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Progress of Ordnance Abroad Compared with that at Home

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Monday, May 16th, 1864.

Captain LEOPOLD G. HEATH, R.N., C.B., in the Chair.

NAMES OF MEMBERS who joined the Institution between the 2nd and 16th of May, 1864.

LIFE.

TAYLOR, C. S. S., Lieut., Royal Horse Artillery, £9.

ANNUAL.

Plummer, H., Capt., 7th Royal Fus., 1l.	Dakyn, J. H., Surg., late St. Kit's Militia, 1l.
Barker, J. B., Capt., 75th Regiment, 1l.	Hall, W. King, Capt., R.N., 1l.
Paley, R. S., Capt., 12th Royal Lancers.	Sim, C. E., Capt., R.E., 1l.
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PROGRESS OF ORDNANCE ABROAD COMPARED WITH THAT AT HOME.

By Commander R. A. E. SCOTT, R.N.

In my lectures in April and May, 1861,* I gave an account of the various systems of rifling in this country, and showed the advantages and defects of the plans of Mr. Lancaster and Mr. Haddan for firing iron shot, and of Mr. Jeffrey's and Mr. Britten for firing lead-coated projectiles.

I showed that neither of the two former were well adapted to round ball firing, Mr. Lancaster's rifling giving the round shot an increasing spiral motion instead of spinning it round its axis, and Mr. Haddan's rifling cutting away too much of the surface of the bore.

I also pointed out that the elongated projectiles of both these rifled guns pressed outwards against the bore with a violent thrust, which, in shell firing, especially from the Lancaster gun, was liable to cause

* See Journal, Vol. V, p. 423, et seq.—Ed.

the fracture of the shells, as happened in the competition trials of 1861; but I omitted to point out, that Mr. Haddan's larger projectiles were proposed to be made with two bearings, put on in line with their long axis, (Plate XXXIII. fig. 1):—* Mr. Haddan was, I believe, the first to fire a large cannon projectile, tapered at the rear (Fig. 2), but Mr. Woolcombe, of Plymouth, was the first to show clearly the advantage in range attainable by this form.

Of the lead-coating plans I showed that, from the lead being driven out at the base of the shot, the shot's point, having no support to keep it up in the centre of the bore, it must of necessity drop; also that lead would not withstand the large charges of powder necessary to pierce armour plates, and that such shot were extremely liable to accidental injury, in carriage, handling, and storage on board ship.

With reference to the coil guns, as then constructed, I pointed out their liability to open, from the numerous small pieces of which they were constructed, and from these not being hooked together; and of the liability of their inner tubes, to show flaws; and I predicted the failure of such delicate weapons in actual warfare. After adverting to the evils arising from the use of lead-coated shot, and showing the great strain thrown upon the gun in the compression system, to the danger of the breech apparatus, the serious fact that the breech-loader, from this weakness, was as unsuited for chase as for broadside guns, was pointed out: in short, I endeavoured to make it clear, that the requisites for good naval guns were not complied with, either in the systems proposed for adoption by the inventors I have named, or in those guns actually adopted into the service.

In my lecture this evening, I propose going through the modifications since then introduced into our own, as well as into foreign artillery; and I trust I shall be excused if here and there I appear too anxious, in the comparisons I shall have to institute, to show that, in what I foresaw and foretold, I have been correct. Unless I had been correct in some of my conclusions as to results, I should have little excuse for again trespassing on your time and attention. And I further hope, in my concluding remarks, to touch upon some of the points in connection with the vessels which are to carry and withstand the ordnance I shall have to describe.

There is nothing like ventilating these questions in a country so full of inventive genius and mechanical ability as our own, and I believe it is owing to the course pursued by the Iron Plate Committee, presided over by that accomplished sailor, Sir John Hay, and numbering amongst its members Dr. Percy, of European celebrity, as well as Mr. Fairbairn, that such a vast improvement has been already made in the

* The projectiles used for the Lancaster guns in the Crimea were straight, and about the middle of 1860, the cast-iron shot for the oval rifled cast-iron 32-pounder were still straight, but covered at the rear with a wrought-iron casing, which projecting 4 inches beyond their base gave space for the insertion of wooden wedges. These were intended to force out the casing, which had two slits so as to fill the bore, but the plan was afterwards given up, and about the beginning of 1861, shot were for the first time made which were fitted to the spiral of the oval rifling.—R.A.E.S.

Fig. 1.

Haddan's Proposed Heavy Shot.
Haddan's Early Shot,

Fig. 2.

with tapered rear

Fig. 3.

French.

Fig. 5.

French Button Shell.

Fig. 7.

Parrott Rifling.

Fig. 8.

Parrott Shell.

Fig. 6.

Parrott Gun.

Fig. 9.

15 Inch Navy Gun.

Fig. 11.

Brook Rifling (Atlanta)

Diameter of Gun 7"

Section

Plan

Fig. 10.

13 Inch Sea Coast Mortar.

Fig. 13.

Blakely's Solid Shot.

Elevation

Plan

Fig. 12. The Horsfall Gun. Scale $\frac{1}{2}$ Inch = 1 Foot

manufacture of armour plates. Their course has been to freely invite both the target contractors and the ironmasters to come forward, and when at Shoebury, to give them every information; and the result has been, that steady progress which has enabled our manufacturers to produce plates of very superior quality to those made in other countries. I cannot forbear also mentioning the name of Captain Harrison, of the Artillery, the indefatigable secretary, whose courteous behaviour and readiness to impart information has been noticed by all, and I sincerely believe that the valuable hints so readily given by Lieutenant Colonel Henderson, of the Artillery, and by all the committee, have had a considerable influence in the improvement of armour plates. In truth, the whole iron manufacture of the country seems to have received a great impulse from the tidal wave from Shoeburyness. After all, there are few, if any great inventions; it is the constant little improvement in one's own special calling or profession, and the onward progress towards a goal kept steadily in view, that comes at last to be "the great invention."

As that able mechanic, Mr. Anderson, said to me, when I took up with rifled ordnance, in the beginning of 1859, "If you wish to be successful, lay down upon paper all the requirements for a naval gun, consider each point day by day for months, and when you have decided upon what you want, and marked out your course clearly, then submit your plans." Had the course indicated by Mr. Anderson been followed by all, and the same means of knowing results as in the case of the armour plate experiments, been afforded, England's naval ordnance would not have been still in a transition state, but would have been settled upon a firm basis, and the nation would now possess an armament as immeasurably superior to that of other countries, *in proportion to cost*, as are the armour plates now manufactured by her.

It is not, however, too late to retrace the steps which have been taken, and although large sums have been expended through the concealment, hitherto adopted in respect of the coil guns; the different result obtained through the opposite course in plates, *must* for the future, ensure also a more liberal policy in the gun question; this should not be a contest between one powerful company and another, or between individuals for precedence, but a full and open trial of the principles of rival guns, after which there should be selected, without fear or favour, the most practical plan, or the best part of two or more plans, for the national armament. Had the Armstrong mode of construction in the Royal Arsenal been open to the view of the makers of guns, public would have stimulated private manufacture, and *vice versâ*, and England would be at this moment the armoury of the world, as she undoubtedly is the great iron plate maker. True it is, that the energy of our gun makers is fast breaking through all obstacles, but the difficulties interposed have greatly tended to check production, and driven at least one firm to leave the trade. The true policy of England is, to make herself the mart of the world, and by keeping the gun, shot, and armour trade in her own hands, to command the market, and thus have the benefit of production in enlarged trade, and in the superior capabilities and skill in manufacture, which

would be available for the national benefit in all times of need. This policy, alone worthy our great nation, whose favourite motto is, "a fair field and no favour," would in time of peace prevent the squandering of the national treasures, and by keeping us prepared for the time of war, enable Britain to securely maintain her seat as mistress of the seas.

Public opinion, expressed through Parliament and the press, is a great safeguard and a surer defence than dozens of fortresses; but should war overtake us, or another panic occur, a story of the ships (so armed as to be unfit for warfare) might follow "the story of the guns." It has already done so in America. Hear what the New York correspondent of the English "Army and Navy Gazette," (dated 23rd January, 1864,) says, "We are ruled in these matters by a few monied men, who back up the Ericsson interest. No one can deny the fact, that John Ericsson is a splendid engineer, and that there are but few such inventive minds in the United States; but surely that gives him no right to use his utmost endeavours to crush out all who are opposed to him; in certain official quarters his word is law, and the plain truth is, that the Swedish engineer sways a power, in reference to our iron-clad navy, a king might well be proud of. He can purchase opinions; reports can be toned to suit him; faults can, or at least have been, concealed in reference to our ships. Our people have been duped and science thwarted by this man. The reports of the commanders of the iron-clads at Charleston opened the eyes of the public, and queries are more frequent in reference to our ships than ever. It is a sad state of things to contemplate, yet, for all that I can see, we must submit for a time at least. He who favours a Monitor is in favour, but woe to him who reports against them. Look at Drayton, Warden, Rhind, and others, all suffering in a quiet way the displeasure of the department, because they did not say what they did not honestly believe."

French Guns.—In my second lecture, that "on the progress of ordnance abroad compared with that of ordnance at home," given in this theatre on the 20th January, 1862, I pointed out that the principal value of the French cast-iron guns, which had been hooped and rifled, was, that they still fired the round ball—making use of the rifle shells holding a large quantity of powder, but which were projected with a low charge—for the purposes of bombardment; and I showed that the gaining twist adopted by the French, under the impression that the weak cast-iron was relieved by the easy starting of the shot, was a mistake. To-day, I am enabled to say that I have been informed, on what I consider to be good authority, that the French are making steel guns, which they have rifled with an *even* twist upon a simple plan, giving, it is said, a long bearing to their shot. (See Fig. 3.)

Of the performance of their steel ordnance, it is said that 4-3-inch plates, with backing similar to that of the "Warrior," were pierced at 1,000 yards by steel shot from a gun weighing 6 tons.

Prior to the adoption by the French of the central grooving, in December, 1862, the French tried a plan (Fig. 4) on a similar principle to that of the shunt, but the buttons upon the projectiles required too

great a nicety of fitting; for, if the shot were large in their diameter, a great strain was thrown upon the gun by outward pressure at x , and if small, then there was a tendency to slip over the shoulder at y . The rifling of the French field-pieces, which are muzzle-loaders, continues to be the same, and the projectiles have similar studs to those that were first adopted by them. (Fig. 5.) This plan, which was used at Solferino and in China, was at the last place very unfavourably contrasted with the Armstrong, but now bids fair to supplant it altogether. (Studs of copper have been lately adopted in England for the projectiles fired from the shunt gun.)*

United States' Guns.—In the same lecture I gave an account of the American ordnance, and have since had opportunities of talking with officers who have taken part in the struggle going on, on the shores and on the rivers of that vast continent. They told me that for ships, their naval men have always been opposed to rifled guns, and though several of the larger Parrott's have been introduced in lieu of heavy smooth bores, it was in opposition to their opinion. One naval officer, who had commanded a squadron, said that their crews were afraid of using the large rifled guns, and that in consequence he gradually got rid of all but a few light chase pieces. Experience gained at Charleston shows that the men's fears were not without foundation, for out of all the Parrott rifles, the great proportion gave way below an average of 300 rounds a-piece.†

A few of these guns went through the re-inforce (Fig. 6), but the greater part gave way in front of it and some guns split near the muzzle, owing to the increasing twist, which, by checking the shell, caused an explosion in the bore, where the shot caught against the rifling.

This was the case in the first 300-pounder at Charleston, which had its muzzle broken after a few rounds. The premature explosion of the shells is about to be attempted to be remedied, by the introduction of a fuse similar in its properties to the fuse of Colonel Boxer.

I should mention that most of these guns were fired at very great elevations which, by preventing recoil, threw a heavy jar upon them at each discharge; they answered well on the practising grounds when fired horizontally, but could not bear the increased strain arising from being fired at high angles of elevation.

The Parrott rifling consists of several rectangular grooves, similar in form to those used by Manton in 1790, and more lately in England by Mr. Britten (Fig. 7); it has an increasing twist towards the

* The French experimented with copper studs, but found that they caused greater wear upon the rifling of their brass field-pieces than those of zinc, which they adopted. With the larger shot for their canon rayé of 30, zinc buttons could be readily run upon a rough cast projectile, and were very cheap; the plan was therefore also adopted by the French for the elongated shot of their cast-iron rifled guns.

† Although many of the Parrott guns burst prematurely at Charleston, 1,000 rounds were fired by a Parrott 100-pounder at West Point, and another similar gun has fired 1,400 rounds on service. A 30-pounder also has fired 3,000 rounds into Charleston at from 30° to 40° elevation; and one of the 300-pounders at Charleston has fired 600 rounds. All these guns are still in use, and are in good condition. —R.A.E.S.

muzzle, and the projectiles have a brass ring round their base (Fig. 8), which is expanded out into the grooves by the explosion of the powder. This ring is, however, liable to break without giving rotation to the shot, and it sometimes fails with heavy charges to take the rifling properly. The Parrott guns were at first cast solid and then bored out, but the contractor, who thus made them for cheapness, has now commenced to cast guns hollow, but without trunnions. These are put on afterwards. The early guns were similar in this respect. Parrott and others are now following Rodman's plan of giving no preponderance to the breech of the gun, which is kept in place by the elevating screw. This plan is found to lessen the jar upon the gun, and to preserve the carriage from injury in firing large charges.*

The Americans have now turned their attention to steel, and a firm has recently purchased the right to use the Bessemer process. Actual war, however, is a bad time to make changes in, but the Northern States have so long felt the necessity for a stronger material than cast iron for rifled guns, that they intend to commence the manufacture of mild steel immediately.

The Northern Government very early had an Armstrong gun made by workmen who left Woolwich Arsenal, which gave quite as good results as to accuracy, &c., as the weapons made in England, but on their testing it for continuous firing at high angles, to try its powers for distant bombardment, the breech first got out of order, and then gave way, which caused an abandonment of the plan. It would have been well had they tested their contract Parrott guns in a similar manner.

The 15-inch smooth bore guns, cast hollow, seem to have been a complete success, and to have given velocities of 1,300 feet with 50 lbs. of powder and a hollow shot weighing 420 lbs. (Fig. 9.) The Army gun weighs $22\frac{1}{2}$ tons, and the Navy 19 tons, the usual charge for the latter being 35 lbs., and for the former 50 lbs. The American opinion still is, that to damage an armour-clad or other vessel seriously, it is not the clean, small hole-piercing property they need; "it is the smashing effect, the staving in of planking and timber; or if a hole alone is made, that it shall be so large as to defy plugging." So confident are the Americans of the truth of this, that their forts are either armed, or fast being armed, with $22\frac{1}{2}$ -ton guns of 15-inch bore, which will fire hollow shot, and also shells having a large capacity for powder or molten iron. Their effect may in some measure be imagined from the fact that the shell fired from our own "Big Will," the 600-pounder of 13.3 inches bore, entirely smashed the floating "Warrior" target, moored 1,000 yards from the shore, at the low velocity of little more than 1,000 feet per second.

Captain Fishbourne has already told you of the new cast-iron 10-inch American gun, of $7\frac{3}{4}$ tons, throwing a nearly solid shot of 125 lbs., and a shell of 100 lbs., and intended to fire a customary charge of 30 lbs. of powder. This gun has, in addition, a special charge of 43 lbs. for use against iron-clads—a charge which constitutes it the most power-

* The weight of the 10-inch Parrott is between 11 and 12 tons, charge of powder 25 lbs.—R.A.E.S.

ful broadside gun belonging to any foreign nation. The 11-inch Dahlgren guns have been ordered by the Secretary of the Navy to fire a charge of 30 lbs. of powder if engaging an iron-clad; but the usual charge is, 20 lbs. for a solid shot, and 15 lbs. for a shell.

The charge of 30 lbs. was adopted, after considerable trial when it was found that these 11-inch charcoal iron guns were far stronger than anticipated, and that, as an iron-clad would be engaged at close quarters, and the gun then be laid nearly horizontal, it would have a comparatively small strain thrown upon it.

In the Northern States of America great attention has been paid to the subject of gun carriages, and as the improvements have been suggested by those who have to use the guns, the arrangements for working the guns are exceedingly simple, and the carriages strong, and little liable to get out of order. Their naval gun carriages are in advance of those of any other nation, and they are now about to use iron for their construction.

In their mortars the Americans have adopted as the best plan, that of placing the trunnions at the re-inforce (Fig 10), a plan pointed out in this Institution, which has been found to prevent that splitting in halves in consequence of the wrong position of the trunnions which took place at our own bombardment of Sveabourg. It is a curious coincidence that the solid cast English mortars at Sveabourg, and the solid cast but strengthened Parrott rifled guns, which were likewise fired at high elevations at Charleston, showed about equal endurance.

By placing the trunnions at the re-inforce the mortars can be brought to the horizontal position with comparative facility, and hence used as howitzers for horizontal firing. This property so impressed the Secretary of the Northern States' Navy, that a squadron of mortar-boats was sent to the Mississippi, but the mortars were unhandy, and the damage produced was so trifling, from the inaccuracy of their fire, that they were soon landed.

The Confederate Guns.—The South, although unaccustomed to the founding and manufacture of iron, soon started a foundry for ordnance, and have since continued to turn out cast-iron guns in considerable numbers. The size of bore most in favour for their defences is 10 inches, and it was round steel shot from those 10-inch smooth bore guns which did them such good service at Charleston. Large numbers of their steel shot are said to have been made in this country, and were, I imagine, sent out as *cheeses*, during the time of the supposed famine. It was, I imagine, through pure philanthropy and nothing else, that the sides of the Northern Monitors were pierced.

The Southerners have also their pet rifled gun, which, like the Parrott, is of cast-iron, strengthened with a band over the breech, it is called after Captain Brooke (see Fig. 11), but they found from the capture of their vaunted "*Atalanta*," intended to destroy the Northern gun-boats in *detail* by firing at long range, that they were egregiously deceived in the power of their rifle, and that their smooth bore was their best gun. The rude means of dispelling their confidence was a 420 lb. shot from the "*Wechaken's*" Rodman

gun, which shook every timber of the "Atalanta," killing and wounding about 20 men, and paralysing the remainder of her crew. The shock must have been terrific, and from a computation made as to its velocity, it has been estimated that the force of the blow was about equal to that delivered on the "Warrior" target by the 282 lb. shot from the Horsfall gun (Fig. 12), which, when fired from a distance of 800 yards, struck with a velocity of 1,282 feet per second.

The Southerners have received a considerable number of field guns from Europe, and some strengthened cast-iron guns of large bore; and I believe shot of form like Fig. 13 were fired at Charleston. It is said that they have had some built-up steel guns sent them lately. Fig. 14 (Plate XXXIV) represents the pattern of two or three guns which were some time since made at Low Moor, of the 65 cwt. 8-inch pattern, but only bored to $7\frac{1}{2}$ inches, which were then strengthened by steel hoops; but very few of us have now any faith in cast-iron as a fit material for rifled guns. Fig. 15 shows the wrought-iron gun made for the Northerners in 1845 by the Mersey Company, to replace the gun which caused such serious loss of life by bursting on board the United States' frigate, "Princeton." It was proved in England with the following charges, which are very heavy for a gun weighing only 7 tons:—

1st charge of powder, 30lbs., with a wad and shot weighing—
 2nd to 4th, 3 charges of powder, each of 41lbs., with double wad and shot.
 5th to 30th, 26 charges of powder, each of 30lbs., with wad and shot.
 Total, 30 charges.

				ft.	in.
Length from breech ring to muzzle	..	..	14	0	$\frac{1}{2}$
Do. from breech to muzzle	..	..	13	0	
Do. of bore	..	..	12	0	
Thickness of metal at breech	..	..	0	$7\frac{3}{4}$	
Do. do. at muzzle	..	..	0	$3\frac{1}{2}$	
Diameter of bore	..	..	0	12	

The Prussian system, from which our own lead-coating and breech-loading is a delicate off-shoot, consists of a rifling similar to the Parrott and Manton, with the exception that the grooves instead of being equal in width throughout, narrow towards the muzzle, which I omitted to mention in my former lecture. The object of this is to keep squeezing the lead together, and thus hold the shot up, so that its long axis may continue to coincide with the axis of the piece during its passage through the bore, for as the shot moves onward, the lead coating on its bearings necessarily becomes worn down, and hence the projectile would drop to the bottom of the bore did not this narrowing of the grooves towards the muzzle of the gun, by squeezing the lead together laterally, have a tendency to keep up the shot. It is possible that this ingenious arrangement, which certainly has the merit of not overstraining the gun, suggested the contrivance of the muzzle-nips for the English finely-grooved and shunt guns, as well as suggested the French plan (Fig. 4), the principle being similar and like that of our own early Enfields.

The Prussian projectiles are leaded so as to show raised projections

Fig. 14. Blackely's Strengthened Cast Iron Gun of 7½ Inches Bore Rifled. with Scott's Projectile.

Fig. 15. Early Mersey Gun.

Prussian 24 PF. Gun.

Fig. 16.

For Loading

Fig. 17.

loaded

Fig. 18. Exterior

7½ Gun and Shell. Transverse Sections.

Longitudinal Section.

Fig. 19. Austrian Rifled Gun-Cotton Gun.

Fig. 21. Russian Shunt Rifling.

Fig. 23. Plain Groove. Shot in Loading Position. Shot coming out of Gun.

Fig. 22

Armstrong 100 PF Wedge Gun.

Fig. 24. Plan of Shunt Groove (Armstrong) Section through A.B.

Muzzle Plan.

Reference.
A . Loading Side.
B . Driving D.
C . Muzzle Grip
D . Shunt
E . 2nd Shunt to Lock Shot
F . Powder Chamber

of lead (see Vol. V. page 428), which readily squeeze down into the rifling, and hence throw comparatively small strain upon the gun. The Prussian early plan of breech-loading was with one wedge, they then used two wedges (Figs. 16, 17, and 18), but they have not found breech-loading to be so satisfactory as they anticipated, for their guns of the 24-pounder bore and throwing projectiles of 56 lbs. The Prussians commenced the adoption of rifled guns by having field-pieces, made by Krüpp, of mild steel, and the wear of these guns has given them no reason to regret their choice of the metal.* Besides these weapons the Prussians have converted many of their brass guns (remelting several) into rifled breech-loaders, on the wedge plan. The 24-pounder guns of between 50 and 60 cwt., which they were casting and rifling when I read my last paper, are now out of favour, and they are replacing these and their old cast-iron rifles with steel guns. It appears to have been a shot from one of the steel 24-pounders that lately did such damage by piercing the upper deck of the Danish cupola ship "Rolfe Kraake."

The *Austrians*, after numerous experiments with gun-cotton, and almost perfecting the use of that manufactured under the direction of General Lenk, seem to be unwilling to incur further expense. They have made little progress since my last notice of their artillery. The rifling of their guns, used for gun-cotton, is shown in Figs. 19 and 20. The peculiarity of this rifling is, that the projectile is given stability to, by tightening itself in a curve of gradually lessening radius, and that the grooves prevent an extreme of wedging action at high velocities; they also give facility of loading.

The position of the *Spanish, Swedish, Danish, and Italian* artillery is much as when I described them in January, 1862.

The *Russians* have been recently making numerous experiments; they have copied the French button plan, and in some of their solid steel guns have tried a rifling like Fig. 21, and also used a grooving like that in Fig. 3; they have likewise experimented with the rounded form of groove. A very large number of steel shot has been supplied to them from England; and it is understood that most of the 9-inch and 11-inch built-up steel guns, of from 15 to 22½ tons, now making by the Blakeley Company, are for this nation. The Russians have, however, given large orders to Krüpp for *solid* steel guns, and have likewise manufactured several cast steel guns from their own iron, which is of excellent quality, but the large charges and heavy elongated shot used have prevented the heavy solid steel guns, which have been as yet rifled, from withstanding 100 consecutive discharges.† This failure might, I think, be easily cured altogether, but certainly be lessened by the use of lighter shot. But there can be no doubt that the guns are powerful, and will, behind the thick slabs of iron with which their forts are to be covered, prove formidable to

* The French Emperor rejected Krupp's steel from finding, after careful experiment, that guns made of it broke up more readily than French bronze under the blows of the shot which were fired at them.—R.A.E.S.

† The reported premature bursting of these guns is said to be in part at least due to the character of the shunt rifling adopted.—R.A.E.S.

any ships venturing to attack them, for they can fire round shot with the heaviest charges.

Having thus briefly noticed the progress of ordnance abroad, it is time to turn to what has been doing at home, and as since September 1861, trials have been made almost exclusively with that principle of making guns and rifling them, concerning which it was declared by one in authority, that the country having adopted the system, was bound to work it out, my account must necessarily be a *résumé* of Sir William Armstrong's plans and inventions.

I have, however, the gratification of being able to state, in respect to some of the mistakes and omissions I pointed out, that although the fine grooving has not been entirely abandoned, no new 110-pounder guns are being thus rifled, and that the Armstrong 12-pounder has been reduced a foot in length, and that by the skill of Lieutenant Reeves, of the artillery, a sort of Dutch case has been adapted to the gun, for use at close quarters.

Instead, also, of the new guns being made of excessive length, the 600-pounder is so short, that it approaches the Howitzer, and the 50 Somerset guns building in the Arsenal, are, as to length and general form, all that could be desired for 6-ton naval guns.*

The vent-piece of the Armstrong's is also giving place to double wedges (see Fig. 22), and a vent-hole in the gun, following closely in these changes their Prussian type; in a word, breech-loading having been abandoned by Mr. Whitworth, is flickering in its socket, before being finally given up. The reputation of the shunt system, which was being introduced in 1861, is also on the wane, it having been proved that the early impressions as to the damage that would be done to the muzzle from squeezing the shot were well founded; the whole of the heavy guns rifled on this plan having cracked round or shown flaws at the muzzle, and hence it is in contemplation to give up the shunt and grips, and to come to a plain groove,† with sharp corners, similar to that advocated by Captain Palliser (Fig. 23).

I need not dwell longer upon the failure of the shunt guns, the reasons for which were so clearly pointed out by Captain Fishbourne; but as the same tendency to fracture exists in the sharp cornered groove about to be experimented with, as in the shunt groove, I may call attention to what he says as to the disadvantages of such a form, from its allowing the bearing edges of the projectile to strike the driving sides of the grooves with a force which must wear them, and ultimately cause rupture; the grooves being also liable to foul and difficult to sponge. To reduce the shock upon the shunt gun, the French field-piece button has been adopted by Sir W. Armstrong but instead of white metal, copper, which was at first tried by the French, has been taken, and this has been lately made very soft—a

* They are 9 inches diameter in the bore; the weight of their cast-iron shot is 95 lbs. and shell (which are of 1½ inch thickness) 66 lbs., windage 0·1 inch; the full powder charge is 25 lbs.—R.A.E.S.

† This rifling has been since tried and found to be deficient in accuracy, from having no principle of centring and steadying the shot in its passage through the bore of the gun.—R.A.E.S.

quality which causes the studs to have a tendency to shear, with high charges, and get out of shape in carriage. To further lessen this shock, there is a projection upon the loading side of one of the grooves, which pushes the studs close to their bearing, when, to use the phrase derived, I believe, from Sir W. Armstrong, the shot becomes "locked," and a very tight fit it is (Fig. 24).

The Armstrong and Whitworth Competition.—It was arranged that this trial should be entirely at the public expense, and after various preliminary experiments, Sir William brought into the field three multi-groove breech-loading 12-pounders, firing lead-coated shot, and three muzzle-loading 12-pounders of the shunt pattern, rifled with three grooves and firing shot with copper buttons, the former being supposed to represent the service system, and the latter that system with which it seems to have been proposed to replace it. The Elswick Company also sent three breech-loading 70-pounders, with double wedges substituted for the usual service vent-piece and firing lead-coated shot, and three muzzle-loading 70-pounders, firing projectiles with copper studs. The weight of these latter guns is about 77 cwt., and the breech-loaders, though lighter, are heavier than the three hundred 70-pounders* (Fig. 25, Plate XXXV) made for the service. The projectiles also are different from the service pattern, and so are the shells used with the breech-loading 12-pounders.

All these 70-pounders have steel tubes, and the 12-pounders a solid steel barrel, the rear of the breech-loading 12-pounders is also larger to enable a thicker vent-piece, and a larger screw to be used, which has more threads, for the purpose of holding the vent-piece more firmly than is the case in the service gun. These guns comprise therefore Sir William's latest improvements, but do not represent any guns in the service.

Mr. Whitworth brings to the contest three 12-pounders and three 70-pounders, such as he proposes for the service. He has rounded out the angles of his rifling, and the shot, which are entirely of iron, are also rounded at the corners, a modification which appears to have improved the facility of loading, and to have lessened the wear upon the driving side of the rifling of the gun. Mr. Whitworth's competitive 70-pounders are about 78 cwt., which is a trifle more than the weight of Sir William's competitive 70-pounders.

The contest commenced with one 12-pounder of each pattern—the other 12-pounders being kept in reserve. The weight of these field pieces is:—

Armstrong breech-loader.....	8 cwt. 1 qr. 16 lbs.
„ shunt muzzle-loader....	8 cwt. 3 qrs. 27 lbs.
Whitworth muzzle-loader	10 cwt.

The last gun had a vent aperture in the rear, through which it was intended to fire the charge, but there being some objection to the plan, Mr. Whitworth cleverly closed it with a plug, and uses a new vent-hole on the top, which ignites the powder charge at the centre of the cartridge.

* Since called 64-pounders.—R.A.E.S.

In diameter the bore of Mr. Whitworth's gun is smaller, and hence his projectiles have to be longer than those of Sir William's shunt gun, and their length, in order to obtain the requisite weight, has to be further increased owing to the shots being tapered at the rear. The weight of Mr. Whitworth's 12-pounder shot is 11 lbs. 9 oz., and that of the shunt shot $11\frac{1}{2}$ lbs. (Fig. 26). In order to contain the same quantity of powder (11 oz.), the Whitworth shell has to be lengthened to four diameters, which is rather beyond what even the sharp rifle twist of Mr. Whitworth's guns can give stability to over 800 yards; hence there is a slight loss of accuracy in firing shells from his gun as compared with those of the shunt, the shells for which are under three diameters in length (Fig. 27), and have a third button in the centre which seems to give them greater accuracy than the shunt shot which have only two.

In firing shrapnel or segment, the one invented by Colonel Boxer, and the other by Mr. Holland, which may be considered as the normal projectiles for the guns, the Whitworth had a slight superiority in range and accuracy. The initial velocity given by the guns was nearly equal, being about 1,350 feet per second, with projectiles brought to the same weight; the advantage was, however, on the side of the shunt, but the retardation of its shot being greater, the velocities were equal at 400 yards, and then the Whitworth took the lead. At 10° of elevation Whitworth's range was about 4,100 yards with shot, and the shunt about 400 yards less, indicating the flatter trajectory given by the Whitworth field-piece. On the commencement of the trial a wet sponge was used for the shunt, subsequently a dry one, but from not using a lubricating wad, the gun had to be well rubbed inside with the sponge. Still it was not loaded with the same facility as Mr. Whitworth's, for it required a tap with the rammer to send the shot home. In the quick firing of 200 rounds, Boxer's lubricator, made for the Whitworth gun, was also used for Sir William Armstrong's shunt, but the time occupied was longer, and the firing was not considered so accurate by outsiders.

The guns have now fired considerably over 1,000 rounds, and are all showing signs of wear; the lands of the shunt rifling being worn on the upper side of the bore, just where the shot lies, from the rush of gas past it, and the rival gun being very slightly rubbed by its own iron projectile; a trifling flaw or fissure also showed itself behind the vent after the 200 rounds of quick firing, but does not appear to have much increased since. It has been thought that the heating of the gun and the consequent intensity of the action of the gases from the powder being ignited at the centre of the charge, may have affected the carbon in the steel, and hence produced this flaw behind the vent. The damage to the shunt, in all probability, had its origin in the want of lubrication, which in Whitworth's gun left a coating which formed a protection against the heavy powder gases that rushed along the bore past the shot, and a rub once being established, the damage would go on increasing.

The advantage of the Whitworth system consists in the projectile being indestructible and capable of being re-fired. The wear upon

the steel bore from the iron shot is very trifling, and, probably, little if at all greater than the wear upon the shunt rifling by the copper studs, which are somewhat liable to injury. The shunt-gun has, however, the advantage of a round bore, and hence is better able to fire any other description of projectile than its own special shot.

I have not hitherto spoken of the breech-loader's performance, for the gun is so far below the standard of the other two, that even some who were the strongest supporters of the system now say, "Let us, at all events, have a muzzle-loader." And in truth they have good reason to say so; for whenever 40 or 50 rounds are fired consecutively, even with moderate quickness, the men in rear of the gun have their faces and clothes blackened by the *mild* escape of gas. It is useless indeed further to conceal the fact, that the soldiers dislike the gun as much as the sailors, and become so nervous in firing rapidly, that during the 200 rounds which were fired quickly about a fortnight since from the gun, the vent-piece was put in the wrong way, which was seen by a bystander, and once the breech-screw was not screwed up, which was also seen in time to prevent accident, by a looker on. The difficulty of working the breech-screw when fouled by the powder gases, and the water which has to be poured over the breech, to stop the heating and expansion of the gun's delicately adjusted parts and allow them to work, have been already publicly noticed. I need therefore scarcely add that the inferiority of this later improved breech-loader to the Whitworth as well as to the shunt, sufficiently justifies what has been said against breech-loading guns, and Mr. Whitworth's complaints of the hasty condemnation of his weapon.

The 70-pounders have not yet been tried, but I have no hesitation in saying that, Mr. Whitworth's projectiles having greater stability communicated by the sharper twist of his rifling will have greater penetration than the Armstrong shot, especially at distant ranges.

The breech-loader will of course be the worst; it is, in fact, 10 or 12 cwt. lighter than the other guns.

The steel shells of Sir W. Armstrong, which have been provided with thin iron caps, will not, I think, produce any very great effect, for the cap which is screwed on in front of these shells will serve as a buffer to break the blow—just as happens with his present hollow-headed shot—a form which has the disadvantage of largely increasing the deflection or drift, and of destroying the evenness of ricochet; serious drawbacks to naval use.

Captain Palliser's Strengthened Cast-iron Guns.—Captain Palliser was furnished with two 68-pounders and one 10-inch gun.* The first 68-pounder was bored out and provided with a single wrought-iron tube of about 2 inches in thickness—so as to leave the finished bore 9 instead of 8 inches in diameter. After enduring 100 rounds with

* Captain Palliser's guns were purposely passed to destruction,—in the usual manner,—to test their strength. One of Messrs. Walker's 68-pounders had previously withstood 76 discharges, which is the largest number of rounds sustained (with a single charge of powder, and iron cylinders increased by the weight of one shot after every 10 rounds) by any cast-iron English gun before being destroyed.—R.A.E.S.

16 lbs. of powder, and increasing cylinders, the gun subsequently burst at the 7th round with double charges of powder and a cylinder weighing 200 lbs.

The 10-inch gun had two tubes, and was finished with a bore of $6\frac{1}{2}$ inches diameter. This gun burst at the 81st round with a powder charge of 16 lbs., and a cylinder weighing 612 lbs. The third gun had a steel tube placed inside one of wrought iron, but the steel quickly split.

The Blakely Guns.—Captain Blakely was the first to strengthen cast-iron guns, and, as Captain Palliser states, to point out the principle of equalizing the strains on concentric tubes. In 1861, two $7\frac{1}{2}$ -ton guns and one steel gun were rifled by me for him, and he adopted my principle of centring for iron shot. Captain Blakely also took the same form of grooving for guns firing lead-coated shot, and having, after careful trial, ascertained the greater accuracy obtained from it, he has since rifled all his guns in a similar manner.* Captain Blakely has latterly taken Messrs. Vavasseur's gun premises, and very much extended the works, which are now employed in turning out large built-up steel-guns. These have the peculiarity of being finished with massive cast-iron trunnions; † and I have only to mention that the system used by Captain Blakely is, to fire the round ball, and all the other smooth-bore ammunition, so strongly urged by Captain Fishbourne as essential for naval guns.

Having already explained to you the direction which the alterations in the French, the Whitworth, and the Armstrong guns have now taken, let me specially direct your attention to the groove I have so often and so warmly advocated in this room. You will notice that the French commenced with a gaining twist, that Sir W. Armstrong commenced with an angular groove, which could not fire either the round ball or any of the service ammunition, and Mr. Whitworth with an angular bore and sharp edges to his shot. The French some time since, adopted a groove similar to mine for centring the shot; they have now, it is reported, given up the gaining twist for the *even* twist advocated by me. The Select Committee, who have all these different systems before them, and ought, if any body does, to see the way in which things are tending, are using a groove recommended by Captain Palliser, because, as he believes, the particular angle he selects will centre the shot in the same manner as by my form of grooving which the committee have taken for the gun they intend to fire the leaded-projectiles of Mr. Britten and Mr. Jeffrey from.

I wish now to say a few words on the Armstrong 600-pounder.

This gun, with a charge of 70 lbs. of powder, has been found at 200 yards' distance to just penetrate the "Warrior" backing, covered by a $6\frac{1}{2}$ -inch plate; and the striking velocity of its steel bolt of 612 lbs.

* In the rounded form of grooving the iron is not, as it were, "nick'd," and has no such tendency to break as in the case of sharp-cornered rifling, which gives a line for fracture. What Captain Blakely says of the rounded grooves fouling less and being much more easily sponged, should not, I think, for the safety of the arms of the men loading the gun, as well as for that of the toes and bodies of those standing behind it, be overlooked.—R.A.E.S.

† Since changed to wrought iron.—R.A.E.S.

was rather over 1,100 ft. per second. With 90 lbs. of powder the same gun gave a steel round ball of 340 lbs. weight, a velocity on striking of over 1,600 ft., the ball hitting near the centre of the small piece of 11-inch plate fired at, indenting it $4\frac{1}{2}$ inches, and owing to its being unsupported in the centre, splitting it in halves. This blow was undeniably by far the hardest yet struck at Shoeburyness, and was effected with much less strain upon the gun than in the case of firing the heavier elongated shot—which were far more difficult to raise for loading and required a very much greater force to send home in the gun. That the strain upon the breech in firing the elongated shot was much more, may be safely inferred, because the weight of the shot to be moved was far greater, and hence the pressure of the gas must be also much greater. A familiar illustration of this is afforded by loading the safety-valve of a boiler with a heavier weight, and then the steam requires to be of greater pressure, before the valve can be lifted; just so in the gun; and there is this further difference, that the elongated projectile has to be fairly pushed out, unthreading itself from the rifling, whereas the round ball rolls over on the first pressure of the elastic fluid, and at once relieves the gun. In cast-iron guns it has been found that after rifling they cannot use half their old charge with the same safety to the gun, as when fired with their full charge as smooth bores.

It is now time to briefly notice the different plans tried in this country to give rotation without rifling the gun.

Hogge's shot, which were amongst the earliest, were scored in front, and although some of them went tolerably straight, the greater part had little stability of flight, and of necessity, a short range. I need not describe them more particularly than to say that from Hogge's early efforts to Sir William Armstrong's late ones, to obtain rotation either by scoring the shot in front so as to be turned round by the air, or to be acted upon in rear by the powder, all attempts to fire with accuracy elongated shot out of unrifled guns have utterly failed.

The disc gun of Mr. Thomas Woolcombe, of Plymouth, is a very ingenious invention. The shot for this gun (Fig. 29) are, as the name of the gun implies, "discs," and are made so as to have their centre of gravity *not* in the centre of the figure. In loading, the heaviest part of the disc is placed on the upper side of the bore of the gun, and is pushed home in this position by a special rammer. On being fired it gives a very flat trajectory up to the first graze; but hitherto the accuracy obtained has been less than that from the ordinary rifled gun, and the shape of the projectile militates against its powder capacity; the penetrating power of the disc is however very great.

The Mackay Gun.

Length, extreme	11 feet 9 inches
Length of bore	10 " $1\frac{1}{2}$ "
Thickness through breech	2 " 11 "
" " muzzle	1 " $2\frac{1}{4}$ "
Diameter of bore	0 " 8-12 "
Number of grooves	12

Weight of some steel projectiles... 153 lbs. length 12 inches
and of others 167 " " 13 "

Charge of powder 30 "

The gun weighs 9 tons, and was forged hollow by the Mersey Company, and afterwards hooped from breech to trunnions.

Initial velocity given by 20 lbs. of powder	} 1508 feet
and projectile of 100 lbs.	
" by 30 lbs. of powder	} 1640 "
and projectile of 112 lbs.	

The Mackay gun with an elevation of 12°, a powder charge of 25lbs., and a cast-iron shot weighing 129 lbs., gave a range of 3,735 yards. This cast-iron shot was square at the base (see Fig. N). The steel shot fired through the Minotaur target were cupped in the rear (see Fig. M).

Liverpool is the place where these experiments have been carried on, and where the gun was forged by Mr. Clay, who formerly constructed the celebrated Horsfall gun, presented to the nation (Fig. 12), and also made the gun (Fig. 15) which took the place of the piece of ordnance which so disastrously burst on board the American "Princeton." The charges which this gun withstood, viz., 44 lbs. of powder, are very great for a gun so light, especially considering that this was the first attempt at large ordnance made by the Mersey Company, and was the only powerful wrought iron gun made till many years afterwards. It cannot but be a cause of regret that there has been so little inducement given to them to continue the gun manufacture.*

Having thus briefly touched upon the various systems of rifling and the descriptions of guns made in foreign countries and at home, I may show how far the changes made, agree with what has been stated in this Institution, from which it may be fairly inferred that the ventilation of these questions is of great national advantage; and that, had this ventilation been earlier and more thoroughly made, a large portion of the money expended upon weapons, which are of small power and comparatively little value, would have probably been employed in developing the steel manufacture of this country, admitted by Sir W. Armstrong to be still far behind that of the great Prussian firm, represented by Krüpp.

I may remark that other countries have utilized the material already in hand, and expended very little upon new guns; but that England at once embarked in an entirely new manufacture, viz., that of Armstrong guns, and that it was pointed out in the beginning of 1861, at the very outset of this manufacture, that neither the system of construction, the rifling of the gun, nor its lead-coated projectiles, any more than the numerous tools pertaining to the weapon, were adapted for actual service. Later in 1861 the "leading" of the guns, and the delicacy of their whole mechanism began to attract attention;

* The Horsfall gun was fired at Shoeburyness with 74·45 lbs. of powder and a cast iron ball weighing 279 lbs., which got an initial velocity of 1620 feet per second, and gained the first victory over the Warrior target.—R.A.E.S.

and the shunt rifling and muzzle-loading were put forward, and on a war panic, an enormous number of cast-iron shunt-rifled guns were ordered for the navy; happily some of these were burst on the practising-grounds at Shoeburyness, instead of between the decks of our ships; and the war rumour having died away, the order was rescinded. After this the Armstrong guns were alone proceeded with, and their first generally known failure was in the cupola erected on board the "Trusty;" but on the first trial of the larger guns in actual warfare, happily not with foes "yard-arm and yard-arm," but where the ships could move as they liked, the breech-loaders entirely failed, as shown in the report from Kagosima.

A letter which appeared in the "Army and Navy Gazette" of April 30th last, signed by Sir W. Armstrong, inferred that the Admiralty were to blame for this failure through having allowed the old pattern vent-pieces to be used, but it did not state that the vent aperture in the 40-pounders was too small to admit of the new vent-pieces being used, and that there are nearly 300 similar guns out on service. Besides, as the gun is constantly undergoing changes, how is it possible to keep the vessels on foreign stations supplied with the latest improvements.

The construction of the guns has been very much simplified, and in several respects improved since the Arsenal manufacture was left to its proper development, for its chiefs have sought the very best mode of putting guns together, so that even in the limited competition in the Government manufactory of guns, as well as in the free competition in making plates, the country has already derived great benefit. It only now remains to have a "fair field and no favour" in rifling guns, for England to be in possession of what should be the best naval weapon in the world. And I sincerely believe that, were practical naval men appointed, a sufficient sum would be saved in the matter of ships' armaments, &c., to pay the additional cost of a standing navy, and to give the officers that increase of pay which they have been so long and so anxiously looking for.

Lastly, as to plated vessels, I think that erroneous notions of construction are prevalent, from the builders not being thoroughly acquainted with the mode of mounting and working naval guns, and the effects produced by their projectiles, and that hence they have laid too great stress upon the advantages of a thick wooden backing, with a thick armour plate in front of it. Now, Mr. Whitworth has shown us that he can so admirably temper and arrange the metal of his shells, that where he can put a steel shot, he can put a shell also; and it should be remembered that the effect of the explosion of powder always takes the line of least resistance, and hence on a thick plate being penetrated by a shell, moving at a high velocity, and being slightly turned from its direct course so as to close the aperture made, the force of the discharge will act upon the weaker skin of the ship (that is, upon the side proper of the ship), which will in all probability be blown inwards, and the backing set on fire, with a draught through the hole thus made, to keep up the flame. The plate also, in proportion to its thickness, will receive and transmit a greater shock to the

whole structure of the vessel, which, under a continuance of the blows of heavy shot, would be shaken to an extent endangering her safety. The plates, however, would certainly be so much damaged as to require removal, and the sides supporting them would, perhaps, be in nearly as bad a case.

The remedy for this is to put, say, a 6-inch planking of wood over the armour, coating it underneath with Jeffrey's marine glue, and caulking between the planks with the same material.

The wood (compressed pulp or paper would be better) in this position would serve as a buffer, to deaden and reduce the force of the blow: and to support the wood, so as to prevent its opening and spreading laterally, instead of being merely squeezed before the shot, there should be longitudinal stringers of thin iron, crossed by vertical stringers, into which the wood should be firmly packed.

An experiment was tried at Shoeburyness with an inch plate of iron placed in front of wood bolted on over $4\frac{1}{2}$ -inch armour, but having no iron stringers to support it: and although the indentations in the thick inner plate were less than half those usually made upon iron plates without this buffer, shells at last blew off the front plate, and destroyed the wood; but this was an experiment made with the advantage of a quiet concentrated fire upon one spot, and therefore very different to what would occur in an action at sea.

But were such an arrangement as that proposed carried out, the sides of vessels of the "Minotaur" class would be impregnable to foreign artillery, and though some of the wood would be doubtless knocked off, still it is not probable that two shots would strike on the same spot.

As to protection from vertical or plunging fire, the vessels of the "Minotaur" class are sufficiently large to admit of an additional inch of thickness of iron upon their decks, for which the necessity was seen in the case of the "Keokuck," at Charleston, sunk by one shot, which went through her deck and bottom; and more lately in the case of the Danish cupola ship so materially injured.

What, then, would be the position of an iron-clad, with a large shell striking upon her deck? The shell would go down through the vessel's bottom, and she would visit Davy Jones's locker, sinking, like the target ship at Portsmouth, which went down from a single 68 lb. shot hitting the underside of the armour plate, and being deflected downwards through her bottom.

We have already in our armour-clads a noble class of ships, with ports much higher out of water than the French ships, and sailors who I think it will be admitted are second to none. It only remains, therefore, to have the best guns, and the best means of working them, together with what is still more important, a thorough knowledge of their power, and of the tactics necessary for fighting our iron-clad navy.

I have already shown that excellent weapons are now being turned out from the Woolwich Arsenal, and that the shot, shell, and fuzes made there are very good, but I cannot say that we yet have that desirable means for fighting our guns, or that our knowledge of

tactics for "iron-clads" is not susceptible of improvement. In these we want a thorough ventilation, and perhaps a small naval committee, to encourage improvement, and point out where rewards would be most fitly bestowed, and I have little doubt that the stigma of not having even a good handbook for naval warfare would be soon removed, and with it the danger of going into action without having carefully studied and thoroughly understood what has to be done to bring the fight to a successful termination, and to make it a complete conquest with the least loss of life and damage to our ships (points hitherto too much overlooked). Were this done, England, as skilful in warfare as in iron manufactures and the arts of peace, would still hold her old and undisputed sway as mistress of the seas.

Commander DAWSON, R.N.: I should like to ask a question with reference to the American guns, whether the monster guns spoken of so favourably have any relation to the ones tried against Charleston, of which we read that they burst on the average at the fiftieth round. One is supposed to have reached the seventy-fifth round. I should like to ask if the lecturer is convinced in his own mind that he has good grounds for the statement he has put forth? I do not doubt that he himself is satisfied that he is uttering statements which he has received, but the question is whether he has received them from reliable sources. Again, with reference to the Southern States, I did not hear him describe the shot belonging to the Rodman gun; and as I have had the advantage of hearing a description of the shot from a Confederate officer, it may be interesting to add it to the lecture. The Confederate officer described the process of rotation as being given by a brass sabot, which was fastened to the shot by a spindle. The space between the sabot and spindle was filled up with grease; the sabot itself had a sort of saw edge with a corresponding edge in the rear of the shot. So that on firing the gun, the sabot fitted into the rear of the shot, and being forced out into the grooves, gave rotation; and on the shot escaping from the gun, the sabot fell off. The shot pursued its course without any attachment but the sabot spindle. This I had from the Confederate officer, and I suppose it is correct. With reference to our own guns, I think we ought to take with a certain amount of caution what our friend Captain Scott says about the Armstrong guns. We must remember that Captain Scott is an inventor; he has his own particular hobby, and his own particular class of guns. I should like to ask him with reference to this particular groove that he has put forth, with the rounded edge, whether any guns have been tried with that groove? and if so, what has been the effect as regards the accuracy and endurance of the gun? I must say it is a shame that in these days we should have so few large rifled guns in the navy. I have been struck with reading of the success of the French in cast-iron guns; and I understand that Mr. Bashley Britten has succeeded in rifling cast-iron guns with such success, that they produce good accurate practice with rifle shot; and what is still more extraordinary, that the rifling increases the accuracy of round shot fired from the same gun. I think it is a great point that we should be able to fire round shot from whatever is to be the future gun of the navy; because for almost all sea purposes spherical shot has a great advantage in the ricochet which you will never get from elongated shot. Another point on which I should like to chronicle my opinion is with reference to these monster guns. As a rule, I think that as yet, they are mere artillery curiosities. We have not yet had sufficient experience of their capabilities, except in bursting, to know that a 300-pounder or a 600-pounder will ever make a good weapon of war.

Captain HARRISON, R.A.: There is one remark that Captain Scott made shortly after I came into the room, with reference to which I should like to ask on what authority he obtained his information; because I have heard it distinctly contradicted. He said the French have guns—I do not speak of experimental guns, which I think is very probable—but that they have guns which will penetrate four and a half inches of armour plate at 1,000 yards. I was distinctly told on very good

authority that a French naval officer in this country on being asked that question laughed at it. He said, "We certainly have an experimental gun which has done this amount of penetration: but that we have guns which will do that amount of work, is all nonsense, we have not got them." I was also told that so much faith have the French in rifled cast-iron guns, that they are not allowed to fire them except when in action. Such is the opinion they have of their cast-iron guns. With reference to what Captain Scott has said about the competitive Armstrong guns at Shoeburyness, that they completely differ from the breech-loading service gun; so far as I am informed, it seems to me that in the alteration which has been made, it has been a decided disadvantage; because the competitive breech-loader is inferior in every particular to the one in the service now. On the other hand, I never understood that Sir William Armstrong ever objected to the use of steel. Commander Scott seems to think that the introduction of steel had arisen since Sir William Armstrong left the arsenal. I always understood Sir William Armstrong said, "Let us have steel lining as soon as we find we can rely on steel." Query: up to this time has steel been at all reliable for ordnance to stand heavy charges? Take for instance the Prussian steel gun; the charge for that gun is simply 5 lb. Has Commander Scott information of any large steel guns—I do not mean to say that plenty have not been made—but can he give us any information of the number of rounds those guns have stood, and with what charges? The whole question turns upon that. If he cannot, have we been wrong in using wrought iron guns? for certainly we have not seen yet that steel tubes have been as reliable as those of plain wrought iron.

Rear Admiral HALSTED: With respect to the statement just made by my friend Captain Harrison, I would ask him to be good enough to inform us how it is, in a question which is so absolutely critical between the principles of the Armstrong gun, and the principles of the Whitworth gun, representing the polygonal system, that the Government have not put into the pending competition a single gun of all those for which they have paid hard upon three millions of money? and how it is, that the gun with which Sir William Armstrong is now competing, is so absolutely different from his guns in the services, that no pattern whatever of such guns has ever been previously constructed in this country? The service gun consists of two distinct characters, a long gun and a short gun. Neither the long gun nor the short gun, *i.e.*, neither the long gun built upon the pattern of 1860, nor the short gun built upon the pattern of 1863, are represented at the present moment in that contest against the Whitworth polygonal gun. Captain Harrison himself says that neither of these patterns are there. It certainly seems a very wonderful thing, when Sir William Armstrong is challenged for the first time openly, or rather when he accepts for the first time openly a challenge such as that now pending that then he fails to put forth any single sample of any gun which the three millions have purchased from him for the country. I hope Captain Harrison will explain what he means by the distinct assertion that the service guns are better than those which are now being put forth at Shoeburyness by Sir William Armstrong.

Captain HARRISON: I will repeat what I said. I understood Commander Scott to lay great stress upon the fact that Sir William Armstrong had substituted a different breech-loader for our service breech-loader. My remark was this: that so far as I understood, there was no alteration in principle; inasmuch as the breech-loader now in competition at Shoeburyness was a coil gun simply, with a steel-tube inserted.

Admiral HALSTED: No.

Captain HARRISON: This is what I wished to say, that so far as my information goes, the breech-loader at Shoeburyness is a coil gun with a steel tube inside; that if that were the case, Sir William Armstrong had not departed from his principle, because in the very first letter which he wrote on the subject, and which is published in the Report of the Ordnance Committee that sat in the House of Commons, he distinctly stated, that as soon as steel could be obtained of a reliable nature, he wished to use it as a lining for his gun; that at that time he could not rely upon it; therefore he considered the gun ought to be made of hooped iron. That was my first remark regarding what Captain Scott said, that if it be true that the

present competition gun is a coil gun with a steel tube, I did not consider it a departure from the Armstrong principle. Secondly, that even supposing it was, it did not appear to me that Sir William Armstrong had gained by the change, inasmuch as the breech-loader which he at present uses at Shoeburyness is inferior to our service breech-loader; therefore, that Sir William Armstrong would have done much better to have stuck by his old plan, and have used the service gun.

Admiral HALSTED: Permit me to say, that there is nothing more than your statement to shew that the service gun is better.

The CHAIRMAN: We are not now discussing the Armstrong gun; we are discussing the subject raised by the lecturer, the progress of ordnance abroad. You are making this a personal question.

Admiral HALSTED: Permit me to say, that I do not think you are right in bringing me to book, and saying that I am making this a personal question; I am only answering the speaker.

The CHAIRMAN: I do not think you have a right to speak a second time.

Admiral HALSTED: That is another thing. You stated that I had made a remark that was personal.

Rear-Admiral Sir F. NICOLSON, C.B.: I am afraid that our discussion is becoming very heated; and I am quite sure my friend, Admiral Halsted, would be the last to raise anything like a discussion in which any expression that fell from him, quite accidentally, should be objected to. I think it would be a great pity if in his ardent advocacy of one system of guns, he should make us depart from the rule which our Chairman has laid down.

Admiral HALSTED: I did not make it a personal question. Captain Harrison made a statement which I knew to be wrong. He is misinformed, no doubt. It is not a coil-gun, and I merely asserted that it is not a coil-gun.

Mr. J. W. GIRDLESTONE, C.E.: I should like to ask Captain Scott if the screw bolt alluded to as the invention of Captain Palliser, where the part of the bolt on which the thread is cut is of larger diameter than the other part, is supposed to be new in principle, or in its application only for securing armour plates on ships; I suppose the latter, for I myself once showed on some drawings, not a bolt for armour plates, but a screw, where the part on which the thread was cut was of so much larger diameter than the other part of the screw, by the thickness of the thread; which drawings I laid before the Ordnance Select Committee some two years since.

With respect to Mr. Mackay's gun, which has been mentioned this evening, where the shot rotates by the action of the gas, the projectile used being, I believe, only one and a half diameters in length, I would suggest that even if the gas will give sufficient rotation to such a projectile, which I imagine is too short for general use, that it does not follow that it will give anything like sufficient rotation to a projectile of two and a half or of three diameters in length; the projectile having no grooves of any kind on it.

Captain J. H. SELWYN, R.N.: I am anxious to say a word before this meeting, in view of what has been stated in a leading journal within the last day or two, with respect to the naval action fought off Heligoland. That leading journal took occasion to inculcate, with the authority of one who holds the pen with great ability, but who I doubt has ever held the trigger lanyard, the system of long balls as opposed to "close quarters." I do say it is a most dangerous thing for the naval supremacy of this country, that the very talented members of the press should fancy themselves such authorities on such a subject, as to lay down such utterly false premises, and to draw from them such still more false conclusions. It is dangerous, for this reason: young officers are now perhaps better read in the daily journals than they are in the history of their profession; and they are too apt, with the great mass of the British public, to follow the lead of a gentleman, who sitting at home at ease, fancies himself entitled to write of all things, in all places. It is not many months since, that in this Institution a gallant Admiral, whose age and whose experience entitle him to the utmost attention, got up and distinctly laid down as a rule, what I think most naval men of experience will join him in announcing, that no naval action ever was or ever will be decided at long ranges. It is

perfectly true, that owing to that trajectory, which some writers in the journal I refer to, also despise as a piece of professional slang, long range guns will occasionally do considerable damage to ships, when the shot strike them on the decks, but not on the armour; but the gun which cannot pierce armour at 200 yards, cannot be expected to do so at 2,000. If any gentleman connected with the press will be kind enough to watch shot falling at three miles distance, and tell me how many of them strike and where they strike, then I shall be obliged to adopt his opinion, and condemn the tactics of the Austrian frigate in running in between her two antagonists and giving them as much as she could, though in that case, as in almost every other, two to one proved too much for her. Though the Prussian gun-boats took part at long balls, yet we learn that they went away, *hoping* they had done the enemy a great deal of damage, but utterly ignorant as to what that great deal was. If any English officer, having fought an action under such circumstances, were to come home to England, saying he *hoped* he had done a great deal of damage to his enemy; he would not be received with those cheers and acclamations, and those laurels which it is the hope and pride of every English officer to deserve. Captain Dawson said, in the course of his argument against what Captain Scott had stated in his lecture, that the guns which Captain Scott advocated were advocated by him because he was an inventor. Now, I must say that it is not a fair thing in any profession for members of that profession to get up and say that because one of their number has turned his attention particularly to this or that subject, and has arrived at a conclusion which day by day is being demonstrated to be more correct, that he is to be regarded simply as an inventor; that he is advocating his own principles; and that he cares nothing about the public service. I do believe that any officer in that position thinks first how he may benefit the service, and next how he may benefit himself. I am sorry to say that in the majority of instances those who do most for the service spend the most money with the least benefit to themselves. I think it is open to the recollection of every one here present that those guns such as Captain Scott advocated, the old cast-iron guns rifled on a particular principle, have been tried with very considerable endurance.

Captain FISHBOURNE: Not advocated.

Captain SELWYN: Captain Scott has advocated a particular principle of rifling cast-iron guns.

Captain FISHBOURNE: Not cast-iron guns.

Captain SELWYN: I did not say advocates cast-iron guns. I said rifled on the principle which Captain Scott advocates.

Captain DAWSON: I did not allude to his principle of rifling. I did not understand him to advocate his own principle of rifling at all.

Captain SELWYN: Then one of us misunderstood the question. I hope it was myself; because Captain Scott will be happy to hear that there is no objection to his rifling. But that system of rifling is one which, to a mechanical mind, must commend itself, because the whole force is communicated in the direction of the line in which rotation is required. It is at the first blush the great excellence of that form of grooving which has led to its adoption in the Jacob rifle, in small arms, and in other arms of the same character. It has next, that which Captain Dawson admired particularly, the power of firing round balls with the least possible injury, and, moreover, with the least possible windage, which is a very valuable condition. Granted that the edges of the grooves must not be injured, then that is the only groove which, with small windage, is capable of firing round ball. The French gun was adverted to by Captain Harrison as a doubtful specimen. I must say that it appeared in journals whose reputation entitles them to credence on such a subject, that that gun did pierce iron plates of the thickness adverted to by Captain Scott at 1,000 yards.

Captain HARRISON: I referred to guns.

Captain SELWYN: I have yet to learn that the French have constructed any other gun. If one gun will do it, that is quite sufficient for our purpose. We only want to know that there is a gun that will do this at such a distance without being damaged or injured. That it does so with diminished powder charge is very little to the purpose, because the effect produced is what we seek. If Sir William Armstrong

has not infringed upon his principle by adopting a steel tube, may I ask to what thickness the steel tube is to go before the coils are considered eliminated altogether? When are coils to cease to be considered the great feature of Sir William Armstrong's principle, as he has himself announced them to be? and when is the internal steel tube to be allowed to take their place? Again, it is said that Sir William Armstrong was ready to take steel whenever he could get it. Now, at a lecture which I am sorry to say was very thinly attended, given here by Mr. Bessemer, he stated to us, what he has stated long ago to the Government, that he could give them steel of any quality they desired, from the same quality as the best and softest wrought iron upwards to the hardest steel, by a mere alteration of the proportional parts of his materials; that he could do so for the Government at £7 per ton. Was this gentleman not equally well worth considering and treating with as another who professed to give us coils which would never weld, which never could be welded between the bars, and which have failed and will fail as long as they are used? And should we have spent three millions of our money less usefully by giving a proper proportion to the development of a metal which promises us the greatest tensile strength? Captain Scott has given a very able *résumé* of the principal features of foreign artillery; but I must draw attention to the fact that in no instance do we see in the foreign artillery any great improvement or advance upon what we know ourselves, unless it be in those instances where they have taken the most valuable principles of our own inventors, and so far demonstrated the value of them as to induce our Government to send officers abroad to look at guns, the designs for which, if not the guns themselves, were made at home.

Commander SCOTT: I think Captain Selwyn has left me very little to answer. Captain Dawson seems to have entirely misunderstood what I meant. He says I spoke in favour of cast-iron. On the contrary, I spoke of cast-iron being given up as a metal fit for powerful rifled guns. I said the Americans had already commenced the mild steel manufacture, had paid a large sum for the patent to Mr. Bessemer, and had an agent over here to be instructed in the manufacture. I must say I cannot understand the purport of Captain Dawson's remarks. He said, on the one hand, that he wants a big gun for the navy, and, on the other, that he does not want a big gun; and then he said that monster guns with a sufficient endurance cannot be made. He also appears to infer that I do not want to fire round shot; whereas, if he had paid attention to what has been said over and over again in this Institution, he would have learnt that the very principle I commenced with was that we had got a good missile in the round ball; that we knew precisely what it would do; and, therefore, it was folly to give up what we knew was good to go after something else, the value of which we did not know. Besides, I called attention to the fact that the very first trial of the Armstrong gun proved it to be inferior to the 68-pounder at close quarters; and I said that for a naval gun you must have the round ball as well as the elongated projectile, but that the first thing was to fire the round ball well, and in my letter to the War Department in 1859 I stated that "the round ball will always finish naval actions." Although I am one of those whom Captain Dawson has kindly stigmatized as an inventor, I must say, that as one of the early gunnery officers, and having paid such attention to the subject that I was enabled publicly to state in 1860 that the plans of Sir William Armstrong were not adapted for naval guns, it became almost imperative upon me to show that they were so. This endeavour has cost me a considerable sum of money, for I had to pay for all my early experiments, because I happened to be a naval officer instead of a civil engineer. If Captain Dawson could point out to me where I have gained in this matter, I shall be particularly obliged to him. With reference to the remarks as to where the steel is in Sir William Armstrong's competitive guns, the simple fact is that they are steel guns. They have a solid steel barrel all the way through till you come to the trunnions, and there are little coils put on, one apparently for the trunnion-holder, and the others I suppose for a make-weight over the breech. Had the service 12-pounder been so satisfactory as was said, Sir W. Armstrong would scarcely have gone from a good thing to a new plan. But he had not a good thing, for the service guns are continually failing. As I have adverted to this, I had better take the official Report and just glance at the performances of the Armstrong guns at Kagosima, and the mishaps that happened to them.

The Report speaks of precisely the same thing: of the vent-pieces sticking in the bore from the tin cup being forced back over their nozzles, just as Captain Fishbourne showed to have occurred at Newhaven. The breech expands when warm, and then the tin cup is jerked over the nozzle of the vent-piece, which necessarily sticks fast, and cannot be got out without mechanical appliances. This misfortune did not occur to Racehorse's (Captain Boxer's) gun only, but it occurred also to the guns of the other ships at Kagosima. I have only now to explain about Captain Palliser's bolts.

Captain FISHBOURNE: And the French gun?

Captain SCOTT: As to the French gun, Captain Harrison has one report and I have another, and I believe mine to be correct. Captain Harrison likewise spoke of the Prussian steel gun as not reliable. I am informed that the Prussians are making them in large numbers, and hence I conclude that they are good guns. They are just like those from Krupp, which have been so successful in English trials. I got the information as to the performance of these guns from different sources; and I also got information from America and other places, of their artillery, but still it is extremely difficult, as Captain Harrison knows, to get information which can be fully relied on. I have no official report, as I have in the case of the Armstrong guns at Japan.

Captain HARRISON: The only question is whether the Prussian guns are making or made?

Captain SCOTT: Making. I was informed that they were going on with them as fast as possible.

Captain HARRISON: Not made?

Captain SCOTT: I have no doubt several of them are by this time, but how many I cannot say.

Sir F. NICOLSON: Have they all been tried?

Captain SCOTT: Several have been tried. As to the "raised screw thread," Captain Palliser only applied the plan for holding armour-plates, and I think great credit is due to him for this novel application of a principle, which is all he claims. It has been, as far as yet tried, eminently successful. I think I have now answered all the questions, in which Captain Selwyn, like a true sailor, has not only kindly helped me onward, but cheered me on the road.

The CHAIRMAN: It only remains for me to ask you to join me in thanking Captain Scott for his lecture. Lectures of this description take about an hour and a half to deliver, but I am sure they take many hours to study and to write. We see the wheat after it has been sifted through the sieve. Captain Scott has been sifting the wheat for us, and it is rather a long process. As Englishmen, I think we may be satisfied with what he has shown us. We seem to have gone through a long course of experiments, gradually and gradually improving; and it is satisfactory to know that all the countries,—France, Russia, Austria, Prussia, except Italy, Spain, and Portugal,—have gone through the same course of disappointment, and have worked their way up to their present position.

NATURE OF GUN.	Powder charge.	PROJECTILES.			Velocity at 30 yards.	Initial velocity.	Remarks.
		Nature.	Weight.	Diameter.			
	lbs.		lbs.	in.	ft.	ft.	
32-pr. Rifled Shunt, 59 cwt., } cast-iron gun	5·8	Elongated shell	51	6·35	1215·7	1224·5	Mean of 4 rounds.
" "	5·8	" "	51	6·35	1122·1	1136·3	Mean of 3 rounds.
32-pr., 59 cwt., Smooth.....	5·8	Cylinder	51	6·35	1187·4	1201·0	
12-pr., A, 8½ cwt.	1·6	Elongated shell	11·9	3·074	1103·4	1111·8	
" "	1·8	" "	11·9	3·074	1238·3	1248·2	
" "	1·8	" "	11·9	3·010	1200·	1209·7	{ Same shell, lead reduced to the same diameter as the gun, except a ring 0·25 of an inch in length at the base.
63-pr., 95 cwt.	16·	Round ball	66·4	7·91	1553·3	1579·0	
" "	"	Round shell	51·8	7·91	1769·4	1809·9	
32-pr., 58 cwt.	10·	Round ball	31·6	6·17	1653·	1690·0	
12-pr., 18 cwt.	4·	" "	12·10½	4·52	1718·	1769·8	
12-pr., 6½ cwt.	1·4	Elongated shell	8·12	4·55	1124·2	1163·4	
12-pr., A, 8½ cwt.	1·8	" "	11·9	3·084	1180·9	1190·2	

NATURE OF GUN.		PROJECTILES.				
		Powder charge.	Nature.	Weight.	Diameter.	Velocity.
		lbs.		lbs.	in.	ft.
Horsfall's Smooth Bore { wt. 2½ tons, { bore 13-0¼ in. }		74-45	Round ball	279-5	10-41	Initial. 1631-0
300-pounder { shunt } wt. 12 tons { rifled } bore 10-48 in. }		50-0	"	150	"	1750-0
" " "		50-0	" wrought iron..	103	"	1700-0
" " "		45-0	" " "	163	10-337	1627-0 At 508 feet from gun.
" " "		50-0	" steel	168½	10-43	1593-8 At 510 feet from gun.
" " "		45-0	" Elongated steel shot...	301	10-46	1254-5
" " "		35-0	" cast iron	308	"	1096-0
Lynall, Thomas { wt. 18 tons, { bore 9-0 in. }		50-0	" steel.....	327	"	1222-0 At 546
Shunt rifled { bore 9-23 in., { wt. 12½ tons. }		44-0	" " "	221	9-14	1461-1 At 510
" { bore 7-0 in., { wt. 6½ tons. }		30-0	" " "	221	9-14	1292-6
" { bore 7-0 in., { wt. 6½ tons. }		25-0	" " "	100	6-91	1507-2
Big Will, 600-pr. { bore 13-3 in., { wt. 22½ tons. }		90-0	Round ball "	344	"	1589-0 At 600
" " "		70-0	" Elongated shot, cast-iron	513	13-25	1255-0 At 120
" " "		70-0	" shell, steel ..	610	"	1143-0 At 2910
" " "		70-0	" Round ball, cast-iron ..	30½	13-2	1273-3 At 510
Committee Gun for lead-coated { bore 7½ in. }.. shot of Messrs. Britten & Jeffrey { wt. 6 tons.		16-0	" Elongated shot, steel ..	119	"	1273-3
Whitworth's 120-pr. { bore 7 x 6¼ in., { wt. 7½ tons. }		27-0	" shell "	149-5	"	1283-4
" " "		23-0	" Elongated shot "	129-0	"	1278-5 At 1740
" " { bore 5-6 x 5-2 in., { wt. 3½ tons. }		12-0	" " "	68-8	"	1275-8 Initial.
Scott's 120-pr. { bore 7 inches, { wt. 7½ tons. }		25-0	" " "	110-0	"	1584-0
" " "		12-0	" " "	110-0	"	1270-0
French " "		25-0	" " "	110-0	"	1550-0
" " "		12-0	" " "	110-0	"	1256-0
Parrott's 100-pr., bore 6¼ in.		11-0	" " "	80-0	"	1403-0
Rodman's 15-inch, bore 15-0 in.		60-0	" Round ball, cast iron ..	400-0	"	1480-0
" "		40-0	" " "	315-0	"	1250-0