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Major-General BOILEAU, R.E., F.R.S.: In reading this paper, I beg to observe that I am only acting as the mouth-piece of Lieutenant Walker, Assistant Instructor of Musketry at Fleetwood, who cannot be present, and I have, therefore, to premise that I am not answerable for any of the opinions expressed.

BREECH-LOADERS FOR THE ARMY, AND GUN-COTTON AS AN EXPLOSIVE AGENT IN MODERN WARFARE.

By ARTHUR WALKER, Esq., Lieut. 79th Highlanders, Lieut. Instructor School of Musketry, Fleetwood.

THE announcement recently made in the House of Commons by the Marquis of Hartington, that two thousand breech-loaders were to be placed in the hands of the troops, to be tried and reported on, will, we believe, be received with unmixed satisfaction by the public in general, and the army in particular. The conviction is fast gaining ground amongst all classes, that the breech-loading system, in some shape or other, must, before very long, be adopted for the army of England.

It will be observed, however, that the step in the right direction taken by the Government is merely one of a tentative character; and therefore, whilst it is still under consideration, and pending the inevitable "report" sooner or later to be sent in, it may not be inopportune to seize the present moment for ventilating some of the important points which the recent course of events has developed or brought to light with respect to breech-loaders as a *military* arm.

It is almost superfluous to remark, that with the exception of Prussia and a few special corps in other countries, breech-loaders have not been introduced into the armies of Europe; and therefore, if we would learn something as to how breech-loaders work practically as military weapons, we must go to Prussia for our information.

The "*Zündnadelgewehr*" or needle rifle, called so from the ignition of the charge being produced by a needle being passed through the cartridge to strike the percussion powder, was introduced into the Prussian service in the year 1848, and the following may be regarded as a correct and comprehensive description of this fire-arm.

* "The barrel, AA, (Fig. 1, Plate XXX), which is 34 inches long, is rifled with four grooves (Fig. 3), and has a "hausse," or sight, adapted to distances of 600 metres. It is screwed into the end of a strong open guider or channel BB. The chamber, properly so called, is bored out

* Vide Sir Howard Douglas's work on Naval Gunnery, 5th edition, p. 560, et seq., whence Figs. 1, 2 are taken.—A. W.

from behind, conically in a slight degree, so that, when the cartridge is placed in it, the shoulder, CD (Fig. 1), of the ball shall meet and be stopped by the projections or ribs of the rifling, the body of the shot being of sufficient diameter to fill the full depths of the grooves. Inside of the guider slides an iron tube, EE, with a strong "hebel" or handle, F, and having at the front end a space, GG, of about $1\frac{1}{2}$ inch in length. In the middle of this space is a "tigo" or pillar, II, which, instead of being solid like that of a pillar-breech musket, is pierced with a small hole in its entire length, and through this passes the needle N, which is to ignite the charge: the steel tige is screwed into a solid plate of iron, JJ, left in the tube EE, and this plate it is, which (like the breech-pin of the ordinary musket) receives the whole reactionary force of the charge."

"Behind the plate, JJ, there is a second tube of iron (which could not be shown in the drawing) having a double catch spring attached, and carrying within it a small inner tube of iron, KK (Fig. 2), having two projecting rings, LL, on one moiety of its length, and a spiral spring, MM, (Fig. 1,) sliding on the other half. Through the tube, KK, passes the needle, NNNN, which is a thin steel wire about $\cdot 03$ inch diameter, bluntly pointed at the end, which is to ignite the charge; at the other end it is screwed into a brass head, O, and this again screws into the inner tube, which carries the spiral spring. The trigger, which is of a peculiar form, and has a bolt movement in firing, could not be shown intelligibly in the diagram."

"At the lower part of the barrel is the sliding tube through which passes the needle for igniting the charge. This tube is capable of being moved backwards or forwards in the barrel near the breech by means of a pin, or handle, in its side, which passes through a perforation similar to a bayonet notch in the side of the barrel. When the tube is drawn as far as the perforation will allow towards the stock, there is formed an open chamber between its extremity and the nearest extremity of the barrels and by means of this chamber the charge is introduced into the barrel. The tube is then pressed forward till its extremity, which is in the form of a frustum of a cone, is in contact with the rear extremity of the barrel; this extremity having the form of a hollow cone to receive the end of the tube; the pin or handle being then turned round in the notch, the tube is, as it were, locked in close contact with the barrel. In this state the needle in the tube is in connection with the trigger of the lock, and the musket is ready for being fired."

The grooves shown in Fig. 3 have a uniform depth and twist, with one turn in 42 inches. The bullet is ogival in form (Fig. 4), and weighs 451 grains, and is fired with a charge of 65 grains of powder in the cartridge. The powder is separated from the bullet by a rolled and compressed paper cylinder, which is hollowed at the end next to the bullet, so as to fit the base of the bullet (Fig. 5). It has also a cavity at G, in which is lodged the fulminating composition to be exploded by the needle driven into it—thus avoiding the use of caps, priming, &c. The elevating sight (Fig. 6) is in part fixed and in part moveable; it is lowered in its position on the barrel either to the front

or to the rear. The cost of the gun is not great, being only between 12 and 13 thalers, or from 36 to 39 shillings English.

The salient properties of the needle-gun may be taken to be the following:—It can be loaded and fired six or seven times in a minute, more or less, according to the skill and dexterity of the soldier. Of course this does not suppose and include time for a careful aim; but when firing into masses, at short distances, very little aiming is required, owing to the flatness of the trajectory on such occasions. All that the Prussian has to do, is to open the lower end of his rifle-barrel—which is done by a most simple contrivance—to take a cartridge from his pouch, which he wears in front instead of behind, insert it without biting or breaking, shut to, and fire. There is no ramming down, which exposes the man when in front of the enemy; no fumbling with tiny caps, hard to feel with cold fingers, but everything is simplified and well-adapted to the desired object.

It has been objected by military men that this kind of gun would easily get out of order; but according to the correspondents of the newspapers, the Prussian officers, who in time of peace always stood up for the excellence of their weapon, are more than ever satisfied with it now that it has been tried in war. The soldiers do not treat it as if it were a very delicate weapon, but, on the contrary, knock it about in loading and handling, quite as much as it would be proper to do with any other kind of rifle.

By a singular coincidence, the field in which this breech-loading rifle was first practically tested was the same as that in which it has recently asserted its terrible destructiveness; and although in the former abortive war between Prussia and Denmark this was not perhaps developed to the same extent, yet the bloody battles of Kolding, Fredericia, and Istedt attest only too fully the deadly effect of its fire. At the latter engagement, it is related, that in seeking to dislodge some Prussian infantry from a bridge, the Danish infantry and cavalry were, in a very short time, nearly decimated; the General in command was struck down, the chief of his staff wounded, and nearly every other officer either killed or wounded in less than an hour.

Since the period in question, no effort has been spared to improve and develop the advantages of the needle-gun, and during the Crimean war one million thalers, or £200,000 were voted by the Prussian Chambers, in excess of the preceding year's expenditure, with the view of extending its manufacture and securing its issue to every soldier in the Prussian army.

The wisdom of this forethought on the part of the Prussian Government, and how this formidable armament has succeeded, may be gleaned from the various accounts which have reached us of the Sleswig-Holstein War, the din of which is still fresh in our ears. From the very first, whenever the Prussian and Danish infantry came into collision, and especially when these encounters took place between masses in the open field, during this deplorable war, the disparity in the losses has told fearfully against the Danes—to an extent, indeed, that at first appears wholly unaccountable. Observation and inquiry, however, soon demonstrated that this disparity was entirely attri-

butable to the superiority of the Prussian rifles. Firing rapidly, about three times as fast as the Danes, who were armed with the ordinary four-grooved, muzzle-loading *Minié*, they availed themselves of the intervals between the successive salvos of the enemy, to pour shot upon shot into him whilst loading. To this the Prussians were indebted for their success at Büffel Köppel, which secured the evacuation of that village and the outlying ground—the Danes retiring rapidly, leaving many men in the hands of the enemy, and carrying off a number of wounded.

A similar result ensued at the final capture of the Düppel forts; and the following episode has been quoted in proof of the effective fire of the needle-gun on the latter occasion:—A company of the Prussian Guards, following up the Danes after their retreat from one of the forts, drove a battalion out of a farm-house and the buildings which it occupied. On perceiving, however, the numerical inferiority of the force that had ejected them, and not seeing it supported, the Danes returned to the charge, and thought of retaking what they had lost, but the Guards opened upon them so formidable and continuous a fire with their needle-rifles, that they were glad and compelled again to beat a retreat.

Now one authenticated fact, such as this, is worth a host of conjectural speculations as to what breech-loaders might effect, and tends strongly to confirm the opinion, that steady soldiers, armed with breech-loaders, are a match for two or three times their own numbers. Had the Danes been provided with this weapon, how different might have been the result of the struggle, wherein this small but gallant nation has had to contend behind entrenchments against overwhelming numbers. Indeed, to nations with small, or comparatively small armies—like England—the breech-loader is imperatively necessary, since, by the very proposition of her paucity of numbers, each man should be equal to ten of the enemy on almost all occasions of conflict. Indeed the argument cuts economically as well, since if the present strength of our army be sufficient, when armed with breech-loaders it might be reduced in accordance with the increased efficiency secured by the weapon.

For our part, now that a breech-loader has been adopted as the universal arm of one great continental army, and as it is known that both the French and Belgian Governments are on the eve of taking a similar step,* we believe that no alternative is left us but to adopt the system without delay. It has just demonstrated its superiority. What more can we need? Can any "Report" whatever rebut the facts of the late campaign in the gory fields of unfortunate Denmark—unfurnished with a weapon which might have given her invaders a lesson to be remembered—instead of seeing her brave little army crushed before overwhelming numbers. Can we for an instant contemplate the possibility of our not taking the most speedy and ample measures to secure to England perfect immunity from such ruin and calamity?

* Since this article has been written the author has been given to understand that a breech-loader, on the needle principle, but much simplified, is being introduced almost universally into the ranks of the Federal army of North America.—A. W.

To hesitate in this matter is to be lost.

But even apart from these considerations, so vital to the existence of the nation, the adoption of the breech-loader is necessary on account of our almost constant state of warfare in some part or other of the globe. As Lord Elcho pertinently put it to the House of Commons on a recent occasion, what would be the position of an English contingent, if it should find itself opposed to a force armed with breech-loaders?*" The alternative of making rapid charges, so as to resort to the bayonet, would doubtless be the practical solution necessitated; but, unfortunately, it is precisely in meeting or repelling such charges that the superiority of breech-loaders would become most evident; for, men so armed, and with bayonets fixed, can keep up a continuous fire *till the very last instant*—since, in a measure, it is never necessary to move the rifle from the position in which it must be held, when resisting the advance, either of infantry or cavalry. General Rémond, of the French army, avers that infantry armed with breech-loaders, and readily "forming fours," will dispense with the usual formation of squares—which checks the advance of troops, and renders them so vulnerable to artillery. With breech-loaders, effectual fire of the deadliest kind could be delivered with a rapidity that nothing could withstand, namely, in four ranks, and even in five,—the first lying, the

second sitting, the third kneeling, the fourth and fifth standing. See accompanying diagram.†

In the presence of these facts, we may hesitate as to which *principle* of *breech-loader* we should adopt, but not for an instant as to the adoption of *the weapon*.

Undoubtedly the most cogent argument against the introduction of breech-loaders into the army, is the alleged likelihood of soldiers squandering away their ammunition; but this argument is very much like that which was advanced as fatal to the introduction even of the *Enfield*. Military men said it was too delicate a weapon to be placed

* In the debate referred to, Lord Elcho pointed out that although a Committee, appointed by the House itself more than two years back, had reported that a much better weapon than the *Enfield* could be manufactured at exactly the same cost, yet the manufacture of the inferior weapon had been continued at the rate of 1,000 per week, and the House declined, by a considerable majority, to endorse the conclusion of its own Committee or make any change.—A. W.

† This diagram is taken from "The Rifle, its Theory and its Practice," by the author.—A. W.

in the hands of the British soldier! Experience has utterly refuted the imputation. Of course, it must be admitted that a badly disciplined regiment, with careless officers and negligent sergeants, at the beginning of an action or campaign, would probably fire away its ammunition too quickly, but it may still be, that its effect, even in such hurried circumstances, would surpass that of ordinary rifles. Moreover, we have no right to assume that men trained to use the breech-loader, and constantly cautioned not to throw away their shots, would necessarily and perversely do so—with every consideration, both national and personal, to make them anxious to husband every shot at their disposal.

But what does the able correspondent of the "Times," who accompanied the Prussian army throughout the recent campaign, declare on this very head? He says, "I repeatedly asked the Prussian officers whether they found that the facility of loading had the bad effect of making the men fire too rapidly, and waste their cartridges; but they tell me it has not." And are we to be told that British soldiers will necessarily be less provident of their ammunition than the Prussian?

But surely, even supposing this objection were well grounded, and even insuperable, it would be better—rather than lose the manifold advantages resulting from the use of breech-loaders—to devise a method of impeding the soldier's access to his ammunition by some mechanical arrangement of the cartridge box. We cannot think such a precaution necessary for the taught soldiers of the British army; and most assuredly the appliance would be absurd, as actually defeating the very object we have in view—the utmost rapidity of fire combined with effect; and in venturing the suggestion our only object is to plead, by all means, for the adoption of this greatest military boon ever vouchsafed to the soldier. If the obstructive prejudice against breech-loaders in this respect prevents its adoption, we can take means exactly to regulate the number of shots he can fire per minute.

It was said, after the introduction of iron-plated ships, that any Minister who should send our sailors forth to battle in wooden ships, to their inevitable destruction, ought to be impeached; but what should be said of him who would allow our soldiers in any future war to be shot down whilst standing up to load his gun, during the tedious rodding and capping motions, when he might be armed with a weapon which would effectually prevent his exposing his body, and unnecessarily sacrificing his life?

At the great Hornsey-wood pigeon match the other day (2nd June), it was remarked that two-thirds of the guns used were breech-loaders, and that more than half the prizes were carried off by them, so that it would appear that the prejudices that existed when they were first introduced have gradually died away. Yet it appears a curious perversity of judgment that a breech-loader should be preferred for pigeon-shooting, deer-stalking, and cover-shooting, on account of its greater convenience and destructiveness, and yet refuse to the soldier the same advantages for dealing with his larger and more dangerous game.

There is another disadvantage connected with a muzzle-loader, which is not likely to present itself except to a man actually in the

service,—we refer to the time and labour required to be expended on the recruit to make him thoroughly conversant with and habituated to that dreadful platoon-exercise, which is one of our military perfections so completely in accordance with the slow-coach of battle in the 17th century. It requires a long time to acquire the habit of loading properly, so that in the hurry and excitement of the battle-field, it shall be as a second nature. Facts amply support this averment. It is related that, after the battle of Gettysburg, the muskets found on the ground not discharged were loaded, or rather mis-loaded, in the most extraordinary variety of ways. In some were bullets without powder, and in others powder without bullets. Others had cartridge after cartridge on the top of one another, whilst at the base of the nipple-hole a piece of paper appeared to have been carefully jammed so as effectually to prevent the ignition of the charge. Some, again, were loaded and capped ready for discharge, with the ram-rod left in the barrel.

But, indeed, we need not cross the Atlantic for illustrations of this malpractice; for, unfortunately, at the last Volunteer Review at Guildford, the death of a clergyman by a ram-rod driven through him, sufficiently testifies to the difficulty of getting indifferently drilled men to go through all their loading-motions correctly.

The action of skirmishers in future battles will be most important; and their special action consists in their well-aimed shots. But all know the difficulties of skirmishers in properly loading on the present system.

It is impossible to get all the powder down to its proper place; after a single discharge some of it must stick to the sides of the bore, even if the barrel be kept perfectly perpendicular—which is impossible in skirmishing. Besides, some must load kneeling or lying. Now it is certain that every grain of powder in the charge is absolutely necessary—the weight being the minimum.

There is absolute immunity from all these disadvantages in the breech-loader, wherein (with the Westley Richards for example) the loading simply consists in raising a lever, pushing in a cartridge tip foremost, and shutting down the lever. The rawest recruit could be taught his “platoon exercise” in the course of a single day, and the veriest tyro could hardly make a mistake.

We might dilate at greater length on the other numerous advantages, in the tactical point of view, which the adoption of breech-loaders would secure to the soldier; but most of these are really too self-evident to need any advocacy, and we shall therefore proceed to consider, in detail, the weapon experimentally issued by the Right Honourable the Secretary of State for War, to whom it is difficult to give too much credit for even giving the principle a trial.

The two thousand breech-loaders referred to at the beginning of this article, are made by Mr. Westley Richards of Birmingham, and the principle of construction is the one identified with his name, and as the weapon is likely in some shape or other to become a service arm, we proceed to give it a brief description.

Fig. 8 (Plate XXXI) represents a section of the breech-loading parts.

A is a gun-metal plunger which enters the breech end of the gun; B is a solid iron block with an inclined plane at the back, C. There is a second inclined plane at the point E, which throws the block B back into its place, and makes it fit close against the end of the box, F, which is also undercut, to fit the inclined part of the block, B, at the point C. The block has a sliding motion to allow this action to take place. By this it will be seen that the greater the pressure on the block and plunger the safer the part becomes, the inclined plane holding the lever firmly down in its place. D represents the cartridge. Fig. 9 exhibits the rifle ready to receive the charge, and shows how the breech is raised to load the gun, the junction being behind the cartridge. When the rifle is closed, a small lump, marked A in Fig. 10, is the only projecting part; in all other respects the gun has the appearance of the ordinary rifle. The barrel is that of the Whitworth in every respect, save the number of sides in the bore, which are eight instead of six—hence the bore is octagonal (Fig. 7, Plate XXX). With the rifle proposed by Mr. Richards as a service arm, the bullet to be used will weigh 500 grains, certainly not more, and probably less,—the charge of powder to be 80 grains or 2·92 drs. The weight of the gun with bayonet is about 10 lbs., the barrel 3 feet in length, and much stouter than that of any musket made for our service. With this gun the following results were obtained at a target on a favourable day:—

20 shots at 600 yards, elevation $1^{\circ} 21'$,	gave a figure of merit of 6·96 ins.			
20 " 800 " $1^{\circ} 50''$	"	"	"	11·85 "
20 " 1000 " $2^{\circ} 50''$	"	"	"	17·50 "

Average shooting, taking all kinds of weather,

600 yards	9·50 to 10 inches.
800 yards	13·50 to 14 "
1000 yards	22·00 to 24 "

These figures speak volumes in favour of its precision of fire and lowness of trajectory; and for safety and simplicity of loading, we believe this weapon to be at present unsurpassed as a breech-loader; but, unfortunately, it is deficient in one essential speciality of a breech-loader,—it retains the detached cap system of the ordinary rifle, introduced at the beginning of the present century as a mode of ignition; consequently, its rapidity and facility of loading are sadly impaired and diminished.

We have reason to believe that Mr. Westley Richards himself suggested to the authorities the propriety of combining with his breech-loader some well-considered method for igniting the charge without the intervention of the now antiquated percussion-cap, by means of a direct detonation applied to the base of the cartridge, somewhat on the principle of the Prussian needle-gun; but he was at once told that the idea could not be for a moment entertained, because any such method was incompatible with the requirements of a military fire-arm! So, to fall in with some fixed and determined rule, the miserable little cap

is to be still supplied to the benumbed, agitated, or fumbling fingers of the fighting soldier on the field of death. The reply bears a striking and rather unlucky resemblance to that accorded to poor Captain Norton in 1824, when he first brought forward a self-expanding, elongated projectile, on the very system now universally adopted, viz., that a "spherical ball was the only shape of projectile adapted for military purposes."

Now, let us examine the question, and see what is really sacrificed by retaining the copper-cap system. It involves the necessity of carrying two distinct kinds of ammunition, and therefore increases the risk of its getting out of order two-fold; in other words, although a soldier's cartridges may be in a perfect state of preservation, should anything happen to impair his caps—which, by the way, must be carried in a separate pouch—it would at once render the soldier's rifle ineffective. Some of the caps may be dropped in capping or otherwise, and he may have cartridges without the means of firing. Everyone knows that there is oftentimes much annoyance and confusion arising from want of caps in time of action, and that either from carelessness or accident they run short long before cartridges.

Moreover, irrespective of the cap itself, the *Musketry Book of Instruction*, p. 18, assigns no less than seven other causes for the non-ignition and non-explosion of the ordinary charge in use, any one of which may occasion a miss-fire. Unquestionably the present mode of charging is utterly incompatible with the requirements of modern tactics, suggested and necessitated by the introduction of the improved rifle.

The practical result of this old system was well exemplified very recently, at the battle of Oversee in Denmark, on which occasion the Austrian rifles, owing to their having undergone some exposure to the weather, would not go off, and a part of the troops engaged had, in consequence, to charge with their bayonets over a long distance under a heavy fire from the Danes, with severe loss in killed and wounded.

In striking contrast with this state of things is the account given of their needle-gun to one present with the Prussians:—"The more they use it the more pleased they seem to be with it. This very morning I have been speaking about it with the adjutant of a fusilier regiment quartered here. He assures me it proves most solid and serviceable, never gets out of order or misses fire, not even when, as in the early part of the campaign, the men were lying out in the snow, and their arms got wet and covered with rust."

Now, unfortunately, owing to the peculiarity of the Westley Richards' cartridge, and the fact that it requires a very strong flame to penetrate the paper powder-case and the fatty lubricant surrounding it, a special description of percussion cap is necessitated; and hence, for a time at least, we must have to endure the evil of two kinds of percussion caps in the service. But even with this special cap, and under circumstances the most favourable, it is notorious that with the Westley Richards' breech-loading carbine, which has been served out to the cavalry for some time past, miss-fires are of very frequent occurrence, averaging

something like 20 per cent.* From whatever cause this serious result may proceed, the fact remains, and it can on no account be overlooked; but in drawing attention to it, we are anxious to point out that it is in no way attributable to the breech-loading system, as a system, which cannot be made responsible for the defect mentioned. The persistence in the use of the old cap is the cause; and had the authorities ever experienced the horrible revulsion of the feelings produced by a miss-fire in a moment of peril, they would doubtless recognise one of the "first requirements of a military arm" to be, the certainty of its fire on all occasions. Latterly attention has been drawn to the number of accidents, in the shape of flesh wounds in the face and injuries to the eyes, inflicted by splinters thrown off by inferior copper caps; the recurrence of such disagreeable contretemps tend materially to impair the soldier's confidence in his weapon, and the precision of his aim.

Perhaps, however, the most conspicuous objection to the employment of a separate percussion cap, is that it requires six separate actions of the hand to knock off the old cap, take up another, place it on the nipple, and press it properly home. An ungloved hand, in warm weather, can, of course, perform all these motions, with comparative ease and rapidity, on target-practice grounds; but having to do the same thing with a fur-glove, in a Canadian winter, during the excitement of active service, is a very different affair, and would constitute a disadvantage, even in breech-loaders, such as would seriously affect the issue of a battle, so far as that issue depended upon infantry.

At best, therefore, we can only regard this description of breech-loader as a sort of compromise or half-measure. Of course the consideration which really influenced the authorities in retaining the percussion-system, might be the safety of the soldier himself; but surely at the present day, with the Prussian needle-gun, and self-igniting cartridge, as a pattern to improve upon, and with our boasted mechanical skill and knowledge of chemistry, something could be substituted as a mode of ignition for that which is nearly as great an inconvenience and disadvantage as the use of the ramrod itself.

If any difficulty is experienced by the authorities in obtaining such a substitute, let the matter be thrown open to competition, and in this 19th century we feel well assured that entire success will be the result.†

* In justice, however, to Mr. Westley Richards, we should state that these miss-fires occurred with caps supplied by the Government Laboratory, and that with caps prepared especially by Mr. W. Richards, miss-fires were reduced to something like one per cent. Since the above was written, Mr. W. Richards has arranged to do away with all the lubrication on the powder part of his cartridges (which amongst other advantages makes them much cleaner to handle), and the Government are about to issue an improved service cap, which will make more than one description unnecessary.—A. W.

† Since the above was written, a Mr. Burton, from America, has exhibited at the Institution a breech-loading rifle, with metallic cartridges, carrying their own ignition, which appears to meet all the requirements of a breech-loading small arm as here indicated.—A. W.

Experience is said to teach; let it teach us before it is too late. We have seen how a brave people has had to succumb to enemies vastly their superiors, not merely in numbers, but in their armaments. Let us take the lesson to heart. Our army, numerically at least, is vastly inferior to those of the great continental powers; then let us make amends for any deficiency by the perfection and efficiency of our equipment and organisation in its minutest detail: and that which we have been considering is certainly one of the most vital importance to us, since it is equivalent to the question whether we shall triple, at least, our effective strength by the adoption of a good breech-loader.

As the Duke of Wellington often said, "Looking at the amount of mechanical skill in the country, and the numerical weakness of our army, as compared with those of the great Continental powers, British troops ought to be the best armed soldiers in Europe;" but until each soldier carries a well-devised and well-constructed breech-loader, with a rifled barrel, either on the *Lancaster* or the *Whitworth* principle, we must remain under the depressing reflection that our present armament is, in this respect at least, inferior to that of more than one Continental power.

The CHAIRMAN: Our gallant friend, General Boileau, need not to have repudiated any responsibility in respect to that paper. It is a very able one; we shall be very glad to hear any questions from gentlemen present, and I have no doubt the General will be able to answer them. Perhaps the gallant General will favour us with some observations of his own.

General BOILEAU: I should like to say a few words upon the subject of breech-loaders. The writer of this paper spoke of the form suitable for the grooving of breech-loaders as being either the *Lancaster* or the *Whitworth* principle. I think there is a great difference in the principle of those two forms of rifled bore. The *Whitworth* bore, being a polygonal bore, has angles which trench upon the metal of the barrel. I believe in a rifle which he has recently constructed, and which has performed such great feats at Woolwich, the barrel could not be made more than three feet long, to bring it within the limit of weight of 10 lbs., that being considered the maximum that a soldier ought to carry; and it certainly is the maximum. On this ground I think the *Whitworth* principle is not suited for a breech-loader, as an arm of precision especially. The Government at present appear to retain the idea, that for a military arm, the calibre should be comparatively large, and the late Duke of Wellington had the greatest objection to permit the bore of the old *Brown Bess* to be reduced at all; it was reduced, however, from something like 0.750 of an inch to its present calibre, which is 0.577 of an inch. An arm of precision requires that the bullet should have a certain ratio of length to the diameter, now generally assumed to be two and a half to one. In rifles of large calibre, the necessity of increasing the length of the bullet, even where the base cavity is very large, adds greatly to the weight. The bullet which Mr. *Whitworth* used at these wonderful experiments at Woolwich, where the figure of merit of his 0.577 bore rifle surpasses probably that of his small bore, had a weight of 600 grains. I have a rifle made for competition at Wimbledon with a very rapid pitch in the twist, retaining, as I was obliged to do, the Government bore; and I find that by the greatest possible care that can be taken to get a bullet which will give precision at long ranges, it is impossible to do so with the 0.577 bore, and to keep the weight of the bullet under 600 grains. Now, if the soldier has to carry sixty rounds of this or similar ammunition, you add 1 lb. to the weight of the bullets alone which he has to carry, and you add at least 1 lb. to the weight of the rifle. That is you cannot make a rifle with a 0.577 bore to carry a long bullet which shall not weigh 600 grains, and to shoot with precision up to 1,000 yards; and you cannot make a rifle sufficiently strong to resist the increased charge of powder, and the increased twist, under 10 lb. So that, I think, if a new form of

WESTLEY RICHARDS

Fig. 8.

Fig. 9.

Ready to receive charge

Fig. 10.

BREECH LOADING RIFLES

TERRY'S.

Fig. 11.

Fig. 14.

Fig. 12.

Fig. 13.

MONT STORM'S.

Fig. 21.

Fig. 22.

Fig. 23.

GREEN'S.

Fig. 15.

Fig. 16.

Fig. 17.

Fig. 18.

Fig. 20.

Fig. 19.

arm is designed, especially a breech-loader, it will be necessary to reduce the diameter of the bullet to such an amount as will admit of an elongated projectile which shall have the length to the diameter in the ratio of two and a half to one, or thereabouts, and which shall not weigh over 500 to 530 grains. This may be done with a barrel having a bore of half-an-inch. I have several rifles made of this calibre, which I hope to produce at Wimbledon. I find that a bullet with a diameter of $\cdot 483$ inches, weighing 500 grains, gives a length of two and a-half times the diameter, and it secures precision of shooting up to 1,000 yards. A rifle carrying a bullet of that weight and of that diameter, may be made to weigh under 9 lbs. I have one which weighs about an ounce and a half under 9 lbs., and another which weighs rather less than 9½ lbs. By reducing the calibre, you secure lightness, and you secure length, with less weight of bullet; so that a man may carry 60 rounds in his pouch, and yet not be loaded to the same extent that he is now, for the Government bullet weighs 530 grains. Then there is another advantage in keeping to the smaller diameter. We shall not, however, come to such a small diameter as shall prevent the rolling of a comfortable and well-constructed cartridge. Now, the diameter of the small-bore Whitworth rifle is too small for this purpose. You cannot make a cartridge which will be sufficiently stiff to retain its form, and to admit of the bullet being loaded as at present. But with a half-inch rifle you can do so. I have made many cartridges, and have fired them out of my rifles with the same facility as I can with the Government rifles. That enables you to retain length of barrel. I do think there is no alteration in the form of a rifle which is more prejudicial in its usefulness in the hands of an infantry soldier, than taking anything, even half an inch, from length of the barrel. I believe in war we shall still have on occasions to decide the issues of a contest by close-quarter action, that is, with the bayonet; and there is no question that the man who gets the first prod, if it is only half-an-inch, has the advantage. Therefore, if you shorten your barrel by three inches, as in the Whitworth large-bore rifle, you put your soldier in a false position; his bayonet will be of no use against the longer bayonet and longer rifle of foreign nations. I hope to exhibit here a half-inch bore-rifle with a 3 feet 3 inch barrel and with a bayonet 3 inches longer than that now in use, and which shall not weigh more than the present Government rifle. Here are some rifles which I shall be happy to explain.* This is a Westley Richards' (Plate XXXI, Figs. 8, 9, 10); Lieutenant Walker thinks it the best design; I am not of that opinion, I think it has one disadvantage. It has a hinge and the breech-piece is fixed. In a breech-loading rifle, if it can be made for all its movements to be rectilinear, that is in a direction perpendicular to the faces which have to be brought together to close the breech, you are more likely to secure contact than you can by any application of curvilinear movements. A rifle has been invented by a non-professional gentleman, and to my apprehension it is the best that has been brought out. It is the design of Mr. Green (Figs. 15—20): its principal is that which I have always approved, that of rectilinear motion. You pull the breech-piece straight out, and push it straight in. The cartridge is dropped in as in Westley Richards'; the breech-piece is closed, the lever is turned down, and then the plug, by the action of two sloping studs bearing against two surfaces in the piston, pushes the breech-piece tight home, and the gun is fired in the usual way. There is a feature in this breech-loader rifle which I do not think exists in any other, it is, that the breech-piece can be taken off and entirely removed from the rifle. You can pull the breech-piece out and put it into your pocket, and make your rifle a present to your enemy, and it will be of no use to him. I have seen no other rifle which possesses this great advantage; indeed, in this respect it has a superlative advantage over all others: the breech-piece can be inserted, and can be pulled out with equal rapidity. The rifle cannot be fired unless the finger-piece is turned down to its proper place. The reason is this: when the lever is turned down, there is a small hole in the bottom part of the plug which goes over a pin. The pin is worked by the trigger, and fits into the hole of the plug. When the lever is not turned down,

* Terry's breech-loader having been referred to at a previous meeting, it has been thought desirable to insert it, for the sake of comparison, &c., in the plate of breech-loaders referred to in this discussion, it is given in Figs. 11—14.—Ed.

the hole is turned on one side, and the pin which is in connection with the trigger is brought against the solid part of the plug, and the piece will not go off; but as soon as the lever is brought down, the piece goes off. That is Green's breech-loader. I shot with it myself last week at Kilburn; I fired eight rounds from it at 400 yards; and out of eight shots, I made six bulls'-eyes and two centres.

Captain BUNSLER: I believe the idea of the Government, with respect to the metallic ammunition for a breech-loading rifle, is that the copper cases carrying their own fulminate are liable to explode. I have had a breech-loading rifle since 1860; it has been half over the world with me, and I have never found the ammunition explode. I think if the Government were to try it in any way they like, they would find that those cartridges are not more liable to explosions than others.

The CHAIRMAN: I am at a loss to conceive what real objection there can be to breech-loading. It is strange that those who recommended the adoption of breech-loading to cannon almost to the exclusion of every other description of gun, should have hesitated about adopting it to musketry. There are just ten reasons to one in favour of a breech-loading musket over a breech-loading cannon. The breech-loading cannon is only of value on certain occasions, where it is fired on the non-recoil principle. Now, the argument that is adduced, or professedly brought forward, against the breech-loader is, that it will lead to a waste of ammunition. Rightly viewed, I believe it is the very reverse of the fact. It is the nervous excitability increased by the fear that you are not loading fast enough when you are ramming home and putting the cap on, which all people feel when they enter into action for the first time, and the excitement arising from success or partial failure, which in my opinion leads to the useless waste of ammunition. But if a man is sure of his gun, if he is sure of everything concerning it, he can put in his charge just at the right time, and have it ready for action at the very moment he wants it; he will be comparatively calm, and can use his gun to advantage; his mind will not be upset by the excitement of haste and uncertainty. I quite concur with the General's remarks about the Whitworth and Lancaster rifling. I do not see how, with Wesley Richards' form of breech-loader, you are to use it effectually with that description of rifling. With the peculiar motion of turning down that he has, with the polygonal form of rifle in one case, and the oval form in the other, you would not have a perfect junction, and there would be an escape of gas; whereas in the other description, where it goes home, there you might have a perfect fit. I do not see how the two can be combined.

General BOILEAU: There is one point I omitted to explain, which is the peculiarity of this plug of Mr. Green's. The fore-part of the plug is finished by a solid disc. The plug is bored, and there is an axis which fits into it, which is finished also with another solid disc. Intermediate between these two Mr. Green places a wad of mixed gutta-percha and vulcanised india-rubber. He found that the rubber itself was too soft, and the gutta-percha probably too brittle. With a mixture of the two he has succeeded in obtaining just sufficient elasticity and resisting power to secure the desired object. When the cartridge is ignited, the powder acting, of course, in both directions, before it has had time to start the bullet has compressed this disc slightly, has squeezed out, so to speak, a portion of the wad all round it, by rendering it thinner; and by that means has most perfectly and effectively rendered the breech gas-tight. I fired fifty-five rounds with another of Mr. Green's rifles at Kilburn, twenty-five from the muzzle and thirty from the breech, to try whether it would act as well as a muzzle as a breech-loader; and after the fifty-fifth round, when we drew the plug out, the breech chamber was as clean and bright, and as free from the fouling which smoke produces, as if it had never been fired at all. That is an unanswerable proof that the apparatus is perfectly gas-tight. Then, it has another advantage, and that is its perfect applicability to the whole of the Government rifles now in store, the long Enfield, the short Enfield, navy, and carbine. In fact, Mr. Green has fitted his breech-loading apparatus to six different forms of rifles for the Government. They are now under trial at Woolwich. The result with the long Enfield is decidedly good. The only point in which he has not succeeded is the construction of the cartridge. The 0.550 small-bore windage bullet does not suit the breech-loader; it does not suit the Lancaster; but the larger-sized bullet, the 0.570 bullet, answers admirably. With the navy five-grooved rifle I had not that

difficulty with the 0-550 bullet, but still the 0-570 bullet gave much better results. There is another rifle which I may bring to your notice, which is commonly called the Mont Storm rifle (Figs. 21—23). The mechanism of this is exceedingly good, and has its advocates. I do not myself approve of it. I think where you commence your operation by counter-marching, as it were, the breech, where you insert your cartridge foremost, your soldier in the heat of action will be apt to make a mistake. Without reasoning upon the mode in which the bullet should go, I think the first impulse of the soldier is to put in the cartridge, bullet foremost. Without wishing to speak therefore but in praise of the beautiful work and mechanism of this rifle, I think that is a wrong point in its design—that the soldier is to be taught to put the bullet in the wrong way, in order to make it go out the right way. There is another objection to this, as in the case of the Westley Richards' rifle, although there the action of the slide to a certain extent does away with the objection. To bring two bearing surfaces into perfect contact, where they move upon a hinge axis, and where the motion is circular, there must be a wear; and where there is a wear there must be an escape of gas. On that account I think the hinge principle is bad for breech-loaders. Therefore, I prefer the plug principle of Mr. Green, which is simple, cheap, and effective, and which must command attention. I have no doubt that before many months are over we shall see something done. But there is another point connected with breech-loaders which I think is very likely to exercise an important influence, both upon the design and upon the weight of the piece, and that is the introduction of gun-cotton. A portion of the weight of the rifle, as it is now manufactured, has become necessary, from the great recoil which gunpowder produces; here is a necessity, therefore, for making the piece of a certain weight to resist that recoil. But with gun-cotton there is comparatively very little recoil, not a fourth part in some cases of the recoil produced by gunpowder. Therefore, I believe it will be possible to reduce the weight of the piece very considerably without in any way destroying its efficiency, should gun-cotton be introduced as the explosive agent for small arms. General Sabine, with whom I have had a conversation on the subject, is of opinion that breech-loaders will ultimately force their way into notice, and become the weapon of the soldier, as well as the form of artillery; that they are so peculiarly suited to gun-cotton, where there is no smoke and no recoil, that they must command attention, and will ultimately force themselves on the notice of our not very fast, though, I believe, very sure Government.

The CHAIRMAN: You will allow me to record our thanks to the officer who sent us the first paper. Although not so important as the second, it is a very important and interesting paper. The comfort of the soldier is a very important thing, because in the field it is a large element in his efficiency. We also return our thanks to the gentleman who sent the second very interesting and very valuable paper. It is a remarkable paper for a young man to produce. He seems to have a genius for his profession, and to take a practical view of the subject. And it is a practical view that we want, for in the present day transcendentalism has taken the place of practice. And though last, not least, I am sure you will return your thanks to our friend General Boileau for the very luminous instruction and explanation he has given with respect to breech-loaders. I may make a remark with reference to his closing observation as to the curious anomaly it appears to be that gun-cotton has no recoil. I heard an explanation offered for it: it was simply this, that there was no residuum from gun-cotton; while there is about 75 per cent. from gunpowder, which is left as practically as another bullet which is projected backwards; while the lead bullet is projected forwards, this 75 per cent of residuum is projected backwards, and is the cause of that recoil. I give it to you as I got it.

General BOILEAU: I am very much obliged to you for the kind way in which you have received the paper this evening, and for the favourable remarks which you have made upon the efforts that I have made to give it the weight which I think it justly merits.