of sides 2.375 inches; diameter of hole 0.575 inches; weight about 1.7 to the lb.

Some powder was also made with the addition of lamp-black to the charcoal. This was fired in the 8-inch S. B. gun. It gave rise to very high pressures, and the trial was not proceeded with (For results of trials of this and other samples of W.A. powder, see Appendix E.)

SECTION V.

GUNPOWDER FOR FIELD AND SIEGE GUNS.

The recommendations as to the use of R. L. G.² powder having been approved, the following are now the regulations under which it is used:—

"It may be used instead of L. G. or R. L. G. powder for all rifled B. L. guns up to 40-pr. inclusive; for all rifled M. L. guns, from 9-pr. to 40-pr. inclusive; for the 6 lb., 8 lb., and 10 lb. charges for 64-pr. rifled M. L. guns, and for all smooth-bore guns.

"It may also be employed for the exceptionally heavy charge for 64-pr. of 64-cwt. R. M. L. guns, Mark III., with steel tubes; but in this case the charge will be 11 lb. of R. L. G.² instead of 12 lb. R. L. G.

"L. G. powder will be retained for smooth-bore mortars."

A specification for this powder was approved, 6-12-80, see Appendix F.

Some R. L. G.² powder fired at St. Thomas' Mount in the 25-pr. R. M. L. gun was found to have given pressures in the bore amounting to 43 tons on the square inch. No particulars however, as to the moisture of the powder at the time of firing were given. Some of the same brand of powder, viz. Lot 2,930 W. A., brand 37, September 1878, was obtained from Purfleet and fired in the 25-pr. gun. The pressures given by it (see Appendix F) were high, but nothing to compare with those obtained in Madras. It was thought that the dry climate of India might have dessicated the powder to such an extent as to give rise to this very violent pressure; accordingly some of the powder was dried until it contained only 0.3 per cent. of moisture. The pressures were then much higher, amounting to as much as 25.2 tons on the bore, and 29.5 tons on the base of the shot (see Appendix F.) The Committee recommended that two more rounds should be fired in India, and the exact conditions under which they were fired should be reported, viz., moisture of powder,

length and density of charge, position of crusher-gauges, and pressure on the base of the shot. Also, that the remainder of the powder should be sent Home for trial. The India Office have been requested to arrange for this.

SECTION VI.

TRIAL OF SMALL-ARM POWDERS.

The question of the deterioration of R. F. G.² powder was referred to the Committee, it having been ascertained that the mean velocity of the Martini-Henry bullet, which, according to the specification, should be 1315 f.s., had fallen below 1290 f.s. The matter had been previously referred to a Departmental Committee, who carried out a series of experiments, an abstract of which will be found at p. 24, marked Appendix G. The Committee submitted an amended specification (see Appendix G.), in which the velocity proof was made to depend on the amount of moisture that the powder contained at the time of proof. It was recommended that this specification should govern manufacture for one year. Superintendent R. G. P. F. reported that the manufacture of R. F. G.² powder had improved, and that he could easily make powder up to the specification. A table shewing the velocities given by the different brands of powder is given in Appendix G. The Committee have recommended the adoption of this specification.

SECTION VII.

METHOD OF IMPROVING THE KEEPING QUALITIES OF GUNPOWDER.

The effort that has been made to improve the keeping qualities of R. F. G.² powder are given in Section VI and its appendix.

The question of coating powder with paraffin to improve its keeping qualities has been considered by the Committee, and experiments are in progress. Some P. powder, coated with 0.2 per cent. of paraffin, was fired in the 8-inch S. B. gun, 28-1-81, with the following results:—

Powder.	Density of charge.	Muzzle velocity.	Pressure, tons per square inch.		
			A.	B.	C.
Paraffined	24.86	1446	14.3	13.3	13.1
Non-paraffined	"	1456	15.3	15.3	14.9

No special fouling was observed.

A further supply of powder has been demanded, half to be coated with 0.2 per cent., and half with 0.5 per cent. of paraffin.

Trials of R. L. G. powder, coated with paraffin, were carried out in 1868 by the Ordnance Select Committee, but were abandoned principally on account of the increased fouling in the bore. It is thought that this may not occur to so great an extent when P. and larger powders so treated are used.

SECTION VIII.

GUNPOWDER OF INDIAN MANUFACTURE.

The India Office, 14-12-80, forwarded a letter from the Inspector-General of Ordnance, Madras, submitting a proof of R. L. G.² powder made from charcoal sent out from England. He was of opinion that the manufacture of charcoal can be carried out satisfactorily at the Madras Gunpowder Factory.

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Artillery
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The Commander-in-Chief, India, informed, that with the siege train in Afghanistan in 1878, Madras modified P. powder was used, it being found from experiment that 8 lb. of this powder gave a less pressure than 7 lb. R. L. G. in the 40-pr. R. M. L. gun, while an increased velocity was obtained.

The Committee recommended that experiments should be carried out with P. powder in the 40-pr. and 25-pr. R. M. L. guns, and also that two barrels of the Madras modified pebble should be obtained.

The India Office, 4-3-81, were requested to obtain this supply of powder.

KIRKEE R. L. G² POWDER.

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The India Office, 5-2-81, informed that two barrels of Kirkee made R. L. G.² were at Purfleet, and requested that they might be tested.

These powders were fired in the 9-pr. and 25-pr. guns, 28-2-81 and 8-3-81. The results are given in Appendix H. These powders do not compare favourably with R. L. G.² powder made in this country, neither lot coming up to the specification.

SECTION IX.

GUNCOTTON AS A BURSTING CHARGE FOR SHELLS.

Endeavours to use guncotton as a bursting charge for common shell are still being made. The Sub-Committee on Plates and Projectiles are trying in the first instance to obtain an effective delay action fuze, such that, even if set in action prematurely, the delay would allow of the shell being out of the bore before the guncotton was detonated. The Committee on Explosives, 2-7-80, considered that experiments should be carried out to ascertain the effect of the premature action of guncotton bursters in shell under the following conditions, viz:—

1st.—In a common shell with a large bursting charge as would be used with howitzers for bombarding purposes.

2nd.—In a forged steel shell with comparatively small bursting charge as would be used with armour-piercing guns under the following abnormal conditions:—

(a.) Shell cracked.

(b.) Delay action fuze defective, so as to come into action on discharge of the gun.

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And, 22-9 80, they considered that a suitable fuze must first be found, and in the first instance trials should be carried out with a small gun, such as the 25-pr. R. B. L. gun firing steel shell at a 4-inch plate, to obtain a really appreciable interval between the impact of the shell and its bursting. These experiments are in the hands of the Sub-Committee on Plates and Projectiles.

SECTION X.

FOREIGN GUNPOWDERS.

The trial of the prismatic powders received from abroad is given in Section IV.

A small sample of Fossano progressive powder brought from Italy by General Younghusband, C.B., R. A., gave on analysis the following results:—

Powder, dry:—

Nitre	...	...	74.74
Sulphur	...	...	10.29
Charcoal	...	...	14.97

Charcoal:—

Carbon	...	...	75.30
Hydrogen	...	...	3.72
Oxygen (loss on analysis)	...	...	19.21
Ash	...	...	1.77

A quarter-barrel of R.F.G.² powder was obtained from the Rottweil Powder Company, Hamburg. The results of its trial compare favourably with those given by our R.F.G.² powder. The mean muzzle velocity of 10 rounds was 1324 f.s., the difference between the highest and lowest velocities being only 15 feet, showing great regularity. In firing for accuracy also it gave better targets than our powder at 500 yards range, viz:—

		Corrected angle.	Figure of merit.
		° ° °	ins.
Service ammunition	..	1 6 36	8.45
Rottweil	...	1 4 6	7.48

The analysis of the Rottweil powder gave the following results:—

Density	...	...	1.750
Moisture	...	...	1.27
Absorption of moisture	...	...	.69
Analysis of dry powder:—			
Nitre	...	...	75.41
Sulphur	...	...	10.17
Charcoal	...	...	14.42
Analysis of charcoal:—			
Carbon	...	...	75.87
Hydrogen	...	...	3.50
Ash	...	...	3.84
Oxygen	...	...	16.79

Experiments are now in progress to compare this powder with R.F.G.² of this year's manufacture.

SECTION XI.

VINER POWDER.

The further trials with this gunpowder have not been successful. A small machine was constructed, and it was attempted to manufacture it by heating it to the melting point of sulphur and then submitting it to pressure, but it was found impossible so to consolidate it. (See reports of Superintendent R.L. and Chemist to W.D., Appendix L.)

It has since been ascertained from Military Attaché, St. Petersburg, that this powder was manufactured by raising the ingredients to the fuzing point of saltpetre, and that several explosions had occurred.

As the fuzing point of saltpetre approximates the firing point of gunpowder, the Committee decided to await the result of Colonel Viner's trials.

TRAVELLING TRIALS OF PRISMATIC POWDER.

In order to decide how prismatic powder would stand travelling, and the ordinary rough usage of the service, the Committee have organized a few experiments, the most extensive of which were carried out on board the *Excellent* (see Appendix I.) The powder was in land service cylinders, evidently not suitable for the carriage of prismatic powder charges for sea service, and did not stand the severe knocking about given it by the Navy, as well as P² powder—the latter, however, was in a measure protected by its central sticks, which acted as buffers. The Committee are of opinion that it will be found to stand the ordinary rough usage of the service well enough. Further trials are in progress, the cartridges being packed in suitable cases.

TRIAL OF PRISMATIC POWDER FIRED WITH RADIAL AND AXIAL VENTS.

Some experiments have been carried out with prismatic powder in the 12.5-inch proof gun, using the radial (or service) and the axial vents. The results tend to show that there is but little difference either in velocity or pressure whichever vent is used. (For results of experiments, see Appendix K.)

POWDER FOR 1-INCH NORDENFELT GUN.

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The question of obtaining a suitable powder for the cartridges of the 1-inch Nordenfelt Machine Gun was referred to the Committee, 22-10-80. Three different sorts of powder were selected for trial in the first instance, viz., L.G. powder, Pigou and Wilks, No. 8, and a W.A. special powder. For the purpose of ascertaining the pressures given by these powders, a barrel of a 1-inch Nordenfelt gun was fitted with a crusher-gauge, and the velocities and pressures given by the different powders observed. These trials were carried out at the Royal Small Arms Factory, Enfield (for results see Appendix M.) From these results the Committee recommended that further experiments with compressed charges should be carried out.

SECTION XII.

GENERAL REMARKS.

The Committee, in forwarding the final report of their trials, wish to point out what, in their opinion, are the points concerning explosive substances which still most urgently require to be dealt with. They are:—

1. Improvement in the manufacture of prismatic gunpowder.
2. The extended use of prismatic powder for heavy guns, and its trial in siege and field guns.
3. Improvements in the keeping qualities of all powders.
4. The proof of gunpowder for the larger natures of guns.
5. The use of guncotton as an explosive for shells.
6. The more secure packing and storage of prismatic and other gunpowders, more especially for transit to and storage in foreign stations.
7. The devising suitable powder cases in ships' magazines for prismatic powder, and also suitable cartridge cases for its supply to the guns.

R. J. HAY, *Colonel, R.A.,*
President.

ROYAL ARSENAL, WOOLWICH,
28th March 1881.

APPENDICES.

APPENDIX A.

Experiments with 100-ton R.M.L. Gun, No. 3458, Proof Butts.

Date of firing.	No. of round.	CHARGE.			Weight of projectile.	Observed velocity at 250 feet.	Muzzle velocity.	PRESSURES, TONS PER SQUARE INCH.		
		Nature of powder.	Weight.	Cubic inches per lb. and density.				A.		Shot.
								...	...	
16-2-81.	4	Westphalian prismatic ...	lb. 425	40·1 0·691	lb. 2,000	f.s. 1,481 1,485	f.s. 1,493	14·0	13·4	11·7
"	5	" "	450	37·87 0·733	"	1,538 1,534	1,546	15·3	15·4	12·8
18-2-81.	6	Lot 5, 10·77 pieces to lb....	450	37·87 0·733	"	1,544 1,541	1,553	15·3	15·3	13·3
24-2-81.	7	" "	450	37·87 0·733	"	1,538 1,539	1,549	15·3	15·2	12·8
"	8	" "	"	"	"	1,534 1,535	1,545	15·4	15·2	13·3

APPENDIX B.

FORCE OF BLAST OF 80-TON GUNS.

D.N.O., 22-11-79, requests that the following may be ascertained:—

1. The force of the blast from the 80 ton gun when the gauge is situated and is firmly held within the cone of the explosion, and near the muzzle. This to be ascertained both with and without a projectile.

2. To ascertain by gauge the amount of the unbalanced pressure of the atmosphere per square foot under similar circumstances, due to the velocity of the air current past a surface exposed to the blast. In other words, it is desired to know the amount of force tending to blow a structure from the line of fire of the gun, and also that which tends to blow it towards the same line.

D. of A., 15-11-79, forwards to President, Committee on Working Heavy Guns; and, 30-12-79, asks for report as to what is proposed to be done; to be sent in when arrangements are completed.

President, Committee on Working Heavy Guns, 3-3 80 (*Minute* 37, 749), would be glad to know more exactly what the requirements of the Admiralty are before making any arrangements.

D.N.O., 17-3-80, replies that no more information can be given than that conveyed in S 11,257 22-11-79.

President, Committee on Working Heavy Guns, 24-3-80, asks if Admiralty are prepared to go to an expense of 200*l.*; if so, a simple structure of piles and woodwork will be arranged, which, with the gauges recommended in Admiralty letter of 22-11-79, may give sufficient data to meet their requirements.

D. of A., 8-4-80, with the concurrence of I. G. of F., 5-4-80, approves of erection of a structure as proposed.

D. of A., 30-4-80, refers paper to Committee on Explosives, the Committee on Working Heavy Guns having been relieved of subjects connected with 16-inch R.M.L. gun (*see Minute* 37,894).

Inform President that Captain Bridge, R.N., Member of Committee, knows what is required.

President, Committee on Explosives, 20-5-80, on suggestion of Captain Bridge, R.N., and Superintendent R.G.F., proposes that four pressure gauges, at a cost of 50l. each, should be constructed for carrying on these trials, and enquires if a demand shall be sent in on approval of D. of A., 8-4-80, which was for a structure to be erected on I.G. of F's. vote, to cost same amount (200l.), and which is not now required.

D.N.O., 12-5-80, requests to be informed when experiments to ascertain the force of the blast from the 80-ton R.M.L. gun are to be carried out, in order that Admiralty officers may be present.

D. of A., 14-5-80, forwards to President, Committee on Explosives, who draws attention to Minute, 20-5-80, on G. N. as above, which is sent to D.N.O., 21-5-80.
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D. of A., 24-5-80, understands that Superintendent R.G.F. having made one gauge, requires a covering order, and considers that one more will be sufficient. Its manufacture is to be proceeded with, and this paper passed to Secretary, W., to give the necessary demand.

Secretary, W., and Committee on Explosives to note.

Secretary, W., 28-5-80, puts forward a demand, No. 13,128, for two gauges, noting on demand that these gauges cost 50l. each, and that 200l. has been authorized, as probably four gauges will be required.

Experiments with instruments for measuring the Blast of Guns.—Proof Bullets.

Date of firing.	Nature of gun.	No. of round.	Charge.	LEFT OF GUN.			RIGHT OF GUN.			Remarks showing position of stand after firing.	DISTANCE OF INSTRUMENT BEFORE FIRING.			Height of instrument from ground.	Height of muzzle of gun from ground.
				Instrument and spring.	Register.	Pressures lb. per square inch.	Instrument and spring.	Register.	Pressures lb. per square inch.		In front of muzzle.	From line of firing.	From muzzle.		
					Before firing.	After firing.		Before firing.	After firing.		ft. ins.	ft. ins.	ft. ins.	ft.	ft.
19-5-80	80-ton, No. 4.	52	Weight 450 lb. Westphalian prismatic.	Y.	0	3	200	.....	.....	.....	.....	.....	.....	3	8
"	"	53	"	Spring a weak one, not in series care-fully tested	0	2-67	1920	Moved 6 ins. towards line of fire and 15 ins. forward.	.....	.....	.....	.....	.....	8	"
16-6-80	"	54	475 lb. Westphalian prismatic.	.....	0	3-4	2430	Moved 4 ins. towards line of fire and 1 foot forward. A 1,700 lb. shot was placed in rear of stand, and was moved back 3 feet.	.....	.....	.....	.....	.....	3	"
21-6-80	80-ton, No. 5.	1	425 lb. W. A. P. ²	.....	0	5-7	590	Moved 18 ins. forward. Spring broken.	.....	.....	.....	.....	.....	"	"
3-8-80	8-in. gun, No. 139.	1	35 lb. P. Lot.	Z. A.	0	5-5	590	.....	Y. A.	.....	.....	.....	.....	"	"
"	"	2	"	"	.....	1-23	1330	.....	"	.....	.....	.....	.....	"	"
"	"	3	"	"	.....	1-47	1610	.....	"	.....	.....	.....	.....	"	"
23-7-80	8-in. S. B. gun, No. 199.	245	"	"	0	3-8	381	.....	"	.....	.....	.....	.....	"	"
"	"	246	"	"	.....	7-2	770	.....	"	.....	.....	.....	.....	"	"
"	"	247	"	"	.....	2-20	2430	.....	"	.....	.....	.....	.....	"	"
4-8-80	8-in. S. B. gun, No. 208.	691	"	Y. A.	0	1-59	1730	.....	Z. A.	.....	.....	.....	.....	"	"
"	"	692	"	"	1-6	1-97	2140	.....	"	.....	.....	.....	.....	"	"
"	"	693	"	"	2-0	2-21	2430	.....	"	.....	.....	.....	.....	"	"
5-8-80	80-ton gun, No. 2.	1	425 lb. P. ² Lot 2909.	Z. A.	2-5	3-08	3360	Moved 2 ins. towards line of fire and 1 in. forward.	Y. A.	.....	.....	.....	.....	"	"
"	"	2	415 lb. P. ² Lot 2909.	"	2-5	2-87	3146	Moved 3 ins. forward and inverted. Spring broken.	"	.....	.....	.....	.....	"	"

Secretary, Committee on Explosives,

Two instruments (Y and Z) were made and tested with springs of various strengths (A, B, C, D), being placed symmetrically near the muzzle of 9-prs. and 64-prs. fired at proof. The results were very irregular, but it became clear that the stronger the spring, the higher the pressure it registered. This, I think, shows conclusively that the action of the blast resembles a blow, not being sustained long enough to compress the weaker spring to the full extent required to register the pressure indicated by the shorter travel of the index carried by the stronger spring. For heavier guns, therefore, the strongest springs only were used. In some cases the springs were pinned down to about the pressure expected, the blast then compressed them still more, though not to the same extent as when they were free. This confirms the view that the action of the blast much resembles a blow.

The Tables sent herewith give all that we know regarding the effect of the blast of the 80-ton gun, but we might perhaps test the effect of the return draught by reversing one of the instruments.

The information given by the springs does not seem to give very satisfactory data for calculating the true pressure on a fixed structure, but I shall be happy to carry out any further experiments you may wish to make.

E. MAITLAND, *Lieut.-Col., R. A.,*
Superintendent, Royal Gun Factory.

23-9-80.

APPENDIX C.

Committee, 10-9-80, forward result of 36 rounds fired from No. 1, 12.5-inch chambered gun with charges from 180 lb. to 209½ lb. of powder, W. A. P.² and Westphalian prismatic powders having No. 3 crusher-gauge at the contraction of the powder chamber. There is no increase of pressure at this point due to the form of the chamber. The following table gives the results of proof:—

Weight of projectile—810 lb.

Date of firing.	No. of round.	CHARGE.			Observed velocity at 135 feet.	Muzzle velocity.	PRESSURES, TONS PER SQUARE INCH.						
		Nature of powder.	Weight.	Cubic inches per lb. and density.			A.	1	2	3	4	Base of shot.	Mean on chamber.
19-8-80	1	W. A. Prismatic, No. 13	180	33.3 0.833	f. s. {1189 1193 1390 1391	f. s. 1198	*	†	†	†	†	10.3	...
"	2	" No. 14	"	"	{1390 1391 1505 1507	1399	*	11.3	13.1	12.8	12.4	12.0	12.4
"	3	" No. 14	200	30.0 0.924	{1505 1507 1339 1342	1515	*	17.3	16.9	15.8	16.1	15.9	16.7
"	4	" No. 13	"	"	{1339 1342 1615 1618	1349	*	12.0	11.5	11.9	9.3	14.0	11.8
20-8-80	5	W. A. P. ² 5-8-80	"	"	{1615 1618 1617 1597	1626	24.3	21.8	23.3	19.0	27.1	16.1	22.1
"	6	" 9-8-80	"	"	{1615 1617 1597 1595	1625	25.7	24.1	18.4	20.2	26.2	21.8	23.1
"	7	" 12-8-80	"	"	{1597 1595 1537 1536	1605	22.7	21.1	21.5	18.1	24.1	18.9	20.8
"	8	" 20-5-80	"	"	{1537 1536 1557 1554	1545	22.1	†	18.9	18.3	20.2	20.5	...
"	9	" 25-5-80	"	"	{1557 1554 1563 1565	1564	20.8	18.0	21.4	18.4	21.5	17.4	19.6
"	10	" 28-5-80	"	"	{1563 1565 1549 1549	1576	21.1	18.1	21.8	19.8	22.4	19.4	20.2
"	11	" 2-6-80	"	"	{1549 1560 1565 1613	1558	20.5	†	21.0	19.4	20.0	16.7	...
"	12	" 3-6-80	"	"	{1560 1565 1613 1610	1572	20.7	21.5	22.2	18.6	22.9	19.0	20.7
23-8-80	13	" 9-6-80	"	"	{1613 1608 1603 1614	1621	24.3	24.7	24.1	20.9	26.0	20.9	23.5
"	14	" 10-6-80	"	"	{1608 1603 1614 1612	1615	23.8	18.2	23.1	21.0	25.9	16.8	21.5
"	15	" 17-6-80	"	"	{1614 1612 1597 1592	1622	23.8	23.0	22.7	22.9	27.2	15.9	22.8
"	16	" 21-6-80	"	"	{1597 1592 1580 1577	1604	23.7	21.1	22.5	19.1	24.2	19.9	21.4
"	17	" 23-6-80	"	"	{1580 1577 1604 1600	1588	22.1	22.1	21.0	19.9	21.6	18.6	21.3
"	18	" 24-6-80	"	"	{1604 1600 1592 1593	1611	23.2	22.7	23.0	20.7	24.0	19.4	22.6
24-8-80	19	" 16-8-80	"	"	{1592 1593 1596 1597	1602	22.3	22.2	22.4	21.8	24.6	19.9	22.2
"	20	" 19-8-80	"	"	{1596 1597 1595 1597	1606	22.6	23.4	22.5	21.7	24.9	20.1	22.2
"	21	" 30-6-80	"	"	{1595 1597 1593 1592	1605	21.9	20.0	21.8	21.2	26.0	19.1	21.2
"	22	" 2-7-80	"	"	{1593 1592 1612 1608	1602	21.9	22.6	22.8	22.2	47.0	20.7	22.4
"	23	" 5-7-80	"	"	{1612 1608 1618 1616	1619	24.2	20.9	22.3	21.6	24.1	21.9	22.2
25-8-80	24	" 7-7-80	"	"	{1618 1616 1608 1604	1626	25.5	22.3	23.1	22.1	24.9	20.0	23.2
"	25	" 9-7-80	"	"	{1608 1604 1620 1615	1615	22.9	23.4	23.5	21.6	22.8	19.9	22.6
26-8-80	26	" 13-7-80	"	"	{1620 1615 1600 1600	1627	23.1	22.4	22.6	22.4	25.4	21.4	22.6
"	27	" 14-7-80	"	"	{1600 1600 1617 1615	1609	22.4	24.0	19.0	21.7	24.0	20.1	21.8
"	28	" 17-7-80	"	"	{1617 1615 1624 1620	1625	23.2	24.1	23.3	22.7	24.9	21.5	23.4
"	29	" 22-7-80	"	"	{1624 1620 1617 1612	1630	24.4	22.0	24.9	23.4	23.9	21.6	23.7
"	30	" 24-7-80	"	"	{1617 1612 1616 1612	1624	†	24.0	23.1	22.8	24.2	21.4	...
"	31	" 28-7-80	"	"	{1616 1612 1625 1623	1623	26.6	23.6	22.4	22.5	25.5	20.9	23.8
"	32	" 30-7-80	"	"	{1625 1623 1529 1531	1633	26.7	23.9	23.6	23.2	26.6	21.9	24.4
27-8-80	33	Westphalian prismatic, 38-ton.	209½	28.7 0.966	{1529 1531 1533 1531	1539	*	17.6	18.8	18.5	20.1	17.0	18.3
"	34	" "	"	"	{1533 1531 1540 1536	1541	*	16.7	18.3	18.1	20.4	17.1	17.7
"	35	" 80-ton	"	"	{1540 1536 1529 1525	1547	*	18.4	19.3	18.5	21.1	...	18.7
"	36	" "	"	"	{1529 1525	1536	*	17.6	18.6	18.5	18.4	...	18.2

APPENDIX D.

ANALYSIS OF 2ND SUPPLY, ROTTWEIL POWDER.

Composition of the dry powder.

				For 80-ton gun. per cent.	For 38-ton gun. per cent.
Nitre	...	...	...	74.97	74.56
Sulphur	...	...	...	10.17	10.63
Charcoal	...	...	...	14.86	14.81
Moisture	...	...	...	1.19	1.06
Density	...	...	...	1.775	1.776

Trial of Rottweil Prismatic Powder.—(See Minute 39,162.)

Gun, 12.5-inch. Experimental No. 448.

Date of firing.	No. of round.	Charge.	Observed velocity at 135 ft.	Muzzle velocity.	PRESSURES IN TONS PER SQUARE INCH.						
					A.	1	2	3	4	Mean on chamber.	Shot.
29-11-80	69	180 lb. 33.3 cub. inch per lb...	{1319 1321}	1328	*	†	†	†	†	...	...
"	70	"	{1352 1353}	1361	*	†	†	†	†	...	...
"	71	210 lb. 28.57 cub. inch per lb.	{1492 1495}	1503	*	14.1	14.7	15.1	12.1	14.6	...
"	72	"	{1524 1530}	1536	*	16.9	17.3	16.6	16.3	16.9	...

* Axial vent used. † 12-ton copper used, not further compressed.

Committee, 3-12-80, forward results, and report that the 38-ton powder has complied with the conditions laid down, and may be passed; the 80-ton powder has been fired in 38-ton gun, in which it gave very low pressures. It will now be fired in the 80-ton gun with a 450 lb. charge.

Trial of the Rottweil 38 and 80-ton prismatic powder.

Gun, 16-inch R.M.L. No. 3. Fired 29-12-80. Projectile, 1,700 lb.

Nature of Powder.	No. of round.	Density.	Moisture.	Charge.	Muzzle velocity.	PRESSURE IN TONS PER SQUARE INCH. A.				
						1	2	3	Mean on chamber.	Shot.
Rottweil, 38-ton	6	1.776	1.06	450 lb.	1578	17.2	15.3	17.1	16.5	14.6
" 80-ton	7	1.775	1.13	32.34 cubic inches per lb.	1563	15.6	15.4	15.6	15.6	13.6

Committee, 17-1-81, consider that the powder has fulfilled the conditions required.

ANALYSIS OF 2ND SUPPLY, WESTPHALIAN POWDER.

Composition of the dry powder.

				Per cent.
Nitre	...	...	...	76.30
Sulphur	...	...	...	9.88
Charcoal	...	...	...	13.82

Lots.	Moisture.	Density.
1	1.19	1.768
2	1.28	1.772
3	1.19	1.772
4	1.12	1.771
5	1.16	1.762
6	1.13	1.766
7	1.09	1.763

RESULT OF PROOF OF 2ND SUPPLY, WESTPHALIAN POWDER.

1st Proof. Gun, 12.5-inch. Experimental No. 448.

Date of firing.	No. of round.	Lot.	Charge	Observed velocity at 135 ft.	Muzzle velocity.	PRESSURES IN TONS PER SQUARE INCH.						
						A.	1	2	3	4	Mean on chamber.	Shot.
23-11-80	60	1	200 lb.	{1515 1517}	1525	*	14.8	13.9	17.4	13.2	15.4	16.5
"	61	2	"	{1520 1520}	1529	*	17.8	17.7	17.0	22.3	17.5	16.1
"	62	3	"	{1513 1510}	1521	*	17.0	18.0	16.2	21.6	17.1	15.4
25-11-80	67	4	"	{1507 1512}	1519	*	†	15.6	14.6	13.0	.....	...
24-11-80	63	5	210	{1552 1552}	1561	*	18.5	18.9	15.1	21.4	17.5	17.3
"	64	6	"	{1545 1547}	1555	*	15.7	15.7	15.4	19.6	15.6	17.2
"	65	7	"	{1565 1560}	1572	*	19.1	19.6	19.4	25.4	19.4	20.2
"	66	8	"	{1567 1563}	1574	*	19.0	16.6	22.0	28.0	19.2	22.9

* Axial vent used.

† 12-ton copper used not further compressed.

Committee, 1-12-80, consider that all the lots, except 7 and 8, should be accepted at once. In order to test the uniformity of the powder, and for further proof of lots 7 and 8, they recommend that another round be fired from each lot with the same charges, and drawn in the same way as before; also that a 210 lb. charge be fired from No. 2 lot.

2nd Proof.

D. of A., 6-12-80, approves of Committee's recommendation, 1-12-80.

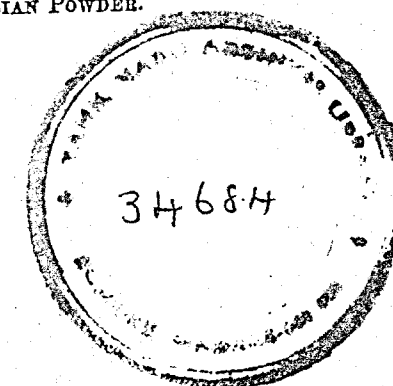
Secretary submits following results of further proof. Axial vent used:—

Date of firing.	No. of round.	Lot.	Charge. Weight.	Density.	Muzzle velocity.	PRESSURES IN TONS PER SQUARE INCH.				
						1	2	3	4	Mean on chamber.
8-12-80	76	2	200 lb.	c.i. 30.0	f.s. 1522	17.6	17.9	17.8	19.2	17.8
9-12-80	77	2	210	28.57	1555	16.9	19.0	18.5	14.9	18.1
"	78	3	200	30.0	1523	17.9	18.2	17.8	18.5	18.0
"	79	4	200	30.0	1521	16.1	17.5	17.5	16.4	17.0
10-12-80	80	5	210	28.57	1561	17.7	18.7	18.5	19.6	18.3
"	81	6	210	28.57	1553	17.1	18.5	18.3	19.5	18.0
"	82	7	210	28.57	1552	17.6	18.4	18.6	16.8	18.2
"	83	8	210	28.57	1551	15.8	17.9	18.2	16.4	17.3

Superintendent R.G.P.F., 17-12-80, informs the Committee that he considers that lots 7 and 8 may be passed.

Committee, 23-12-80, report that they concur with Superintendent R.G.P.F., the results show that the powder is very uniform.

RESULT OF PROOF OF 3RD SUPPLY, WESTPHALIAN POWDER.



Proof of 3rd Supply of Westphalian Prismatic Gunpowder.

DESCRIPTION OF POWDER.				12.5-INCH GUN. EXPERIMENTAL No. 448. CHARGE 210 LB. 28.57 CUBIC INCHES PER LB.											Remarks.		
Density.	Moisture.	No. of pieces to lb.	Brand.	Lot.	Date of firing.	No. of round.	Observed velocity at 215 feet.	M.V. for projectile and gas-check 810 lb.	Pressures in tons per square inch.								
									A.	1	2	3	4	Mean on chamber.		Shot.	
																	.
1.754	...	1.06	...	9	24-2-81	96 {	1520 1517	} 1531	*	*	17.5†	18.4	17.7	19.0	17.9	18.1	* Axial vent used. † Crushers placed in end of cartridge.
1.758	...	1.12	...	10	"	97 {	1517 1522	} 1533	*	*	18.1	18.5	17.3	20.0	18.0	18.5	
1.760	...	.99	...	11	2-3-81	98 {	1513 1517	} 1527	19.9*	19.8*	16.4	18.3	16.8	19.0	...	16.8	
1.754	...	.99	...	12	"	99 {	1517 1522	} 1532	20.1	18.7	17.8	19.3	18.0	24.1	...	16.8	

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Proof of 3rd Supply of Westphalian Prismatic Gunpowder.

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DESCRIPTION OF POWDER.				12.5-INCH GUN. EXPERIMENTAL No. 451. CHARGE 210 lb. 28.57 CUBIC INCHES PER lb.										Remarks.			
Density.	Moisture.	Num-ber of pieces to lb.	Brand.	Lot.	Date of firing.	Number of round.	Observed velocity at 135 feet.	M. V. for projectile and gas-check, 810 lb. weight.	Pressures in tons per square inch.						Mean on chamber.	Shot.	
									1	2	3	4					
1.767	1.03	10.87	...	14	8-3-81	1 {	1525 1527	1535	20.2	19.7	19.5*	18.5	17.6	21.2	16.8	Axial vent used.	
1.762	1.15		...	16	"	2 {	1531 1536	1543	19.2	19.8	19.1	18.9	18.5	24.1	19.2	* Crushers placed in end of cart-ridge.	
1.757	1.08		...	17	11-3-81	9 {	1525 1529	1536	20.0	20.2	17.8	17.7	18.1	20.5	17.3		
1.754	1.09		...	18	"	10 {	1517 1525	1530	18.3	20.0	19.0	18.1	18.4	21.8	17.3		
1.755	1.15		...	19	"	11 {	1514 1520	1526	19.8	20.0	17.2	17.4	17.9	21.0	16.8		
1.762	1.15		...	20	"	12 {	1518 1522	1529	19.6	17.5	19.2	18.0	17.8	19.9	17.4		
1.750	1.03		...	13	"	13 {	1521 1517	1528	20.1	20.0	18.6	17.9	18.3	20.9	17.7		
1.762	1.12		...	15	"	14 {	1517 1515	1525	18.3	19.6	19.2	17.6	18.0	21.1	17.0		

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PROVISIONAL SPECIFICATION to guide 2nd and 3rd Supply of Prismatic Powder.

1. *Ingredients*.—Every 100 parts of the gunpowder to contain 75 parts of pure saltpetre, 10 parts of pure sulphur, and 15 parts of charcoal, made from the best alder or white willow woods, charred in cylinders.

2. *Analysis*.—Samples may be selected from any portion of the gunpowder supplied, and subjected to chemical examination and analysis.

The analysis should show:—

1st.—That the saltpetre exists in a proportion of not less than 75 per cent., nor more than 76 per cent.; and that not more than one part of chlorine, nor more than four parts of sodium are contained in 3,000 parts of saltpetre.

2nd.—That the proportion of sulphur is not less than 9.5 per cent., nor more than 10.5 per cent., and that it has been thoroughly freed from earthy matters and other impurities.

3rd.—That the charcoal contains in 100 parts from 85 to 87 per cent. of pure carbon and 2.75 to 2 of hydrogen.

3. *Size of prisms*.—The prisms to be of the following dimensions:—

Height $24.8 \pm .2$ mm., to be determined by passing through a high gauge of 25 mm. and failing to pass through a gauge of 24.6 mm.

Diameter (over sides) 34.7 mm. to pass through a gauge of 34.9 mm., and to fail to pass one of 34.5 mm.

The hole to be 10 mm. in diameter.

4. *Density*.—The absolute density of the finished powder must not be less than 1.76.

5. *Moisture*.—The finished powder must contain not less than 1.0 per cent. of moisture, nor more than 1.3 per cent.

6. *Velocity*.—A charge of 200 lb. of the powder rammed in the 12.5-inch R.M.L. chambered gun, to a density of 30 cubic inches per lb. of powder (*i. e.*, to a gravimetric density of .924) shall give a muzzle velocity of not less than 1,525 feet per second, to a projectile fitted with a gas-check and weighing a total weight of 812 lb., or—

A charge of 210 lb. of the powder rammed to a density of 28.5 cubic inches per lb. of powder (*i. e.*, to a gravimetric density of .973) shall give a muzzle velocity of not less than 1,550 feet per second to a projectile fitted with a gas-check and weighing a total weight of 812 lb.

7. *Pressure*.—The pressure indicated on firing, as above, by the compression of copper cylinders, adjusted in crusher-gauges A, 1, 2, 3, situated as follows:—

A. Bottom of bore,

1. One foot from bottom of bore,

2. Two feet from bottom of bore,

3. Three feet from bottom of bore,

is not to be greater in any one gauge than 20 tons on the square inch, and the mean of the indications of above gauges shall not exceed 18 tons.

Supply and selection of samples for proof.—The powder to be supplied in 8 uniform lots of 100 cases (each case to contain about 125 lb. of powder).

For firing and other proof, the contractor shall supply, free of charge, 250 lb. for every 100 cases or less quantity delivered.

Approved, 28th January 1881

Specification to guide 4th Supply.

REVISED PROVISIONAL SPECIFICATION, for the 4th Supply of 1-hole Prismatic Powder.

1. *Ingredients*.—Every 100 parts of the gunpowder to contain 75 parts of pure saltpetre, 10 parts of pure sulphur, and 15 parts of charcoal, made from the best alder or white willow woods, charred in cylinders.

2. *Analysis*.—Samples may be selected from any portion of the gunpowder supplied, and subjected to chemical examination and analysis.

The analysis should show:—

1st.—That the saltpetre exists in a proportion of not less than 75 per cent. nor more than 76 per cent., and that not more than one part of chlorine, nor more than four parts of sodium are contained in 3,000 parts of saltpetre.

2nd.—That the proportion of sulphur is not less than 9.5 per cent., nor more than 10.5 per cent., and that it has been thoroughly freed from earthy matters and other impurities.

3rd.—That the charcoal contains in 100 parts from 85 to 87 per cent. of pure carbon, and 2.75 to 2 of hydrogen.

3. *Size of Prisms*.—The prisms to be of the following dimensions:—

Height $24.8 \pm .2$ millimetres, to be determined by passing through a high gauge of 25 millimetres, and failing to pass through a gauge of 24.6 millimetres.

Diameter (over sides) 34.7 millimetres, to pass through a gauge of 34.9 millimetres, and to fail to pass one of 34.5 millimetres. The hole to be 10 millimetres in diameter.

4. *Density*.—The absolute density of the finished powder must not be less than 1.76.

5. *Moisture*.—The finished powder must contain not less than 1.0 per cent. of moisture, nor more than 1.3 per cent.

6. *Velocity*.—A charge of 200 lb. of the powder rammed in the 12.5-inch R.M.L. chambered gun, to a density of 30 cubic inches per lb. of powder (*i. e.*, to a gravimetric density of .924) shall give a muzzle velocity of not less than 1,525 feet per second, to a projectile fitted with a gas-check and weighing a total weight of 812 lb.

7. *Pressure*.—The pressure indicated on firing, as above, by the compression of copper cylinders, adjusted in crusher-gauges A, 1, 2, 3, situated as follows:—

A. Bottom of bore,

1. One foot from bottom of bore,

2. Two feet from bottom of bore,

3. Three feet from bottom of bore,

is not to be greater in any one gauge than 20 tons on the square inch, and the mean of the indications of above gauges shall not exceed 18 tons.

This specification was also, on the recommendation of Committee, forwarded to the leading English powder makers for their information.

8. *Supply and selection of samples for proof*.—The powder to be supplied in uniform lots of 100 cases.

Each case must contain not less than 125 lb. of powder, and will be paid for as 125 lb. The weight of each case, with packing, but without powder, is to be marked in plain figures outside the case.

For firing and other proof, the contractor shall supply, free of charge, 250 lb. for every 100 cases or less quantity delivered.

WAR OFFICE,
The 28th January 1881.

Appendix E.

TRIAL OF SAMPLES OF W. A. PRISMATIC POWDER.

General description of samples.

No. of sample.	Height.	Diameter across sides.	Diameter of hole.	Pieces to lb.	Density.	Moisture.	Remarks.
	in.	in.	in.	lb.		per cent.	
12	.98	1.36	.375	11.1	1.789	1.00	3 hours hard burnt charcoal.
13	2.00	2.375	.375	1.6	1.808	1.08	The powders were made as nearly identical as possible, except 15 L. B. had half of lamp black to half of charcoal.
14	1.75	1.70	.375	3.6	1.789	1.00	
15	.98	1.36	.375	10.7	1.789	1.125	
15 L. B.	.98	1.36	.375	10.9	1.750	0.90	Prisms without central holes.
16	2.00	2.375	.575	1.7	1.780	1.075	
17	1.75	1.70	.375	3.7	1.787	1.02	
17 S.	1.75	1.70	.375	3.7	1.787	1.02	
18	2.00	2.37	.575	1.7	1.789	1.00	
19	2.00	2.375	.750	1.8	1.784	.93	
20	1.75	1.70	.475	3.4	1.811	1.00	
21	2.00	2.375	.575	1.7	1.789	1.03	
22	1.75	1.70	.475	3.9	1.766	1.12	

RESULTS OF PROOF OF SAMPLES OF W. A. PRISMATIC POWDER.

8-inch S. B. gun. Projectile, weight 180 lb.

No. of sample.	Date of firing.	Moisture when fired.	Density of charge.	Charge.	Muzzle velocity.	PRESSURE IN TONS PER SQUARE INCH.			Remarks.
						A.	B.	C.	
15	2-11-80	1.125	$\frac{24.28}{1.125}$	lb. 35	1437	14.0	14.5	14.8	The trunnion ring of the gun burst below the left trunnion, and the gun dislodged about an inch to the rear, shearing the three sets of sight sockets set in the trunnion ring.
15 L. B.	"	.90	"	"	1606	28.0	27.7	28.1	

12.5-inch R.M.L. Gun, No. 415. Projectile, 810 lb.

of Number sample.	of Number round.	Date of firing.	Density of charge.	Charge. lb.	Muzzle velocity.	PRESSURE IN TONS PER SQUARE INCH.						Shot.
						A.	1	2	3	4	Mean on chamber.	
12	279	25.5-80	33.3	180	1474	...	16.1	16.7	17.2	18.4	17.6	...
12	280	"	30	200	1578	...	20.8	20.8	15.9	27.1	19.2	...
12.5-in. R.M.L. Gun, No. 1.												
13	1	19.8-80	33.3	180	1198	...	9-ton coppers not further com- pressed-					10.3
13	4	"	30.0	200	1349	...	12.0	11.5	11.9	9.3	11.8	...
14	2	"	33.3	180	1399	...	11.3	13.1	12.8	12.4	12.4	12.0
14	3	"	30	200	1515	...	17.3	16.9	15.8	16.1	16.6	...
16	51	24.9-80	33.3	180	1443	...	15.4	14.5	14.3	14.4	14.7	...
16	52	25.9-80	28.57	210	1566	...	19.3	18.3	16.9	18.3	18.2	...
17	58	22.11-80	33.3	180	1476	...	15.1	15.0	15.4	15.4	15.2	...
17	68	26.11-80	30	200	1517	...	16.6	17.4	17.1	16.6	17.0	...
18	73	29.11-80	30	200	1483	...	15.3	15.6	15.9	15.4	15.6	...
19	74	30.11-80	33.3	180	1451	...	14.8	15.4	15.6	14.7	15.3	...
20	86	10.1-81	33.6	180	1290	...	9.1	9.8	9.6	9.8	9.5	...
21	94	18.2-81	33.3	180	1441	...	14.8	14.5	14.6	19.3	14.6	...
21	95	"	28.57	210	1539	...	18.3	18.5	17.6	20.1	18.1	...
22	...	17.3-81	33.3	180	1461	...	14.7	9.3	14.6	17.1	12.8	...
22	...	"	28.57	210	1563	...	18.0	15.9	17.5	19.2	17.9	...

16-inch R. M. L. of 80 tons, No. 3. Projectile weight, 1,700 lb.

Number of sample.	Number of round.	Date of firing	Density of charge.	Charge.	Muzzle velocity.	PRESSURE IN TONS PER SQUARE INCH ON AXIS					Remarks
						...	...	...	Mean.	Shot.	
17	4	23.12-80	32.34	450	1596	19.0	18.2	18.9	18.7	16.3	Fired with B.L. steel tube for preventing es- cape of gas.
18	5	24.12-80	857	"	1587	18.5	18.5	18.3	18.5	15.5	

Analysis of W. A. Samples. *15 and 15 L. B.

						SAMPLES.	
						15	15 L. B.
Nitre	...	...	...	...	...	75.27	75.04
Sulphur	...	...	...	...	...	10.49	10.60
Charcoal	...	...	...	...	...	14.24	Charcoal and lamp black 14.36
Moisture	...	...	...	...	...	1.07	.74
Density	...	...	...	...	...	1.799	1.772
Moisture absorbed in 48 hours	...	...	...	...	...	.37	.60

Remarks by Chemist to W. D.

The smaller percentage of water in the L. B. powder, its lower density, and more particularly its greater porosity (as indicated by its higher hygroscopic power), combine to account to a considerable extent for the very high pressures developed, but the latter must also be ascribed to the comparatively rapid combustibility of lamp black.

APPENDIX F.

Trial of R.L.G.² powder. Lot 2930, in 25-pr. R.M.L. gun. Charge, 4 lb. Projectile 25 lb.

No. of round.	Moisture per cent.	Date of firing.	Density of charge.	Muzzle velocity.	PRESSURE IN TONS PER SQUARE INCH.	
					B, 5 inches from end of bore.	Shot.
1	0.95	5.10-80	32.6 851	1393	17.7	21.7
2	"	"	"	1370	15.0	19.3
3	"	"	"	1368	17.3	21.1
4	0.31	10.11-80	"	1391	21.2	27.8
5	"	"	"	1393	16.7	24.8
6	"	"	"	1411	25.2	29.5

Analysis of above powder.

Composition of dry powder.

Nitre	...	...	...	...	75.56
Sulphur	...	...	...	...	10.48
Charcoal	...	...	...	...	13.96

Specification to guide the manufacture, and conditions of acceptance of R. L. G.² Gunpowder:

Approved, 6th December 1880.

1. *Sample Barrel.*—A sample barrel of powder will be sent from the Royal Gunpowder Factory, Waltham Abbey, as a guide to contractors in finishing their powder, and as regards the charcoal to be used, which must not be "slack-burnt."

2. *Ingredients.*—Every 100 parts of the gunpowder should contain approximately 75 parts of pure saltpetre, 10 parts of pure sulphur, and 15 parts of charcoal made from the best alder or white willow wood charred in cylinders.

3. *Analysis.*—Samples may be selected from any portion of the gunpowder supplied, and submitted to chemical examination and analysis.

The analysis must show:—

1st.—That not more than one part of chlorine, nor more than four parts of sodium, are contained in 3,000 parts of the dried saltpetre.

2nd.—That the proportion of sulphur is not less than 9.5 per cent., nor more than 10.5 per cent.

4. *Flashing.*—Samples of the powder should show, upon being fired on a clean glass plate, results not inferior to those given by an equal quantity of the sample, reduced to the same state of division.

5. *Size and shape of grain.*—The powder, when finished, must pass through a sieve of 3 meshes to the linear inch, and be retained upon a 6 mesh sieve.

If, however, a portion of the powder, not exceeding one-sixteenth part of the whole, pass through the 6-mesh sieve, its acceptance may be sanctioned by the Inspecting Officer, provided it fulfils the other conditions laid down.

In shape the grains should be compact (not flat nor flaky), clean, and glazed according to samples.

6. *Density.*—The absolute density of the finished powder must not be less than 1.65.

7. *Hygrometric test.*—The gunpowder when fired in proof must not contain less than 1.00 per cent. nor more than 1.2 per cent. of moisture, and further when it has been thoroughly dried and exposed to an atmosphere saturated with moisture, at a temperature of 60° Fah., must not absorb more than 1.5 per cent. in 24 hours.

8. *Velocity.*—The muzzle velocity imparted to a 9 lb. 3 oz. shot, fired from the 9-pr. rifled M.L. proof gun of 8 cwt. at Woolwich with a charge of 1½ lb. of the gunpowder, must not be less than 138', nor more than 1430 feet per second, or corresponding results must be given if a new proof gun is used.

9. *Pressure.*—The pressures indicated on firing as above by the compression of copper cylinders in crusher-gauges A and B, must not be greater on any one gauge than 15 tons per square inch.

The gunpowder to be delivered in barrels of 120 lb. each.

WALTHAM ABBEY, } C. B. BRACKENBURY, Lieutenant-Colonel, R.A.,
November 1880. } Superintendent, Royal Gunpowder Factory.

APPENDIX G.

PRECIS OF TRIALS OF KEEPING QUALITIES OF SMALL-ARM CARTRIDGES.

Committee on Siege Operations, 17-10-79, ask for information as to M. V. of bullets from machine guns and M. H. rifles firing the same service ammunition on the same day, the rifles being fired from the shoulder.

Secretary W., 12-2-80, forwards the following:—

TABLE A.

Velocities taken with the Martini-Henry Rifle fired from the shoulder, also Lowell machine gun.

Proof Butts, 21st October 1879.

No. of round.	Observed velocity at 110 feet.	No. of round.	Observed velocity at 110 feet.	Remarks.	No. of round.	Observed velocity at 110 feet.	No. of round.	Observed velocity at 110 feet.	Remarks.
Martini-Henry Rifle.					Lowell Machine Gun.				
1	1268	6	1232		1	Missed	7	1240	
2	Missed	7	1235		2	screen	8	1216	
3	2 ft. screen	8	1239		3	1238	9	1246	
4	1233	9	1256		4	Missed	10	1251	
5	1251	10	1259		5	screen	11	Missed	
6	1243	11	1252		6	1235	12	screen	
					7	1237	13	1236	
					8	1244	14	1258	
		Mean	1245	M. V. 1301 f. s.			Mean	1240	M. V. 1296 f. s.

Mark III Martini-Henry small-arm cartridges were used; they were manufactured, 1879.

TABLE B.

Velocities taken with Service Gatling Gun, 0.45 inch, and Martini-Henry Rifle fired from the shoulder.

Proof Butts, 25th November 1879.

No. of round.	Observed velocity at 110 feet.	Remarks.	No. of round.	Observed velocity at 110 feet.	Remarks.	No. of round.	Observed velocity at 110 feet.	Remarks.	No. of round.	Observed velocity at 110 feet.	Remarks.
Service Gatling Gun.						Martini-Henry Rifle.					
1	Missed		6	1336		1	Missed	6	1214		
2	1342		7	1320		2	1227	7	1242		
3	1342		8	1340		3	1187	8	1242		
4	Missed		9	1261	Minimum.	4	1226	9	1230		
5	1344	Maximum	10	1308		5	1201	10	Missed		
			Mean	1324	M. V. 1384 f. s.			Mean	1220	M. V. 1296 f. s.	

TABLE C.

Velocities taken with Martini-Henry Rifle to test ammunition of various dates of manufacture.

Date of firing, 12th December 1879.

No. of round.	Observed velocity at 110 feet.	Remarks.	No. of round.	Observed velocity at 110 feet.	Remarks.	No. of round.	Observed velocity at 110 feet.	Remarks.	No. of round.	Observed velocity at 110 feet.	Remarks.
M.H., Mark III, 1876.				M.H., Mark III, 1877.				M.H., Mark III, 1878.			
1	1181		1	1207		1	1213		1	1212	
2	1206		2	1205		2	Missed		2	1226	
3	1110		3	1221		3	1208		3	1233	
4	1197		4	1193		4	1212		4	1238	
5	1203		5	Missed		5	1218		5	1236	
6	1194		6	1184		6	1211		6	1220	
			7	1213					7	1221	
			8	1200							
Mean	1194	M. V. 1242	Mean	1203	M. V. 1252	Mean	1212	M. V. 1263	Mean	1227	M. V. 1282

TABLE D.

Velocities taken with 0.45-inch Gatling Gun to test ammunition of various dates of manufacture.

Woolwich, 18th December 1879.

No. of round.	Observed velocity at 110 feet.	Remarks.	No. of round.	Observed velocity at 110 feet.	Remarks.	No. of round.	Observed velocity at 110 feet.	Remarks.	No. of round.	Observed velocity at 110 feet.	Remarks.
1874.						Mark I, 1879.					
1	Missed		6	1307		1	1282		6	1319	
2	1327		7	1288		2	1315		7	1310	
3	1315		8	1307		3	1277		8	1312	
4	1277		9	1293		4	1297		9	1298	
5	1300		10	1286		5	1307		10	1324	
			Mean	1300	M. V. 1362				Mean	1304	M. V. 1366

TABLE E.

Velocities taken with Martini-Henry Rifle and Cartridges S.A. ball B.L. experimental solid cases. R.L., 1876.

Proof Butts, 1st January 1880.

No. of round.	Observed velocity at 110 feet.	Remarks.	No. of round.	Observed velocity at 110 feet.	Remarks.
1	Missed		6	Missed.	
2	1239		7	"	
3	1242		8	1253	
4	1246		9	1261	
5	1252		10	Missed.	
			Mean	1249	M. V. = 1305 f. s.

TABLE F.

Velocities taken with Martini-Henry Rifle and 0.45-inch Gatling Gun to test various kinds of ammunition.

Proof Butts, 27th January 1880.

Cartridges, S.A. ball, Rifle, B.L., Martini-Henry, Mark III, R.L. 1880.			Cartridges, S.A. ball, Martini-Henry arm. Experimental solid cases. R.L. 1880.			Cartridges, S.A. ball. Gatling Gun 0.45-in. Mark I. R.L., 1880.		
Number of round.	Observed velocity at 110 feet.	Remarks.	Number of round.	Observed velocity at 110 feet.	Remarks.	Number of round.	Observed velocity at 110 feet.	Remarks.
1	1217		1	1230		1	Missed.	
2	1214		2	1237		2	1302	
3	1212		3	Missed		3	1283	
4	1229		4	1246		4	1291	
5	1229		5	1231		5	1287	
6	1228		6	1232		6	1296	
7	1229		7	1237		7	1297	
8	1235		8	1238		8	1299	
9	1237		9	1232		9	1297	
10	1223		10	1230		10	1296	
Mean	1225	M. V. 1280	Mean	1235	M. V. 1292	Mean	1295	M. V. 1355

Secretary remarks on the above—

Table A.—Rounds of same ammunition were fired from the Martini-Henry from the shoulder, and from a machine gun, to see if the recoil made any difference in the velocity. This was shown not to be the case.

Table B.—Ten rounds of service Gatling ammunition and 10 rounds service Martini-Henry ammunition were fired from their respective guns on the same day. The Gatling gave a mean muzzle velocity of 1384 f.s., the Martini-Henry 1275 f.s.

Table C.—Result of firing Martini-Henry ammunition of different dates. The mean muzzle velocity of 1879 ammunition was 1282, falling off in each year till the 1876 ammunition, which gave only 1242 f.s.

Table D.—Result of firing Gatling ammunition of 1874 and 1879. The results were 1362 f.s. and 1366 f.s. respectively, showing no falling off.

Table E.—Result of firing 16 rounds of solid bottle-shaped cartridges from Martini-Henry Rifle. R.L., 1876. Muzzle velocity 1305 f.s.

Table F.—Ten rounds of service Martini-Henry, solid bottle Martini-Henry, and solid service Gatling were made by R.L. from same brands of powder, and carefully weighed, filled, and fired on the same day.

The result was—

Martini-Henry	...	...	...	1280
Solid bottle	...	...	...	1292
Gatling	...	...	...	1355

These results show that the average velocity for the Martini-Henry service cartridge is some way below 1290. In the specification for R.F.G.² powder, drawn up in December 1876, the limits of velocity are laid down as from 1290 to 1340 f.s. The standard Martini-Henry velocity has always been taken, however, at 1351, and on these our calculations and comparisons with foreign small-arms have been based. It is also shown that the powder in these cartridges deteriorates, and that in four years the velocity has fallen to 1242 f.s.

The solid-bottle cartridges appear to give but a very slightly higher velocity than the built-up cartridge (*see Table F.*), whereas the Gatling gives a velocity of from 60 to 70 f.s. more (*see Table F.*); it also appears not to lose velocity by keeping (*see Table D.*). Secretary submits that the question above reported on is a very serious one, and that immediate steps be taken to remedy the present very unsatisfactory state of affairs.

D. of A., 16-2-80, directs that a trial be made of 10 Martini-Henry service cartridges made up with powder of 1876, in comparison with 10 similar cartridges of powder of 1879.

Velocities taken, 13-3-80, with cartridges made up with various dates of powder.

Cartridge—Martini-Henry. Mark III. 1880.						Cartridge—Gatling Gun 0.45-inch. Mark I, 1880.					
W. A., R.F.G. ² , 1876.			W. A., R.F.G. ² , 1879.			W. A., R.F.G. ² , 1876.			W. A., R.F.G. ² , 1879.		
No. of round.	Observed velocity at 110 ft.	Remarks.	No. of round.	Observed velocity at 110 ft.	Remarks.	No. of round.	Observed velocity at 110 ft.	Remarks.	No. of round.	Observed velocity at 110 ft.	Remarks.
1	1210		1	Missed		1	Missed.		1	Missed	
2	1206		2	1227		2	1267		2	1292	
3	1219		3	1228		3	1265		3	1297	
4	1222		4	1232		4	1270		4	1293	
5	1215		5	1223		5	1265		5	1303	
6	1209		6	1228		6	1266		6	1301	
7	1211		7	1248		7	1278		7	1302	
8	1225		8	1242		8	1277		8	1308	
9	1224		9	1252		9	1279		9	1314	
10	1244		10	1253		10	1294		10	1302	
Mean.	1218	M.V. 1273 f.s.	Mean.	1237	M.V. 1292 f.s.	Mean.	1273	M.V. 1325 f.s.	Mean.	1301	M.V. 1363 f.s.

D. of A., 9-3-80, directs a Departmental Committee, consisting of Superintendents, R. L., R. G. P. F., R.S.A.F., and Secretary, W. to consider the following points:—

- As to whether the powder R.F.G.² is found to keep well.
- Whether any improvements in the mode of proof at Waltham and Woolwich can be suggested.
- Whether any steps are taken to ascertain the condition and keeping qualities of Martini-Henry ammunition in store.
- Whether any further steps should be taken to verify the results reported by Superintendent R. L., and Secretary, W.; and, if so, what?
- What reasons were there for lowering the standard as regards M. V. from the original specification of the Committee?

The Departmental Committee assembled, 15-3-80, and reported on the points in question as follows:—

- Superintendent R. L. and Superintendent R.S.A.F., consider that they have nothing before them to determine, and cannot say from their experience that R.F.G.² powder possesses less keeping properties than other powders for small-arms. Superintendent R.G.P.F., and Secretary, W., agree generally with the above, but consider that R.F.G.² powder has a tendency to absorb moisture, and that by so doing, a loss of velocity is occasioned.

b. 1. All Government-made powder should be kept at least a year before being finally passed at Waltham Abbey, in order that it may arrive at its normal state.

2. It should then be within the specification. At Woolwich, in addition to the proofs it now undergoes, it should then be tested for velocity by R. L. before being used for cartridges.

c. It does not appear that any steps are taken to ascertain the condition of Martini-Henry ammunition in store, and enquiry should be made.

d. Further experiments are necessary, and Superintendent R.G.P.F. should be called upon to procure as many brands of R.F.G.² powder as possible, and test them for velocity, to compare with that obtained on proof. The same powders should be made up into cartridges of both rolled and solid metal Gatling description, and exposed to weather and again tested.

Cartridges made up from powders having different amounts of moisture should be similarly treated.

e. The K. powder, as per specification of March 1870, appears never to have been issued as a Service powder. It gave such irregular shooting that the Committee on Explosives were called upon to try and get a better powder; and they, later on, recommended a higher density powder which consequently gave a lower velocity.

D. of A., 8-4-80, approves the recommendations.

Departmental Committee, 16-5-80, report that there is not at present enough magazine accommodation; they, however, consider it very desirable that powder should have come to its normal condition before being passed into the Service, and are of opinion that sufficient magazine room should be provided for one year's produce, with accommodation for examination and blending. A magazine and buildings of this sort are also absolutely required if any large supply is again received from the trade; as, by the "Explosives Act," examination cannot be carried out at the Factories, as has been done. Powder might be provisionally passed into the Service by a special specification laying down the limits of velocity for different moistures.

Superintendent R.L., has now obtained a Boulengé instrument for taking velocities, and, on approval, 8-4-80, will take the velocities of powder before making up cartridges.

As to ammunition in store. At present it appears that it would be impracticable to judge exactly the condition of it by only firing a percentage of it, as it is not known what brand of powder it may be made of, but, for future manufacture, the brand of powder used should be marked on each box, by which means the cartridges could be identified. As the Com.-Gen., W., states that the ammunition at home is not on charge more than two years before it is used up, a velocity test is not absolutely necessary, but at large foreign stations, where the cartridges remain for at least five years, the I. of W. S. should have the means of testing them for velocities.

D. of A., 5-6-80, forwards correspondence to Committee on Explosives, who, 21-6-80, report that, in their opinion, an additional clause should be added to the specification,—viz., "The finished powder to contain not less than 0.9 per cent. of moisture and not more than 1.2 per cent."

Also that the clause as to velocity should be altered to the following:—

"The muzzle velocity imparted to a 480-grain bullet fired from a Martini-Henry Rifle, charge 85 grains at proof, to be proportionate to the amount of moisture it contains."

They point out that R.F.G.² powder was introduced to supersede K. powder, which gave irregular results. These were overcome by increasing the density of this powder which decreased the velocity. They further suggest that the filling of the cartridges for small-arms should be carried out in an artificially dried room, which they believe will, in a great measure, prevent the deterioration of the powder in small-arm cartridges. They consider that the recommendation, 22-5-80, of Departmental Committee, in W. O. paper $\frac{7669}{4387}$ as to making of small-arm boxes, should be approved.

D. of A., 16-7-80, forwards remarks of Superintendent R. L. to the Committee on Explosives, and directs them to submit their amended specifications.

Abstract of minute of Superintendent R. L., 13-7-80, above referred to, in which Chemist to W.D., 15-7-80, concurs.

The recommendation that cartridges should be filled in an artificially dried room can be carried out by making some alterations in the Cartridge Factory. As soon as a building, in course of erection, for drying gun-cotton is completed, experiments will be made to ascertain the degree of temperature and duration of time necessary to produce a proper amount of dryness in the gunpowder.

A recent examination for moisture of samples taken during the process of manufacture showed that powder, commencing with 1.55 per cent. moisture, gradually became less damp until, when packed in boxes, it had only 1.41 per cent. moisture; but in this example the powder, in the first instance, had more than the 1.2 per cent. moisture, the limit recommended by the Committee. The day was by no means exceptionally dry.

No difficulty will be found in the marking of small-arm boxes with the number of the lot of the powder employed in making the cartridges.

Secretary, W., 20-7-80, forwards a comparative table of the velocities given by Martini-Henry cartridges fired from the Service rifle, and solid drawn cartridges fired from a rifle bushed to take the Gatling 0.45-inch cartridges.

No. of rounds.	Rifle.	Mean muzzle velocity.	Powder.
10	Service	f. s. 1273	R.F.G. ² , 1876.
10	Gatling	1333	
10	Service	1294	R.F.G. ² , 1879.
10	Gatling	1363	"

Showing a mean gain of 65 f.s. in favour of the Gatling bushed rifle. The recoils, as taken at R.S.A. Factory, were:—

Mean of rounds.	Rifle.	Mean recoil.
10	Service	lb. 37.05
10	Gatling	40.275

Committee on Explosives, 23-3-80, submit amended specification.

D. of A., 10-9-80, approves.

Superintendent R. G. P. F., 12-11-80, enquires if this is to govern immediate manufacture, or if it is to be worked up to by degrees.

D. of A., 13-11-80, replies that the powder should, if possible, be brought up to specification, but that it need not be rejected if equal to the quality hitherto passed.

Superintendent R. G. P. F., 15-11-80, reports that the R. F. G.² powder of the year's manufacture, as far as it has been examined, is quite up to the new standard specification.

Specification to guide the manufacture of R. F. G.² gunpowder, approved (in substitution for that dated 29-12-76, $\frac{74}{3500}$), 10th September 1880, $\frac{7669}{4402}$.

Sample Barrel.—A sample barrel of powder to be sent from the Royal Gunpowder Factory, Waltham Abbey, as a guide to the Contractor in finishing the powder, and as regards the charcoal to be used.

1. **Ingredients.**—Every 100 parts of the gunpowder should contain 75 parts of pure saltpetre, 10 parts of pure sulphur, and 15 parts of charcoal made from the best selected dogwood charred in cylinders.

2. **Analysis.**—Samples may be selected from any portion of the gunpowder supplied and submitted to chemical examination and analysis.

The analysis should show:—

1st.—That the saltpetre exists in a proportion of not less than 75 per cent., nor more than 76 per cent., and that not more than one part of chlorine, nor more than four parts of sodium are contained in 3,000 parts of saltpetre.

2nd.—That the proportion of sulphur is not less than 9.5 per cent., nor more than 10.5 per cent., and that it has been thoroughly freed from earthy matter, and other impurities.

3rd.—That the wood has been charred to the same extent, not less nor more than in manufacture at Waltham Abbey. The colour of the ground sample powder will be a guide to the Contractor.

3. **Flashing.**—Samples of the powder must show, on being fired on a clean glass plate, results similar to those given by an equal quantity of the sample.

4. **Size, shape, and colour of the grain.**—The size of the powder to be from $\frac{1}{16}$ th to $\frac{1}{20}$ th of an inch.

To ascertain that the different sizes of grain are present in the same proportions as in the Waltham Abbey powder, samples will be sifted by hand on sieves respectively of 11, 16, and 20 meshes to the linear inch, made with copper wire of No. 27 gauge. The whole must pass through the 11-mesh sieve; out of 16 parts, 12 should be retained on the 16-mesh sieve; of the remainder, not less than three parts should be retained on the 20-mesh sieve; one part may be allowed to pass the 20-mesh sieve.

In shape the grains must be compact, not flaky, nor flat.

The colour of the powder must be bright, showing that it has been glazed to the same extent as the sample; *no blacklead* must be used. The appearance of the sample Waltham Abbey powder will be a guide to the Contractor in this respect.

5. **Density.**—The absolute density of the finished powder must not exceed 1.75, nor be less than 1.72.

6. **Hygrometric test.**—The powder when received must not contain less than 0.9 per cent. nor more than 1.2 per cent. of moisture, and when it has been perfectly dried and exposed to an atmosphere saturated with moisture, temperature 60° Fah., should not absorb more than 2.75 per cent. in 24 hours.

7. **Velocity.**—The muzzle velocity imparted to a 480-grain service bullet fired from a Martini-Henry rifle, with the service cartridge, charge 85 grains, to be proportionate to the amount of moisture it contains according to the following table:—

Percentage of moisture.

9 to 1.0

1.0 to 1.1

1.1 to 1.2

Muzzle velocity.

Not under 1310 f.s.

" 1300 "

" 1290 "

8. **Firing proof at Royal Laboratory, Woolwich.**—Targets will be made at 500 yards range with the powder fired from a Martini-Henry rifle, service cartridge, and it will be required to give *mean* results, as regards "*figure of merit*" of shooting, and *freedom from fouling* the rifle, equal to those afforded by the Waltham Abbey sample powder.

9. The powder will be delivered in barrels of 100 lb. each.

WAR OFFICE,
September 1880.

Table of results of proof of R. F. G.² Gunpowder made at Waltham Abbey from November 1880 to January 1881.

DATE WHEN MADE.	Moisture when fired.	Muzzle velocity.	Mean muzzle velocity.	Lowest muzzle velocity permitted by specification.
November 1880	95	1324	1325	1310
" "	90	1336		
" "	90	1304		
" "	90	1325		
" "	91	1327		
" "	90	1333	1326	1300
December "	96	1312		
" "	97	1317		
January 1881	98	1347		
December 1880	104	1335		
" "	107	1309	1312	1290
January 1881	100	1335		
December 1880	120	1301		
" "	120	1305		
" "	114	1294		
" "	114	1307	1312	1290
January 1881	117	1322		
" "	117	1323		
" "	120	1331		

APPENDIX H.

Experiments with 25-pr. R.M.L. Guns. Experimental No. 398, with R.L.G.² Powder. Lots 283 and 292 Kirkee, for comparison with R.L.G.² Powder, fired 10th November 1880.

Proof Butts, 8th March 1881.

Date of firing.	No. of round.	CHARGE.			Weight of projectile.	Observed velocity at 102 feet.	Muzzle velocity.	Muzzle velocity for 25 lb. projectile.	Pressures, tons per square inch.	
		Nature of powder.	Weight.	Cubic inches per lb. and density.					B.	Shot.
8-3-81	1	R. L. G. ...	lb. oz. 4 0	32.6 0.851	lb. oz. 25 8	f.s. { 1313 1312 }	f.s. 1327	f.s. 1340	13.8	18.0
"	2	Kirkee, Lot 283.	" "	"	25 9	{ 1315 1315 }	1329	1344	15.1	17.7
"	3	" "	" "	"	25 8	{ 1312 1313 }	1327	1340	15.3	18.9
"	4	R.L.G. ² ...	" "	"	25 10	{ 1330 1329 }	1344	1361	18.0	23.0
"	5	Kirkee, Lot 292.	" "	"	25 7	{ 1344 1343 }	1359	1371	16.6	21.7
"	6	" "	" "	"	25 8	{ 1339 1338 }	1353	1366	16.8	26.1

Analysis of Kirkee R.L.G.² Gunpowder. Lots 283 and 292.

					Lot 283.	Lot 292.
Nitre ...	...	...	...	...	75.96	75.65
Sulphur ...	...	...	...	...	9.69	9.72
Charcoal ...	...	...	...	...	14.35	14.63
Moisture ...	...	...	...	...	1.14 per cent.	1.16 per cent.

Rounds fired from 9-pr. R.M.L. Gun. Experimental No. 393, for proof of Kirkee R.L.G.² Powder.

Proof Butts, 25th February 1881.

Date of firing.	DESCRIPTION OF POWDER.			No. of round.	Charge weight.	Weight of projectiles.	Observed velocity at 112 feet.	Muzzle velocity.	Muzzle velocity for 9 lb. 3 oz. projectile.	Pressures—tons per square inch.		
	Date of stoving.	Density.	Moisture.							A.	B.	Shot.
					lb.	lb. oz.	f.s.	f.s.	f.s.			
						Kirkee, Lot 283.						
28-2-81				1,276	1½	9 2½	{ 1342 } 1342	1364	1362	12.7	11.4	...
"				1,277	"	9 3	{ 1350 } 1351	1373	1373	14.7	11.8	...
"				1,278	"	9 2½	{ 1348 } 1348	1370	1368	13.0	11.9	...
						Kirkee Lot 292.						
"				1,279	1½	9 4	{ 1374 } 1375	1397	1402	15.8	14.4	...
"				1,280	"	"	{ 1384 } 1384	1406	1411	17.2	14.8	...
"				1,281	"	"	{ 1376 } 1378	1399	1404	15.1	14.0	...

APPENDIX I.

ROUGH USAGE TRIALS OF PRISMATIC POWDER CARTRIDGES ON BOARD THE "EXCELLENT."

The trial consisted of sending the cylinders out in the gunboat *Medway*, when proceeding to Spithead for target practice, 20 times, and each time of sending they were moved as follows:—

- (1). Hoisted up from *Calcutta's* magazine in hold to lower deck.
- (2). Passed to entering port along deck, about 100 feet.
- (3). " into and stowed in boat alongside *Calcutta*.
- (4). " out of boat to deck of *Medway* over gunwale.
- (5). " below and stowed in *Medway's* magazine.
- (6). Transferred back to *Calcutta's* magazine in the same manner.

The cases were subjected to the ordinary amount of severities in handling that the service powder cases receive on similar occasions, orders being given to take no more than the usual care with them.

PRISMATIC.

No. 1.—Out 16 times. Upper and lower layers of prisms broken, and bag very much discoloured with dust; a considerable quantity of dust also having escaped.
Case. Both handles off lid, inside lining damaged, one hook off. Body dented at bottom, and top rim bent and partly broken.

No. 2.—Out 16 times. Prisms broken at bottom, not so bad as I. The shalloon disc at one end was partly torn off after charge had been transferred 10 times to examine interior of charge.
Case. One handle off lid and top dented. Body badly dented; bottom nearly out.

No. 3.—Out 20 times. Upper and lower layers of prism badly broken, and bag very dusty outside.

Case. Both handles off lid, slight dent on top, top edge cracked a length of five inches. A few slight dents in body.

No. 4.—Out 17 times. Cartridge bag torn and powder very much broken up. A small quantity loose in the case.

Case. Both handles of lid broken, rim badly dented, inside lining slightly separated from top. Body slightly dented and broken at one of the brass lugs about 2 inches.

PEBBLE 2.

No. 1.—Out 20 times. Charge intact.

Case. Lid, one handle bent, top broken immediately under the other, body slightly dented all over.

No. 2.—Out 20 times. Charge intact.

Case. Small hole in lid and crack on top, body in good condition.

No. 3.—Out 17 times. Charge intact.

Case. Lid badly bent and broken, body much dented all over.

No. 4.—Out 20 times. Charge intact.

Case. Lid, two slight dents on top, inside band partly detached from top, body slightly dented; otherwise in good condition.

The result of the trials would appear to be:—

- (1.) That the prismatic charges are very inferior to the P² in withstanding the conditions to which they were exposed.
- (2.) That the cases in which all the charges were contained are quite unsuitable to the uses to which they were put in this trial.

All the cases were examined from time to time during the trials, and at the end of 10 shipments a careful examination of the interior indicated the same general conditions of the charges only developed to a correspondingly less extent as these exhibited at the end and given in the report.

It was necessary to prevent some of the cases being sent out the full number of times, on account of the injuries to them being already of such an extent as to admit of the powder escaping from them.

The handles of the cases were especially weak and unsuitable.

D.N.O. considers that the trial was more severe than would be experienced in the ordinary course of a ship's commission; he remarks that it is important to decide whether the damage sustained by the prismatic powder during the trials need affect the question of its future stowage.

APPENDIX K.

Trial of Prismatic Powder fired with Radial and Axial Vents in 12.5-inch R. M. L. chambered proof gun. Powder, Rotiweil Prismatic, 33-ton, Projectile 810 lb.

Date of firing.	Charge.	Vent.	Muzzle velocity.	PRESSURE, TONS PER SQUARE INCH.								
				A.	1	2	3	4	Mean.	Shot.		
26-1-81	180	Axial	1375	...	...	11.0	12.0	11.7	11.6	*	†	†
"	"	Radial	1317	...	*	10.3	10.3	10.4	10.3	9.3	...	...
2-2-81	210	Axial	1523	...	15.8	16.0	15.9	15.7	15.9	...	...	...
"	"	Radial	1516	12.2	12.8	15.1	15.1	14.8	13.8	...	...	...
15-3-81	"	Axial	1520	...	15.5	15.1	15.1	15.9	15.3	...	15.3	16.5
"	"	Radial	1502	15.1	15.1	15.2	†	†	†	...	16.6	16.3

* 9-ton copper not further compressed.

† 15-ton " " "

‡ Crushers placed in the end of the cartridge.

APPENDIX L.

23-10-80.

Superintendent R. L., and Chemist to W. D., to Secretary to Committee.

We have to report, for the information of the Committee on Explosives that, with the aid of a press specially fitted for the purpose, we have carried out a series of experiments on the Viner system of consolidating powder by application of moderate pressure to the mixed ingredients, heated to about the melting point of sulphur.

During the application of pressure, and for some time previously the press bed upon which the composition rested, and the block, were raised to a temperature of 240 degrees to 250 degrees Fahrenheit at which temperature the sulphur melted readily.

The period of heating before application of pressure, as well as the period during which the pressure (from 40 lb. to 200 lb. on the square inch) was maintained, have been varied, but in no instance has any useful consolidation of the mass been accomplished.

The experiment was also made of cooling the pressed mass while still under the prescribed pressure (40 lb.) but with no better result.

In the absence of further information, we consider it useless to pursue these experiments any further.

APPENDIX M.

Trial of Gunpowders in 1-inch Nordenfolt Machine Gun, the powder charge being uncom-pressed.

Date.	Number of rounds.	Nature of powder.	Charge.	Weight of bullet.	Mean muzzle velocity.	Mean pressure, tons per square inch.
7-3-81 ...	16	L. G. ...	grs. 440	grs. 3170	1126	4.46
8-3-81 ...	17	Pigou and Wilks, No. 8 ...	480	3170	1168	5.12
" ...	16	W. A., special ...	450	3170	1194	6.94

The above powders, when fired in Royal Laboratory with the service charge, viz., 625 grains powder compressed into a pellet, gave the following velocities. Pressures were not taken:—

	Muzzle velocity.
L. G. ...	... 1349
Pigou and Wilks, No. 8...	... 1443
W. A., special ...	... 1458

