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The New Military Rifle and its Comparison with other Military Rifles, English and Foreign

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Wednesday, June 16, 1886.

LIEUT.-GENERAL SIR ARCHIBALD ALISON, BART., K.C.B., &c., &c.,
in the Chair.

THE NEW MILITARY RIFLE AND ITS COMPARISON
WITH OTHER MILITARY RIFLES, ENGLISH AND
FOREIGN.

By Colonel H. T. ARDUBHNOT, R.A., Superintendent, Royal Small-
Arms Factory, Enfield.

IN the course of the few remarks I am about to make, I propose very briefly to trace the history of rifles from their first introduction into the Service to the present day, and then to enter somewhat more fully into a description of the new Enfield-Martini rifle (table, p. 914).

The idea of rifling a barrel with the object of giving a bullet a spin or twist is no new one. Rifles were certainly in existence 250 years ago, but the first time we hear of a rifle being used as a service weapon was about the year 1800, or a year or two later, when the old 95th, now the Rifle Brigade, had rifles served out to them. The rifle with which this regiment was armed was called "Baker's Rifle," so called from the name of the inventor. There were two patterns of this arm, one with eleven grooves, and one with seven grooves. The twist of rifling was one turn in 136 in.; its weight was 8 lb. 9 oz., and length, 3 ft. 9½ in., the length of the barrel being 2 ft. 6 in., and bore 0·705. The bullet was spherical; before being rammed down it was wrapped in a grease patch, there being a cavity in the butt for carrying these patches. The object of the patch was partly to lubricate the barrel, and partly to make the bullet fit tight so as to take the rifling. But it was so difficult to force the bullet home when wrapped in its patch, that a mallet was served out with each rifle so as to hammer it down. The rifle was fitted with a sword bayonet.

I cannot trace how long this rifle remained in the Service, but although it was much disliked, owing to its inaccuracy of fire, as well as on account of the extreme difficulty experienced in loading it, no steps appear to have been taken in England towards discovering a more efficient weapon; whereas on the Continent experiments were being carried out continuously. About the year 1836, however, the Brunswick rifle was introduced into the Service.

The weight of this rifle was.....	9 lb. 6½ oz.
Length	3 ft. 10 in.
Weight of barrel	3 lb. 13¾ oz.
Length „ „	2 ft. 6¼ in.
Bore	0·620 in.

Rifling, 2 grooves, 1 turn in 2 ft. 6 in.

This rifle was also fitted with a sword bayonet, weighing 2 lb. 0½ oz.

The peculiarity of this arm was that the bullet, which was spherical, was "belted;" in loading, this belt was placed in the two grooves, this method being adopted to give the bullet a spin. A grease patch was also used with this rifle, which added to the difficulty of loading by making it extremely uncertain whether the belt was properly placed in the grooves or not.

This rifle was the first arm in the English service which had a percussion lock, and it was not until the year 1842 that a percussion musket was generally adopted for the Service.

The Brunswick rifle remained in the Service until 1851, when it was superseded by the Minié, which had some time previously been introduced into the French Army. Up to this time rifles were only issued to rifle regiments, but with the introduction of the Minié rifle it was intended to arm the whole Army with rifles.

The adoption of this rifle was a great step in advance; it was the first time the spherical bullet was discarded, and in its place was adopted one of a cylindro-conoidal form; the bullet had a hollow base, in which was placed an iron cup; on the explosion of the powder this cup forced the bullet into the grooves of the rifling; the grease patch was also discontinued with the adoption of the Minié rifle, lubrication being obtained by greasing the paper in which the bullet was wrapped with a mixture of tallow and beeswax. Some of the regiments in the Crimea were armed with this rifle, but it was cumbersome and heavy, and as early as 1852 experiments were made by order of the Master-General of the Ordnance, Lord Hardinge, with a view of obtaining a better weapon. The result of these experiments led to the introduction of the Enfield rifle, pattern 1853. The chief feature in this rifle was the large reduction made in the diameter of the bore of the barrel, viz., from 0·702 in. to 0·577 in. This reduction of the bore enabled the barrel to be made very considerably lighter without in any way impairing the efficiency of the arm as a shooting weapon; in fact it shot very much better, as the bullet was better proportioned. This was the first arm in which the bayonet was secured to the barrel by a locking ring.

There were two patterns of Enfield rifle, the long rifle for the infantry of the line generally, and the short rifle for rifle regiments and sergeants.

With the introduction of this arm also was the first commencement of manufacturing arms on the interchangeable principle.

The Enfield rifle continued to give perfect satisfaction until the Danish war of 1864 called attention to the very vast superiority of breech-loaders over muzzle-loaders. The Prussian Army had indeed

been armed with a breech-loader, the old needle gun, or "zundnadel-gewehr," for very many years; but it was not till the Danish war that its superiority was manifested. There was immediately an outcry in England for our Army to be armed with breech-loaders, and it was determined, before waiting for an entirely new pattern of arm, to endeavour to convert the large store of existing Enfield rifles into breech-loaders. Experiments were made which shortly led to the introduction of the Snider rifle.

By the adoption of the Snider breech action, the old arms were readily converted, and new arms on this principle were also made in large numbers, so that by the time of the Franco-Prussian war, the whole Army was armed with breech-loaders, and during the winter of 1871-72 the Volunteers and Militia also received these arms. But it was perfectly well understood that the introduction of the Snider was only a makeshift; the Snider was merely intended to fill the gap until a more perfect and more efficient weapon could be devised. Trials on a very extended scale were conducted for some time, and in 1871 the Committee which had been appointed to consider the whole question reported in favour of the Martini-Henry rifle, and the same was finally approved in April of that year. Manufacture commenced shortly afterwards, and the first issue of Martini-Henry rifles to the troops was made in 1874.

This arm was vastly superior to the Enfield or Snider rifles in every respect. The diameter of the bore of the barrel was greatly reduced, viz., from 0.577 in. to 0.45 in., whereas the bullet was maintained at the same weight, and therefore being much smaller in diameter, was of necessity much longer, thus giving it far greater power of overcoming the resistance of the air; the charge of powder was greatly increased, so that the muzzle velocity was much higher. The long rifle was discontinued, and there was but one pattern of arm for all ranks.

There is but little doubt that, at the time of its introduction, the Martini-Henry was the finest military rifle in Europe. I am aware that there is much difference of opinion with regard to the merits of the Martini breech action, but although this action has now been tried in campaigns under every condition of climate and exposure, as an "action" it has never been known to fail. It is true there were many complaints of "jamming" in the Soudan, but this jamming was due more to the cartridge than to the Martini action, and had the same cartridges been used in a rifle with a "bolt" action, the jamming would have been much worse.

Before proceeding further, I should like, with your permission, to draw attention to the successive steps in advance which have been made as each pattern of arm has been introduced since the beginning of the present century. As this paper concerns rifles only, I have said nothing about smooth-bore muskets, but I may remark briefly that from the year 1800 to the year 1812, the infantry of the line, with the exception of the rifle regiments, was armed with the old "Brown Bess" of the Peninsula. It was not till the year 1812 that any alteration was made, but in that year a musket weighing 1 lb. less than the "Brown Bess," and having a percussion instead of a

flint-lock, was introduced. This musket remained the infantry weapon until the Enfield rifle was issued universally to the Army; for although it was intended that the Minié should have been the universal arm, there were never a sufficient number of this pattern of arm made for general issue.

With regard to rifles, the "Baker" rifle was a very primitive weapon, and had but few points of recommendation. The "Brunswick," which superseded it, had a percussion lock, and an endeavour was made to spin the bullet by fitting it into the grooves.

This rifle in its turn gave way to the "Minié," with a reduced bore and an elongated bullet, which was made to take the rifling by being "set up" by means of an iron cup or disc in its base.

The Enfield advanced further in this direction by greatly reducing the bore and still more lengthening the bullet. This was the last muzzle-loader. Then came the era of breech-loaders, the Snider leading the way, to be followed very shortly by the Martini-Henry, in which the principle of increasing the power of the rifle, as well as its accuracy, by diminishing the bore and increasing the length of the bullet in proportion to its diameter, was still further developed.

It was not till about the year 1879 that doubts began to be expressed with regard to the superiority of the Martini-Henry rifle over rifles in use in other countries; it was then found during some experiments which were being conducted by the Siege Operations' Committee at Lydd, that although the Martini-Henry rifle was superior to all other arms at ranges of 500 yards and upwards, it was inferior to them at ranges below 500 yards, so far as regards velocity and flatness of trajectory. The reason of this can be readily understood. In most of the foreign arms there is a greater proportion of powder to bullet than in the Martini-Henry rifle, consequently the muzzle velocity is higher, and the trajectory lower at short ranges. But the foreign bullets being lighter in proportion to their diameter than the English bullet, they have not the same power of overcoming the resistance of the air, and therefore the velocity soon falls off, and at ranges from 500 yards and upwards the Martini-Henry rifle has a higher velocity than the foreign arms. But it was considered desirable that the English Army should be armed with a rifle superior to the foreign rifle in every particular, and at all ranges, and it was for this reason that it was determined to make an endeavour to produce such an arm.

Before describing the new rifle, which is to be called officially the "Enfield-Martini," it will be as well to see in what particulars the foreign rifles were superior to the Martini-Henry, and in what particulars it would be necessary to bring up the Enfield-Martini to a superiority over the foreign arms.

I do not propose to enter into a full description of the principal arms in use in foreign countries, but I have specimens of them here from which it will be seen that the breech actions are all on the "bolt" system, with the exception of the Austrian arm, the "Werndl," which has a revolving block, and the United States arm, the "Springfield," which has a turnover block, and I have prepared

tables (pp. 912, 913), which may be of interest, giving particulars of these arms with regard to their weight, dimensions, velocities, trajectories, &c., in comparison with the Martini-Henry rifle. (Plates XXII, XXIII, XXIV). From this table it will be seen that, with the exception of the Jarmann, none of these arms have so small a bore as the Enfield-Martini rifle; but that they are all smaller than the Martini-Henry, except the Springfield, which has the same bore; they have all a higher muzzle velocity than the Martini-Henry rifle; at 500 yards the velocity of the "Mauser," the "Vetterli," and the "Werndl" is very slightly below that of the Martini-Henry; whereas, that of the "Berdan" and "Gras" is still slightly in excess of it, and the "Jarmann" still considerably in excess. At 1,000 yards the Martini-Henry is superior to the whole, except the Jarmann, which is still slightly in excess of it. At 1,500 yards the Martini-Henry beats even the Jarmann.

The highest point of the trajectory of these arms at the various ranges very nearly follows the velocities, except in the case of the Jarmann, which maintains its superiority to the end.

As regards the weight of the arms with bayonet, it will be seen that the Martini-Henry is lighter than any other arm with which it is compared, and also that, with the exception of the "Springfield," the value of $\frac{D^3}{W}$ is less.

It may be necessary, perhaps, to explain the meaning of the expression $\frac{D^3}{W}$.

This is the mathematical formula used in this country to denote the power of the air to retard bullets in their flight, where D is the diameter of the bullets in inches, and W its weight in pounds; therefore the smaller the value of $\frac{D^3}{W}$, so much less power has the air to retard the bullet; and *vice versa*, the heavier the bullet can be made in proportion to its diameter, the better able will it be to maintain its velocity at long ranges.

From what I have pointed out, it will be seen that in order to ensure the Enfield-Martini being superior *at all ranges* to the foreign arms, it was not only necessary to start with a high muzzle velocity, but to maintain it, by keeping down the value of $\frac{D^3}{W}$ to as low a figure as possible, and this was the problem set me to solve; a further reference to the table will, I think, show that the problem has been solved theoretically, and I trust that the trials now being carried out at various stations will show that it has also been solved practically. And here let me state that I wish to take no credit to myself if the rifle turns out a success; the credit is due to Major McClintock, and to others of the staff at Enfield, who so ably assisted me in working out the details of the arm.

I will now proceed to describe the Enfield-Martini rifle. (Plate XXII.) To begin with the barrel, this being the most important part of the arm.

It is very easy to obtain a high muzzle velocity, all that is necessary is a light bullet in proportion to the powder charge; but when you have to keep up a high remaining velocity the difficulty begins; then a heavy bullet becomes necessary, and with a small bore, a heavy bullet means a long bullet; then the longer the bullet, the quicker must be the twist of rifling, and the quicker the twist, the more liability there is to foul.

Before it was finally determined to recommend a barrel with a calibre of 0.40 in. for submission to the Committee, we tried barrels of various calibres between 0.45 in. and 0.35 in., always fixing the bullet at such a weight as to maintain the value of $\frac{D^2}{W}$ at about the

same figure, viz., 2.9; but I finally settled on the 0.40 in., because I found that with that barrel I got most uniform shooting; with good ammunition it never varied, whereas, when we went below 0.40 in., although we sometimes got magnificent shooting, it was not always so uniform as with the 0.40 in. Another reason for not adopting a very small bore is that a bullet with a very small longitudinal sectional area is more affected by a side wind. The twist of rifling which gave the best results was one turn in 15 in., this is a remarkably quick twist, and for some time we experienced great difficulty in overcoming the fouling; we tried wads of every description, till at length we hit upon the wad which has since been adopted. It is a compound wad $\frac{1}{4}$ in. thick, consisting of $\frac{1}{8}$ in. of hard cardboard next the powder and $\frac{1}{8}$ in. of beeswax next the bullet. On the explosion of the powder taking place, the beeswax is flattened between the cardboard and bullet and then forced into the grooves; and the cardboard being "set up," also takes the rifling and cleans out the fouling. The barrel, therefore, as finally adopted has a bore of 0.40 in. or more, strictly speaking 0.402 in., the rifling has seven grooves with a twist of one turn in 15 in.

I come now to the sighting. As the rifle has a very flat trajectory at ranges up to 400 yards, as you will see by the diagram, it was considered desirable to have two fixed sights which should cover the whole ground up to 400 yards, so that at what may be called the fighting range the soldier will not have to fumble at his backsight. The point blank of the rifle has been fixed at 100 yards, and the small sight at the breech end of the barrel is true for that range, but firing with that sight and aiming at a spot about 5 ft. from the ground the bullet will travel 350 yards before striking the ground. As, however, for the last 50 yards of its flight it would be so near the ground as not to stop a man, it was determined to fit a leaf sight also at the breech end of the barrel, which when put up should be true for 300 yards; firing with this sight up, the bullet would travel 450 yards before striking the ground, so that by using one of these two fixed sights the whole ground is covered up to 450 yards. I may state in passing that the form of the V's and the form of the front sight was determined by the Committee; it is one of the points on which Commanding Officers are requested to report, and there will be no difficulty

whatever in altering them should the form as sent out on the trial rifles not be liked.

The elevating backsight is graduated for ranges from 400 to 2,000 yards. There is a wind-gauge attached to the slide. I am aware that some gentlemen would prefer to see a sight somewhat similar to that on a Springfield rifle lately obtained by this Institution. With regard to the V's, as I said, any form can be adopted, but with regard to the wind-gauge worked by a very small screw, the mechanism is too delicate to withstand the rough usage which a Service rifle must at times be subject to. And I wish it to be distinctly understood that this rifle is not meant as a Wimbledon match rifle, but as a strong, serviceable soldiers' weapon, and, at the same time, one which shoots with perfect accuracy.

I come next to the action. The action remains on the Martini principle by the express orders of the Secretary of State. It is not therefore for me to discuss whether a better action or not could have been devised, but in view of the possibility of the introduction of a magazine rifle, which would necessitate an entirely new action, I certainly think it is better to adhere to an action which is known to be serviceable rather than to embark on endless experiments which would all be thrown away if it were eventually decided to adopt a magazine arm. The only alterations made in the breech action of this rifle are the addition of a safety bolt which acts in the form of a screw and lever, lifting the nose of the tumbler clear of the trigger; and the adoption of a round tumbler axis instead of a square one. This is done because it is found that the square tumbler axis and hole are apt to wear, when the rifle becomes dangerous, whereas with the round axis there can be no wear; but with the round axis it is impossible to have an indicator as in the Martini-Henry arm, but the Committee did not consider this of vital importance. Some alterations have been made in the stocking of the rifle, which are thought to be improvements. The butt is made narrower so as to rest better in the shoulder, and with the view of meeting an objection so often raised, "that the stock of the Martini-Henry rifle is too straight," the angle of inclination of the butt plate to the line of sight has been made more acute, so that when the rifle is brought up to the shoulder the tendency is to keep the muzzle down.

I may remark here that it is a well-established fact that English guns of all descriptions are, and always have been, straighter in the stock than any foreign guns, and I presume the straight stock of the military firearm was adopted from the pattern in general use with fowling pieces—the bend of the stock has never been altered. In all changes of pattern, from the early days of "Brown Bess" up to the present time, the bend of the stock has remained unchanged, and it is only in quite recent years that an idea has sprung up that it is too straight. Without altering the bend we have endeavoured to arrive at the same result as would be obtained by a less straight stock, by setting on the butt plate at a more acute angle. A change also has been made in the form of the fore-end. In all military firearms up to the present time, the fore-end has been grooved out so that the barrel

should lie in it; the thin shell of wood which came up on either side of the barrel gave no additional support to it, and that form of fore-end had the disadvantage of holding water, so that the barrel was constantly being rusted on its underneath side. In the new rifle the groove in which the barrel rested has been cut away, and the barrel now lies on the fore-end, so that it can easily be kept free from rust. A wooden hand-guard has been added to the rifle, so that after rapid firing the soldier will still be able to grasp his rifle without burning his hand. We do not lay claim at Enfield for any originality in the idea of a wooden hand-guard, as several patterns have been brought forward from time to time. Mr. Westley Richards patented a wooden hand-guard as long ago as the year 1870. Colonel Morley, now commanding the 63rd Regimental District, brought the matter forward some years ago, and although he was not successful in getting it introduced into the Service at that time, nevertheless to him is due the credit of first bringing the idea prominently to the front.

I will now say a few words with respect to the quick-loader (Plate XXII), which it is proposed to serve out with each rifle.

This, as its name denotes, is simply a contrivance designed with the object of assisting the soldier to load quickly, especially in the dark, or in wet or cold weather. It is not intended to take the place of a magazine, but is so contrived as to present a cartridge in the readiest position for a man to load. It hangs on the side of the body of the action, and holds six cartridges. The cartridges are acted upon by a zig-zag spring, which forces each one in succession up an inclined plane, the head of the cartridge being forced through an aperture in the lid ready for the soldier to take hold of when he wants to load. When these quick-loaders were issued for trial it was found that in loading from the quicker-loader six rounds could be fired in about twenty-five seconds, whereas in loading from the pouch it took over forty seconds to fire the same number of rounds.

Having described the principal parts of the rifle somewhat in detail, I will now turn to the ammunition. The cartridge case is solid-drawn, and contains 85 grains of powder; the wad, as I have already mentioned, is a compound wad of cardboard and beeswax, the bullet weighs 384 grains.

With this cartridge the arm has a muzzle velocity of 1,570 ft. per second, which is higher than that of any other military rifle, and the remaining velocities at all ranges are higher also than those of any other arm. The penetrative power of the arm is sufficient to take the bullet through a quarter-inch iron plate at 200 yards; the arm shoots with great accuracy as the diagram will show.

By the adoption of this arm and ammunition a very great simplification will be effected, because instead of having four different patterns of cartridges as at present, viz., the solid-drawn Martini-Henry cartridge for rifles, the coiled case for rifles, the carbine cartridge, and the machine-gun cartridge, there will in future be but one cartridge for rifle, carbine, or rifle-calibre machine-guns.

I now come to the last part of my subject, viz., the bayonet. (Plate

XXIII.) There has been a good deal of discussion lately on the subject of bayonets, as you are no doubt aware, and therefore more than usual interest is attached to this subject at the present time. If we again go back to the beginning of the century, you will observe that there were then two kinds of bayonets, viz., a triangular bayonet for the muskets, and a sword bayonet for the rifles. There was very little alteration in the pattern of the triangular bayonet between the years 1800 and 1853; it had a short blade, and a heavy one in proportion to its length. But when the Enfield rifle was introduced, an effort was made to reduce the weight carried by the soldier; the rifle was considerably lighter than the old smooth-bore musket, and the bayonet introduced at that time was also lighter than that in use previously. The Enfield rifle bayonet had a blade 18 in. long, and it weighed 14 oz. On the introduction of the Martini-Henry rifle it was "bushed" to fit the reduced size of the barrel, and thus continued in the Service till the introduction of the bayonet of the present pattern; indeed, it may be said to be still in the Service, for there are even now some regiments in India which have still got this bayonet. It was always supposed that it was a good weapon, but although it may have been used on a few isolated occasions, it was never put to a very severe test until the campaign in the Soudan in 1884. Two regiments, the 1st Battalion York and Lancaster Regiment and the 2nd Battalion Royal Irish Fusiliers, in that campaign had come from India and brought with them the old Snider bayonets with which they were still armed. At the battle of El Teb the York and Lancaster Regiment used their bayonets freely, and they were then found to be miserably soft, and this led to the outcry against the whole of the bayonets. But although the Snider bayonet was still in partial use, it had been superseded in 1876 by the Martini-Henry long triangular bayonet. As at the time of its introduction lightness was still considered of paramount importance, the new bayonet only weighed half an ounce heavier than the old one, viz., $14\frac{1}{2}$ oz., but was $4\frac{1}{2}$ in. longer. There can be no doubt that it was too light in proportion to its length, but nevertheless it was a good weapon, and far superior both as to quality of metal as well as in manufacture to the old bayonet which it superseded. But in consequence of the experience gained in the Soudan, it was considered desirable to strengthen the bayonet if possible. More care was paid to the manufacture, a little more metal was put into the blades, and a more severe test was instituted. I have brought these tests here to-day that you may see the difference between the old and the new test, and that you may judge for yourselves as to the quality of the bayonets now in the hands of the troops. But on the introduction of the Enfield-Martini rifle, the question of the pattern of bayonet to be issued with it had to be considered, and it was decided to discontinue the use of the triangular bayonet which was of use for thrusting purposes only, and to issue in its place a short sword-bayonet, which could be used not only for thrusting, but which, when separate from the rifle, should be a useful and serviceable weapon. This sword-bayonet is a decided improvement on all sword-bayonets which have previously been in use; it has a very sharp

Military Rifles, description of arm.										Ammunition.		
Country.	System.	Weight of arm.		Length of arm.		Barrel.		Charge.		Value of 1000 W.		
		Without	With	Without	With	Calibre.	Length.	Powder.	Bullet.			
lb. oz.	lb. oz.	ft. in.	ft. in.	in.	in.	grs.	grs.					
Austria.....	Wernld.....	9 13½	11 8½	4 2	6 0½	0·433	33	77	370	3·547		
England.....	Martini-Henry.....	9 0	10 0	4 1½	5 11½	0·45	33½	85	480	2·953		
France.....	Gms.....	9 4	10 7½	4 3½	6 0½	0·433	32½	80	386	3·416		
Germany.....	Mausser.....	10 4	11 12	4 4½	6 0½	0·433	33½	75	390	3·453		
Italy.....	Vetterli.....	9 9	10 14½	4 5½	6 2	0·408	33½	62	310	3·759		
Norway and Sweden....	Jarmann.....	10 1½	..	4 4½	..	0·397	32	77	337	3·222		
Russia.....	Berdan.....	9 12½	10 12½	4 5½	6 1½	0·42	32½	77	370	3·336		
United States.....	Springfield.....	9 5½	10 1	4 3½	5 9½	0·45	32½	70	500	2·834		
England.....	Enfield-Martini.....	9 5	10 13	4 1½	5 11½	0·40	33½	85	384	2·917		

Military Rifles—Velocities and Greatest Height of Trajectories.

Country.	System.	Velocities.						Heights of trajectories.			
		Muzzle.	500 yds.	1000 yds.	1500 yds.	2000 yds.		500 yds.	1000 yds.	1500 yds.	2000 yds.
		f.s.	f.s.	f.s.	f.s.	f.s.		feet.	feet.	feet.	feet.
Austria	Wernli	1439	854	629	449	329		8·252	49·41	162·6	426·0
England	Martini-Henry	1315	869	664	508	389		8·594	47·90	147·1	357·85
France	Gra8	1489	878	649	471	348		7·769	46·6	151·8	389·9
Germany	Mausen	1430	859	629	459	338		8·249	48·68	159·2	411·1
Italy	Vetorli	1430	835	605	422	304		8·527	52·17	176·3	469·9
Norway and Sweden	Jarmann	1536	908	675	504	377		7·235	42·97	137·6	348·5
Russia	Berdan	1444	873	645	476	353		7·995	47·01	151·7	388·7
United States	Springfield	1301	875	676	523	404		8·574	46·88	142·3	343·0
England	Enfield-Martini	1570	947	719	553	424		6·704	39·00	122·0	299·47

List of Rifles in the Service from 1800 to present date.

Description of arm.	Without bayonet.		Barrel.						Bayonet.		Ammunition.			Value of W.
	Weight.	Length.	Weight.	Length.	Diameter of bore.	Number of grooves.	Twist of rifling.	Sighted up to yards.	Weight.	Length beyond muzzle.	Charge of powder.	Weight of bullet.	Lubricator.	
	lb. oz.	ft. in.	lb. oz.	ft. in.	in.				lb. oz.	ft. in.	drs.	grs.		
Baker	8 9	3 9½	3 14½	2 6	.705	7	1 in 136"	..	0 15	1 6½	..	..	Grease patch. Do.	
Brunswick..... Patt. 1836	9 6½	3 10	3 13½	2 6½	.620	2	1 „ 28	..	2 0½	1 9½	2½	557		
Minié..... „ 1851	9 13	4 7	4 13½	3 3	.703	3	1 „ 64	1000	1 0½	1 5½	2½	690	Tallow and beeswax on paper.	5.886
Enfield, long ... „ 1853	8 14½	4 6½	4 4½	3 3	.577	3	1 „ 78	900	0 13½	1 5½	2½	535		4.356
„ short ... „ 1860	8 11½	4 0½	4 1½	2 9	.577	5	1 „ 49	1200	1 11¼	1 10½	2½	535	Do.	4.356
Snider	9 5	4 7½	4 12½	3 3	.577	3	1 „ 78	950	0 13½	1 5½	70	490	3 canno-lures with wax.	4.855
Martini-Henry, Mark III, Pattern 1871.	9 0	4 1½	3 5½	2 9½	.450	7	1 „ 22	1300	1 1	1 10½	85	490	Wax paper round bullet and beeswax wad.	2.953
Enfield-Martini. „ 1886	9 5	4 1½	3 13	2 9½	.402	7	1 „ 15	2000	1 8	1 6½	85	384	Cardboard beeswax wad.	2.917

point, it has a keen cutting edge, and is strong and handy and will stand a severe test.

There is one point in connection with the rifle and bayonet together to which I wish to call your attention; the bayonet is fixed to the underneath side of the rifle, instead of being on one side, as previously. When firing with fixed bayonets, the bayonet on the side has a tendency to twist the rifle to that side, which makes the shooting bad; but when it is underneath, it has a tendency to depress the muzzle, which is an advantage, and when in that position it cannot be seen by the eye when taking aim, which is a further advantage, as there is nothing to make the aim unsteady.

I have now dealt with all the principal features of the new rifle, and have shown in what way it differs from the Martini-Henry. There are other minor points of difference which I have not mentioned, as they are not of so much importance.

I know that I have dealt very imperfectly with the subject I have brought before you, but I trust that the discussion which will follow will tend to bring out any points which I may have omitted.

Colonel Sir HENRY HALFORD, Bart. : There are one or two points in the able lecture to which we have just listened upon which I should wish for a little more information. I will not enter upon the previous history of the rifle up to the time of the Martini-Henry. The first point to which I should wish to draw attention is that relating to the action of the Martini-Henry, which the lecturer describes as "the finest military rifle in Europe." If that refers simply to the rifles in use in foreign Services I am quite willing to agree to it, but to say that it was the finest military rifle known in England at the time is to my idea not quite the case; because at that time there were military rifles in use at Wimbledon, perfectly good military rifles in every respect, in outside form and strength, equal to any military rifles in the world, and yet as accurate as the best match rifles are at the present time. Again, Colonel Arbuthnot says that the Martini breech-action was thoroughly satisfactory. I am afraid that that can hardly have been the case, considering that there have been so many reports from that time to the present as to its failure in action by jamming, especially when any sand got into the cartridges. Reports have been made from time to time from India and from the Soudan, according to which the rifles failed very completely. They have been much altered since, and I quite agree with what Colonel Arbuthnot says, that it would be unwise for this country to take a different action at the present time in view of a magazine-gun being probably supplied to the Army within a period not very long distant. The next point I wish to speak upon is that of the trajectory. I have taken some pains in getting out the trajectory, and I believe Colonel Arbuthnot agrees with me that the formula as used in getting out these trajectories is one not applicable to small arms. Colonel Arbuthnot and I have argued this matter out very fully, and I understood him to agree with me that the way in which I arrived at my conclusions was practically a correct one. No doubt he will say it is a comparative matter, and that in comparing the new Enfield-Martini with foreign arms you get at a certain comparative result. That is not altogether correct, because trajectory depends not only on the initial velocity and

the value of $\frac{D^2}{W}$ irrespective of shape, but very materially on the shape of the bullet, and at 2,000 yards even to the amount of something like 8 or 10 feet. I should not have mentioned this subject had not the difference between us been so enormously great as it is. Calculating the trajectory by using the sight as a theodolite, I find a difference of 60 feet between the trajectory laid down by Colonel Arbuthnot and that which I believe to be the accurate or closely accurate trajectory. Whatever the errors are, and there are slight errors in the way in which I worked it out, those errors are all in the same direction—that is, magnifying the trajectory—as

those of Colonel Arbuthnot. Therefore I am overstating it when I say it is 229 feet for 2,000 yards, whereas Colonel Arbuthnot put it at 293, a difference of close upon 60 feet. At 500 yards the difference between us is about 6 inches, and at 1,000 yards about 4 feet. I have consulted with Mr. Bashforth, who got out the tables used by Colonel Arbuthnot, personally upon the subject, and there is no doubt the differences are due to lead being used in small arms, and to iron and steel having been the substances with which his experiments were made, and most careful experiments they were, some years ago. I have worked out the trajectory for the 10-inch gun on the same principle as these I give for small arms, and I perfectly agree in the trajectory that Mr. Bashforth's formula gives, and this proves my case, and I think I am justified in saying that where different metals are used different coefficients of resistance are required to work out the trajectories. No doubt the principles adopted are perfectly valid for use with a proper coefficient for a lead bullet of a certain shape. However, this matter does not affect the rifle, but only our knowledge of what it can do. There is a very much more important point, upon which I observe Colonel Arbuthnot does not touch, and that is the shape of the grooves. He does not tell us what shape he intends to adopt as the final pattern of groove in the rifle. The last patterns which I saw were the ratchet, but the pattern that I have been advocating all through is the segmental form, a form well known to riflemen at Wimbledon, easy to make and easy to repair, and distinctly, in dry weather, more accurate than any other form of rifling. Colonel Arbuthnot has pointed out two diagrams: the 500-yard diagram is a fairly good one, but the 1,000-yard diagram I do not call a good one, it is too much up and down. It was evidently fired on an exceedingly good day, because the lateral deviation is very small, but the up and down deviation is too great for a rifle at 1,000 yards. The difference of accuracy between the two patterns of grooving does not amount to very much in this damp climate. Last summer it came to something, but in India it comes to a very great deal. It is no use making experiments in this matter except in certain weather, that is to say, in very dry weather. The point is this, the ratchet has one deep side and rather a sharp edge; how much that edge has been taken off I do not know, but still the principle is to have a distinct edge of rifling on one side. The segmental rifling is an easy and even curve, and is sufficiently shallow to give the least possible hold to fouling, while deep enough to hold and spin the bullet. I am very anxious upon this point, as a great blunder will be made if the ratchet is adopted. I believe that a certain number of segmental rifles have been made. Practical shots of the present day will always pick a rifle with segmental rifling in preference to any other, because they know they can do better work with it in all weathers. I know that a letter was written to a leading rifle-maker in Ireland, asking his opinion as to the ratchet, and his answer was a very amusing one. He said the ratchet was his first love, but that he had soon seen reason to give that up; he then tried nearly every form of rifling known, and he had come to the solemn conclusion that the only form worth making was the segmental. That is a very strong opinion from a very practical man, and I mention it because, as he has been an opponent of my friend Mr. Metford, it is a thoroughly unbiassed opinion, and if he could have said anything honestly that would have gone the other way I think he might have done so. There is no doubt it is an entirely outside opinion free from bias by me. As for these segmental grooves, they certainly are the easiest form to cut. I have inquired of every gun-maker that I know who has been in the habit of cutting them and also of cutting other grooves, and they all with one accord tell me that they prefer the segmental to any other form of groove. In the matter of the experiments which Colonel Arbuthnot has told us he has carried out, I must confess I think the experiments which have been made by hundreds of men shooting for their own honour and profit during the last fourteen years with the military breech-loader are very much more to be depended upon than a series of experiments from machine rests carried out by foremen at any establishment, however well conducted. I am not in the least throwing any slur upon the Enfield Factory or upon the way in which it is conducted, but the experiments of the shooting men, carried out by firing in all weathers from the shoulder, are to my mind far more exhaustive than any experiments that can be conducted by one or two individuals from machine rests at one establishment.

These experiments by practical riflemen have been conducted at no cost to the Government, and have certainly produced the finest rifles in the world. Witness, for instance, the matches that we have had against the Americans with them, and the work constantly being done in this country with them. Colonel Arbuthnot shows us a cartridge which I have not seen before. Unfortunately, I have not seen any of the cartridges made lately, and I do not know what cartridge is being used now; he informs us that the bullet is put in by pressure.¹ I must say it would have been courteous on his part to acknowledge where he got that plan of putting in the bullet by pressure. That was Mr. Metford's plan, and it was with some difficulty that the authorities were ultimately persuaded of its advantage. It is Mr. Metford's invention, and it has been carried out for the last fourteen or fifteen years for all his cartridges. I am only glad to find that it has been adopted, and I think nearly as great honour is due to those who will adopt the best work as it is to those who invent it. I hope it will be understood that I have no wish to say anything in the least finding fault with the work done at the Enfield Factory; I am only desirous that everything should be done for the good of the Service and for the good of the country. If it had not been for that, I should have saved myself a great deal of annoyance and trouble, but let that pass. All I hope is that the best rifle will be adopted, and by the best I mean with segmental rifling; that the best ammunition will be adopted, and then I have no doubt that this country will have an arm, not only equal, but far superior to that of any other country in the world.

Lieutenant-Colonel HOPE, U.C.: I will begin, Sir, by saying that I am quite sure no apology is needed from Colonel Arbuthnot, for I never heard a better lecture on any subject as an explanatory statement of what the lecturer desired to explain. I say that, because I am afraid I disagree with Colonel Arbuthnot on some points, and therefore I desire further to say that this is the first time in my life that I have had the pleasure of seeing him, that I have never had anything whatever to do with him either officially or privately, and that I have no sort of bias in the matter. I will begin by making one very slight historical correction with reference to the old Minié rifle. I have no recollection of seeing any smooth-bore muskets in the Crimea. My impression is very distinct that *all* the regiments in the Crimea were, in the first instance, armed with the Minié rifle. As regards the iron cups being driven through the bullets occasionally, I can give him a very curious corroboration of that statement. On the 7th of June, in the Crimea, I found a wild Irishman hammering with a great stone on the top of his ramrod, which was sticking out more than a foot. I knew what was the matter, so I took the rifle away from him and hid it, and told him to take a dead man's rifle. In the morning I recovered the rifle, brought it into camp, and made the armourer-sergeant take out the breech, and found that there were no less than eight of these lead cylinders sticking in the barrel, and that this man was hammering down a ninth bullet. Now, Sir, I read with very great pleasure the admission that Colonel Arbuthnot makes as regards the Martini breech action, and I will just read his words. He says, "I am aware that there is much difference of opinion with regard to the merits of the Martini breech action." I consider the Martini breech action to be the worst that was ever invented. I have not invented any small arm myself, therefore I am not speaking for my own arm, but, so far as I know, the Martini is the only breech action which necessitates a straight cartridge describing a curve in entering or being withdrawn from the barrel, and I think there can be no doubt that quite as much of the jamming that we have heard of in the Soudan and elsewhere has been due to that absurd action as to the very bad Boxer cartridges. No other European country has adopted the Martini block, and therefore presumably its inventor was unable to convince any other country that it was a good one, just as no other country has adopted the absurd Boxer cartridge, unquestionably the worst cartridge ever made, and I humbly submit that this is also the worst breech action. And here I will tell you a little anecdote both about breech actions and about cartridges. Just 29 years ago I was appointed Attaché to H.M. Legation at Washington, and on the 19th December, 1857, I sent home a report on the new breech-loading Morso rifle. I

¹ Explained *vide* voce.—Ed.

sent home also lettered diagrams as carefully drawn as I was able to draw them, and a strong report in its favour. So strong and so startling was the statement that I was able to send home, that I was immediately ordered to buy one of these rifles, contrary to the ordinary usages of the War Office, and also a thousand rounds of ammunition, and to send them home. When I had done that, my part of the work was over, but a couple of years later, being in London, I asked what had become of this rifle, and I was told it had been submitted to the usual Committee, which had sat upon it the usual number of months, and had made the usual report. I asked if I might see the report, and the answer was "Certainly." It was as follows:—That it was a very ingenious invention, and it really would do what I said it would do, but it was not adapted for the British Service (it might do well enough for Yankees, French, or Russians), for the three following reasons:—(1.) It fired too quickly—12 rounds a minute; (2.) the cartridges were metallic; (3.) they contained the principle of their own ignition." That was the first metallic cartridge, I believe, ever seen in this country, and I believe the inventor, a certain Mr. Morse, is the true inventor of the metallic cartridge. When the celebrated War Office advertisement came out after the battle of Sadowa, inviting competition for the British breech-loading small arm of the future, that advertisement left everything pretty well open to the inventors, such as length, weight of barrel, calibre, breech action, and so forth, but it went on to say that "all competing rifles must fulfil the three following *sine quid non* conditions:—(1.) They must fire not less than 12 rounds a minute; (2.) the cartridges must be metallic; (3.) they must contain the principle of their own ignition." Ever since the appearance of that advertisement I am bound to say I have lost all respect for constituted authority. Now with regard to the calibre of the proposed new arm. Certainly 0·46 is an improvement upon 0·45, but I think (if Colonel Arbuthnot will allow me to say so) that my respect for constituted authority is not quite sufficient to enable me to come to the conclusion that 0·40 is the best possible form. That is another question, and I think, if we are to go to the expense in this country of a new rifle, we ought not merely to have the best rifle that Enfield can turn out, but the best rifle that the world can turn out. I think it ought to be thrown open to public competition. Let the best man win, and let us have something approaching finality—the best small arm that the science of the present day, and the workmanship of the present day, can possibly produce. As regards the breech action, I cannot quite assent to the proposition that we must preserve the Martini block because we may have a magazine rifle at a short date from now. If so, let us have it at once. It seems rather a waste of money to introduce an intermediate rifle between the Martini-Henry and this imaginary magazine arm of the future. Let us make one bite of the cherry; it is not a very big cherry. There are plenty of magazine rifles in existence which could be adapted to well-known existing movements, and I do not think that anything in the nature of an experimental breech would be required. I say this with the more confidence because Colonel Arbuthnot says that the action remains on the Martini principle by "the express orders of the Secretary of State." I have now come to understand that the phrase "Secretary of State" is really nothing but a bugbear. Of course, by the Secretary of State, Colonel Arbuthnot does not mean Mr. Campbell-Bannerman; I presume he does not even mean Mr. W. H. Smith, at all events—

Colonel ARBUTHNOT: I referred to Mr. Childers.

Colonel MORRIS: I am very glad to hear it. I do not know that Mr. Childers' successes in the Navy and in the Army have been so great as to prove his opinion absolutely infallible; at all events, I think the opinion of a Board of Infantry Officers who have got to use the rifles would be superior even to that of Mr. Childers. That perhaps brings me to the organization of the Ordnance Department. Colonel Arbuthnot is probably as good a man as possibly could be obtained for superintending the factory at Enfield, but I do not know why it should always be an Artillery Officer who settles the form of infantry rifles and cavalry swords, infantry bayonets, cavalry lances, revolvers, and all that kind of thing. I think the artillery have not had such a brilliant success with their own big guns as to justify them in settling the arms of other branches of the Service. I desire, Sir, in conclusion, to enter a very strong protest against that Martini block. I believe it really is, as I have said, the

worst that ever was invented, and for this reason that it forces the straight cartridge to describe a curve in entering and quitting the barrel.

Captain H. JAMES : When I came down here this afternoon it was chiefly with regard to the question of the breech action of the new rifle. Colonel Arbutnot, however, has said it is retained by express orders of the Secretary of State, and there is, therefore, nothing more to be said on the subject. The Secretary of State is, I am aware, an impersonal entity, and is a difficult person to get at ; but in this case the veil has been torn asunder and we are told the gentleman to whom we owe this continuance of the Martini breech in the Service is Mr. Childers. I am perfectly well aware that the Martini breech action is an action that has gone through several campaigns with complete success so far as the action is concerned, but I cannot also be oblivious to the fact that the same may be said with reference to the bolt action—the universal action of every other nation on the face of the globe. Therefore it seems to me, if the argument of the success of a campaign is true of the Martini-Henry, equally is it true of the bolt action. But there are two other reasons why the bolt action should be adopted in any future years rather than the Martini. In the first place the Martini action, by the method of its construction, can never have so efficient an extractor (I venture to differ from Colonel Arbutnot in his dictum on this point) as can the bolt action. In the bolt action the bolt acts directly on the cartridge, whereas in the Martini you are using the short end of a lever to move the long end to eject the cartridge, and that was one great cause of its failure in the Soudan. If you open the Martini-Henry gun with a jerk your cartridge comes out, but if in the heat of an action you do not open it with a jerk, as may happen if you are not quite as cool as you might be when practising at home—if under those circumstances you do not open it with a jerk, the cartridge does not come out, and then you have very often to go through a long process before it is extracted. I am perfectly aware that one great reason why the cartridges did not come out in the Soudan was owing to their faulty construction, but so long as you have the Martini block in the Service so long will you have jams due to the particular action of the block itself, and therefore the block breech-loader can never be so effective with respect to the cartridge as the bolt. With the millions of fire-arms existing at the present moment in every nation of Europe it is quite out of the question to expect anybody to believe that you cannot extract the cartridge with the bolt action as well as you can with the block action. The second reason why the bolt action is the action of the future is that almost every form of repeater which can be possibly introduced into the Service will have the bolt breech action. The repeating rifle is a question, not of the future, but of the present, for it is almost certain that Austria will at once adopt a repeating rifle which has been experimented on in that country. The same is the case with the German Army. We know a story was told some little time ago in the papers about a Frenchman having stolen a new repeater from the guard-house in Berlin. We know also that for some years the French Government have been making experiments with different forms of repeating rifles because the Kropatschek action used in their Navy has not been thought to fulfil the necessary conditions. The little State of Switzerland, a State which in this particular characteristic has always been the foremost in Europe, has for many years had a repeating rifle. They are now experimenting with another rifle, one which has a very much smaller bore, which carries a lighter bullet, and has a still more flat trajectory than even our proposed new rifle. It seems to me, therefore, considering the fact that there is a repeating rifle in the immediate future,—with the highest respect for Mr. Childers as an authority upon rifles, for I had not hitherto known that that was amongst the many things with respect to which he claims authority,—with the highest respect to him, I venture to think that in any future rifle adopted in the British Service the bolt and not the Martini block should be used. I have one more reason. Anybody who has fired the Martini-Henry lying down knows that it is an awkward weapon to work. The lever being underneath the barrel, you have to turn the rifle round, and it is difficult to extract the cartridge. On the other hand, the bolt action, such as the Mauser or the Gras, or any of the Continental weapons, can be loaded perfectly easily whilst lying down, and the bolt action is infinitely better adapted to cramped positions than any form like the Martini-Henry, where the lever to move the block is underneath. I

venture to differ from Sir Henry Hallford on one point on which he differed from Colonel Arbuthnot. I have no hesitation in saying that for a military weapon the Martini-Henry rifle was, except at very short ranges, a far superior weapon to any other weapon which has been used in any Continental army. And that I think is shown by the Russo-Turkish campaign, in which the Turks had practically our own rifle.

Sir HENRY HALFORD: I never said it was not; I said, if it was compared with the rifles in use in foreign armies, it undoubtedly was the best, but if it was compared with other rifles known in this country it was not the best.

Captain JAMES: Then I withdraw my observation. May I say one word in regard to the quick-loader, which very much resembles the Krnka, tried first of all in Russia? It seems to me that anything put on the side of the rifle is bad. For the same reason that the bayonet has been justly turned round, it seems to me to be a bad arrangement to put the quick-loader at the side. The quick-loader is a clumsy substitute for the proper repeating rifle.¹

Lieutenant-Colonel W. C. MACKINNON: I have not had much time to give to the examination of this rifle, but there are many details in it to which I take exception, and these will doubtless be worked out during the practical tests which it has to undergo. There is one point in particular in the lecture with which I cannot agree, it refers to the "jamming" that we have heard so much about, and which the lecturer says is due more to the cartridge than to the action; my experience is the reverse; I have had many opportunities of visiting regiments where jamming has been complained of, and in all such cases, without exception, I found that the actions were out of order, that when pressure had been brought to bear on the armours, and the actions properly adjusted, jamming practically ceased. Jamming is not, in my opinion, so much the fault of the cartridge as of the action; and I may claim some indulgence in speaking of this matter, because I was a sharer in the responsibility of the introduction of the Martini action: when recommended, it stood the tests better than any other action in the competition; the Boxer cartridge was also the best, there was no other cartridge at that time to touch it. With reference to the action of the extractor; instead of the hand working directly on it, the power is conveyed through a series of levers; the cartridge is expanded with immense force, and is consequently tightly held by any dirt or corrosion in the chamber, and the great power necessary to ensure extraction cannot be exerted and properly applied through this series of levers; minor alterations, such as strengthening the extractor arm, may be made, but with the faulty principle the liability to jam will remain. I know it is said that this action is simply a stop-gap, but there is the fear that, once reintroduced, it will be kept on for a long time; there may occur difficulties in altering it, financial, for example; and I consider that its maintenance in the Service until a magazine arm shall be devised, manufactured, and issued would be as great a misfortune as to reproduce ships of the "Warrior" type. With regard to the barrel; the conditions of low trajectory at all ranges, high muzzle velocity and favourable retardation, have been so cleverly combined that, providing it will not foul in excessively hot dry climates, and that its accuracy will be represented by the small diagram shown to us, I think we may be satisfied.

Admiral SELWYN: I should not have risen on this occasion at all but that it seems to me that we are forgetting that most important contribution to the whole subject that was made by Colonel Brackenbury; he called it the "Spirit of Artillery," and I say without fear that to those who will study the question in the spirit in which he attacked it the question of trajectory is one that can be met entirely by the regulation of the powder charge and the bullet, not by any change in the arm;

¹ I said nothing about the cartridge of the new rifle, but I am given to understand that the reason why the bottle-shape was retained is that the Royal Laboratory refused to manufacture the more modern truncated cone form. One of the difficulties that Enfield authorities appear to suffer from is that they are the designers of the rifle only. Waltham decides the powder, Woolwich the cartridge. A private inventor would get exactly what is wanted under the last two heads, and would not be subjected to such interference in his design.

so that I am not afraid to say that I would take the oldest form of breech-loading rifle known, and with a good cartridge, properly filled with powder, I will beat the very last introduction with the lowest trajectory, and that without increasing the weight of the bullet, and while decreasing the weight of the powder. To show how much this is the case I may state that only in the beginning of this year the Germans attempted to make a new description of powder for rifles, and they found that they could get effects with 47 or 48 grains of powder rather superior to what they got with 75 grains before—that is with powder properly made. Mr. Nordenfelt has found that that is the case in his machine-gun, that a certain arrangement of powders known many centuries before the era of modern rifles immediately produces a range nearly double in extent and with corresponding velocity. In these circumstances, it is not worth while in all these investigations not to be bound by that most fatal of all errors which investigators can commit—the adoption of a formula which does not include all the conditions of the problem in hand. It is quite true you may get a bullet that will offer the least resistance to the air, and possibly with a very long range, if it were a weighty material, or, in other words, had a high specific gravity on the formula of $\frac{D^2}{W}$; but in such a case do you fulfil the other

conditions? First of all, do you unduly elongate the cartridge, and therefore introduce enormous difficulties, because the instant you do so you must have a longer breech-block and you must throw away more of the barrel. It seems from Colonel Arbuthnot's paper that, while the rifles are put at 33 inches of barrel, no account is taken of the different methods of breech-loading, which may make a difference of 3 or 4 inches at least. Another question not less important is that of the diameter of the cartridge as applied to all our existing rifles and machine-guns. It is said, "Line up the rifle," but practically you will find in any rifle or in any machine-gun, if you adopt a different calibre, no matter how you "line up the rifle," you will have an enormous difficulty, not only in the supply of multiplied forms of cartridges, but in the arrangement of the internal mechanism, which must be changed altogether. All this is a very serious matter. I urge, therefore, that the utmost attention should be paid, as Colonel Brackenbury said, firstly, to the "spirit of artillery"—the powder; secondly, to the bullet; thirdly, to the cartridge; and lastly, to the rifle. It is now nearly twenty years ago since I drew the attention of this Institution to the value of solid-drawn metallic cartridges. It has taken twenty years to bring out that fact, and now I suppose we shall wait for another twenty years for the best prepared powder. It takes about twenty years on the average to convince the British public that it is not good to do a thing the wrong way first; they generally do it, and they mostly suffer. The next question to be raised is, are we going to have this magazine arm, or are we going to have an intervening arm, which, I presume, is to be supplied to the whole army, both in Europe and in India? How long will it take to do it? What is the prospect of getting a magazine arm if this is done, and why should not we have the magazine arm at once? Why on earth are we to pass through an intermediate stage which is acknowledged to be an inefficient stage, and which does not provide any greater supply of cartridges, but rather complicates the greater supply of cartridges by introducing a new cartridge? Why should not we occupy the time in settling really the question upon the basis of scientific investigation such as I have described, instead of putting into the hands of the troops a new arm which will require new drill and a new set of experiments all over the world to establish its value, and which perpetuates the evils attending the extraction of the cartridge. To pass from that to the bayonet: I should like to ascertain, if possible, when and why the bayonet was made two inches longer, because I can recollect the time in my early experience when I was told distinctly that, in view of the constant fact that the ends of bayonet sheaths will come off in long service, the bayonet length had been settled, because it was the length which a man could double at without sticking the end of the bayonet which was exposed into his calves. I know we have now a steel sheath, but that is almost as bad in this and other ways. I believe the length of the bayonet was increased to that extent, and that it was found necessary to do so in order to make up the length of the barrel to the proper length desirable for thrusting with the bayonet point, and I think, in doing so, that some former experience has been forgotten. It seems to me that our

bayonet sheaths in long service are sure to be liable to the same objection as was formerly raised. I also think that you might do away with the ramrod altogether and might substitute a more useful thing. I do not think that the bayonets should be used to dig with, but I do think that there is an enormous advantage in suppressing every ounce of weight in favour of cartridges. If you can take away one pound of weight and give the men ten additional cartridges, so much the better. We carry that useless block of weight, the stock of the rifle; what is the good of it? Ought it not to be full of cartridges? These are things that we should like to see carefully examined before we see a little change in the curve of the wood and in the arrangement of the bayonet, which is to be considered sufficient to re-arm the troops of Great Britain. Above all, it should not be done under the influence of reports made on previously defined and limited lines. The essence of a good and sound report is that it shall be a report on the action of facts ascertained in your own knowledge. I do not care for a formal report which has certain lines which you must answer, and leaves out altogether certain other lines which you might answer, but which you do not find called for in the report. I say that that is not a report such as the country ought to rely on. It has been the system which has been adopted, but in my opinion it is a very wrong system. No doubt the truth will and has come out on active service, but that is the very last place where we should like it to come out. I therefore deprecate any attempt to solve this question by such a system as is now being acted on, for I am quite sure it can only lead to continued error such as we have seen in the past, and such as we shall again uselessly regret in the future.

Colonel WAKE: As Colonel Hopp has given you his experience of the War Office, I should like to tell you mine. I took the trouble to make twenty steel cartridges and to drill them out the same bore as the Martini-Henry rifle. Into these cartridges I put 75 grains of powder. I fired them against Martini-Henry cartridges from the same rifle through the platoon screen, and my 75 grains of powder in a uniform bore gave exactly the same muzzle velocity as 85 grains used in the bottle-nose cartridge. The bottle-nose cartridge, as it is shown here from the larger base with the gas acting down the barrel, gives ever so much more recoil than if the cartridge were uniform in form. Colonel Arbuthnot does not tell us the difference of recoil as between our rifles and foreign rifles. Now I am positive that anybody who has had anything to do with shooting knows that the question of recoil is one of the most serious difficulties you encounter in teaching young soldiers. Neither does he tell us, if I remember rightly, what is the weight of ten rounds of this new ammunition. I believe, from working at it, that it is heavier than the Boxer, therefore, in carrying sixty rounds, which with the old cartridge weigh 6 lbs., he has now to carry 7 lbs. With the new rifle that is to be brought out, I certainly think he ought to be able to carry ninety rounds without carrying any more weight, and I am certain that such a result would meet the approval of Officers who have seen active service.

Colonel ARBUTHNOT: The recoil of the new rifle is to all intents and purposes nil at the man's shoulder, because the bullet is 100 grains less in weight. As regards the weight, seventy rounds of ammunition will be carried.

Colonel WAKE: I should like also to be told the actual figure of merit of the diagrams that are shown, because, unless the figure of merit is worked out, it is impossible to make a comparison of that shooting with the shooting of other rifles.

Colonel ARBUTHNOT: The figure of merit is marked on the plan.

Major KITCHENER: Captain James has mentioned that the Austrians are about to introduce a magazine rifle. I may mention that yesterday I saw in Pall Mall the authorized field pattern of the German magazine rifle as adopted by them. It contains eight cartridges, and a very ingenious contrivance for closing the magazine so as to use it as an ordinary rifle. The new cartridge comes up and the old one is ejected by a simple movement of the hand.

Captain LUMLEY: I do not want to add much to this discussion. An attack has been made upon Mr. Childers for what he did. I think Mr. Childers spoke more as a statesman and economist than as a General. And I think also Mr. Childers had a very good precedent for what he has done, because we know on the highest authority—German and French—that they have already decided on adopting a repeating

rifle; and the only reason why it has not been carried out is an economical one, arising from the expense that will be incurred. I have no doubt that is the reason why Mr. Childers decided in the same way.

Captain JAMES: I should like to be allowed to explain that I did not mean personally to attack Mr. Childers. I should think it unbecoming on my part to do so, especially as he was sheltered behind that very strong iron-plated target, the Secretary of State for War. I merely wished to draw attention to the fact that in this case we knew what we do not often know, who the Secretary of State really was. Captain Lumley says that the Germans are going to introduce a repeating rifle; it seems to me *raison de plus* why we should not have this intermediate step typified by the Martini-Enfield.

Mr. HENRY WHITEHEAD: I should like to say a word about the block. There is one point that is very important. With the Martini breech-loader, we cannot see through the barrel clearly, neither can we clean it out from the breech,—a very important thing with all rifles. I have had very little opportunity of seeing the new rifle, but there is one objection to it, and that is the wooden shield. I am sure on active service that would very soon get broken. The same object might be attained by putting a piece of strong leather over the barrel. I can only endorse every word that Sir Henry Hallford said about the grooving. I am sure there is no comparison between the ratchet and the segmental. I say that with some little experience, for I have shot with nearly every English rifle brought out within the last 27 years. I should like to suggest whether in an experiment like the present it would not be better to send out say 100 rifles, not only to the best shots in the army, but also to the Volunteers, and not only to the Volunteers in England, but also to the rifle shots in India and our Colonies. Let us get their experience not only in the English climate, but in every climate. Many Volunteers have their own private range, they have every opportunity of testing rifles thoroughly, and I am sure a little of their experience would be of very great service. I can also endorse what has been said about having this rifle as a kind of stop-gap,—it is nothing more nor less. If we are to have magazine guns, let us have them at once.

Colonel SLADE: Sir Archibald Alison, I should like to say a few words on two points. I think the gravest objection to the Martini action has not been stated, and that is, with the prospect of the introduction of a magazine arm at no distant date, the mechanical impossibility of adapting the Martini action to a magazine weapon; and so, by perpetuating the Martini action for the Services, we have, so to say, on account of the great expense,—that would be the reason urged against another change,—put off the introduction of a magazine arm for possibly from 10 to 15 years. I do not pretend to touch upon any manufacturing details, because they have been dealt with so ably by other gentlemen who have spoken, but I have always thought that the mechanical impossibility of adapting the repeating or magazine system to the Martini action should have prevented us from perpetuating that action. There is one other point, and that is the quick-loader. Colonel Arbutnot is a manufacturer, and he has turned out an extremely ingenious quick-loader, but I want to know where our young soldier is to carry it. When he has his valise and great-coat, his pouches, side-arm, haversack, and water-bottle, there is absolutely not room to hang a fourpenny piece on him anywhere,—he is not large enough. It would be a very awkward thing to carry a quick-loader of that nature permanently attached to a rifle, and if you do not carry it permanently attached you must carry it on the soldier's person, and I have looked at soldiers in marching order and tried to find out a place where to put it in vain. I think the only suggestion made was that he could slip it in his pocket. I think, probably, seeing that he sometimes has to sleep in his clothes, he would not carry it long, but would throw it away. Personally I strongly object to having a metal quick-loader of that description. It would add very little to the quickness of loading, it would be highly inconvenient to carry, and it also adds to the weight of the arm, and would burden the soldier with an additional article to look after and carry.

Colonel ARBUTHNOT, in reply, said: The chief point raised by nearly every speaker has been the condemnation of the Martini action. I do not wish to say anything either for or against the Martini action, it has nothing to do with me, and,

in describing this new rifle as compared with foreign arms, I have done so more with regard to the power of the rifle as a military weapon than to the particular means of closing the breech. After all, that has nothing to do with what a rifle will do; what the rifle can do depends upon the cartridge and barrel. The same cartridge can be adapted to a magazine arm, whatever breech action you have behind it. And as to saying that, by manufacturing this arm, you perpetuate the Martini action, that is not necessarily the case, because, whatever magazine arm is to be adopted, whenever that is determined upon, the new barrels and a great part of the rifle can be put on to the new action, whatever it is; the question of the magazine and breech has nothing whatever to do with the barrel,—they are totally distinct questions. And, as we must have made rifles of some sort, it seems to me it is best to go on with a rifle which we know is not a bad one rather than make no rifles at all, waiting till the question of the magazine arm is decided, for that is what it would amount to. With regard to the magazine arm, I have not said a word about magazine rifles in this lecture, because it is a lecture on single-loading rifles. When the time comes, and when the magazine arms are out for trial, I shall be quite prepared, if it meets with the wish of the Council of the Institution, to read another paper on magazine arms in which I will deal with the different patterns which are in use in Europe, and which have been presented to the Committee in this country for trial. It may not be generally known that the Committee on magazine arms, of which Sir Henry Hallford and Colonel Slade are both members, has been sitting for nearly three years, and it has recommended two rifles for trial which are at this moment in process of manufacture, 2,000 for the Navy and 300 for the Army. The Navy undoubtedly will adopt a magazine rifle, and I have not the smallest doubt in the world that before a couple of years are out the magazine rifle will be in use in our Navy. Therefore, I do not think the introduction of the new arm can be looked upon in the light of a stop-gap, and it will not delay the introduction of the magazine rifle by one single day. The magazine rifle which we have recommended—and no doubt Sir Henry Hallford and Colonel Slade will bear me out in this—is superior to any magazine rifle in Europe or America with which we are acquainted. I do not wish to argue the point as to whether what I said in my lecture, that the Martini-Henry, at the time of its adoption, was the best military rifle in Europe, is strictly correct. I meant that it was the best Service rifle. I did not mean to say there was not a better rifle in existence at Wimbledon, and I do not wish to argue that particular point. With regard to the trajectory which Sir Henry Hallford spoke about as being compiled by Bashforth's tables and not by Metford's, that is a question which does not affect me or Enfield at all. Those are things laid down by authority. Bashforth's at present is the authorized formula to be used in calculating trajectory; whether he be right or wrong has nothing to do with me. All these trajectories are compiled according to Bashforth's tables, and if the Metford gives a better trajectory than the Bashforth, so much the better for the rifle. As to the form of the grooves, I am not at all wedded to any particular pattern, but in introducing this pattern we had to be governed partly by the question of repair of old arms. We are making rifles now for experiment with the Metford grooving, and if it be found to be better in hot climates I shall be the last to wish to see the form now used in the new rifle kept up. That is simply a question of trial, it does not affect the shooting a bit. All that is wanted is to make the bullet spin and to keep the rifle clean. The best form of groove to do that certainly ought to be adopted, and if the Metford turns out to be the best, it will be adopted. I am sorry that Sir Henry should accuse me of want of courtesy in not saying that the idea of putting the bullet into a cartridge by pressure was Mr. Metford's invention. I hardly think he was justified in saying that. I certainly did not wish to take claim for a thing that we had not invented at Enfield, and if I did not say who was the inventor it was simply because I did not know. I did not get the idea from Sir Henry Hallford; I got it from the Americans, who have put their bullets in by pressure for a long time. I may also add that we do not make cartridges at Enfield.

SIR HENRY HALLFORD: I did not for a moment suggest that Colonel Arbuthnot kept it back wilfully; I only wished that attention should be drawn to it. The invention was distinctly first made by Mr. Metford, and it was pointed out by me to

Colonel Arbuthnot. He might have heard of it before, but I had great work to get this system adopted amidst great opposition.

Colonel ARBUTHNOT: I think reference has been made to the question of the steel cartridge case, and to the additional velocity gained thereby. The real reason for that is that it fits the chamber more closely, because in the Boxer cartridge there is a very large air space, and consequently a great deal of pressure, when the powder is ignited, is taken up in swelling out the cartridge to the walls of the chamber. I do not think the fact that the cartridge being made of steel or brass, if it fits accurately to the chamber, would affect the question of velocity one bit. If the cartridge is filled up entirely by the powder, and the whole force of the powder is exerted in expelling the bullet and not swelling out the cartridge case, you will undoubtedly get a higher velocity than you will when part of the force of your powder is taken up in doing work which it is not supposed to do,—that is, swelling out the cartridge case. If you have a big chamber and a small cartridge, you lose velocity.

Colonel WAKE: That is hardly proved, because the Boxer cartridge will give quite as high a velocity as a brass-drawn one. I have tried it myself, and I have seen it tried many times with the Gatling.

Colonel ARBUTHNOT: The Gatling cartridge gives 50 feet more velocity than the Service cartridge,—that is a well-known fact,—it has a smaller chamber. What Admiral Selwyn says about the powder is quite true. If we can get a better powder, no doubt we shall get the same velocity with a smaller charge; but I do not think that the rifle should necessarily be kept back until we have got a better powder. The barrel will do just as well when we have invented a better powder. A new powder will always give a higher velocity than an old one, but in our conditions of service, when cartridges may be made nine or ten years before they are used, we must have a good keeping powder. Our conditions are not so easy as those of foreign countries which have no Colonies. Our soldiers are called upon to fight in every climate, almost from the Arctic regions to the tropics, in wet, cold, drought, heat, and every sort of condition, and our magazines are all over the world,—in wet places like the West Indies and the Mediterranean, and in dry places like the Punjab,—so that we must have a good keeping powder. It is not so easy to get a strong powder which will also be a good keeping powder; and it is far more disadvantageous to have a powder that, after being made five or six years, gives very bad results than to have a powder which gives a little less good results at starting, but will maintain those results as long as the cartridge remains in store.

Admiral SELWYN: I did not refer to any different powder to what we have now got—it is the proper mixture of the best powder.

Colonel ARBUTHNOT: I am sure, if the authorities at Waltham Abbey will give me a better powder, I shall only be too delighted to have such a powder as gives better results. It is a thing that I am always asking for myself, but I cannot get it. I should have thought, although the men of our Army are very much cumbered with water-bottles and what not, that they could find room for a small article of furniture like the "quick-loader." It is only meant for outpost duty, sentry work, and so forth, to give the soldier facility for loading without having to fumble at his pouch when his fingers are frosty or wet. It is simply to help him to load quickly; it is not meant for anything else: it is not meant to take the place of the magazine. I am very pleased that nearly all the discussion has been directed to the abuse of the Martini action, and very little to the abuse of the power of the new rifle, and I am very glad to think, as far as I have been able to explain it, that it has met with the approval of those Officers who have listened to my remarks.

The CHAIRMAN (Sir A. Alison): I think that this discussion has been a very interesting one, and it has brought forward a great many important points. It has taken, perhaps, a larger range than was quite justified by the lecture, and has extended into matters which were rather beyond its scope; but it was both varied and suggestive; and I am sure will have done good by directing attention to the subject generally. There is one point which I feel very strongly about, and it is this. We have heard a great deal as to waiting until we have got the most perfect weapon, until we have secured a perfect breech-loader, before we make a change. Well, gentlemen, I entirely go

against this. We are a very great Empire, and we have got a very small Army. We have connections and interests in every part of the world: we may at any moment be brought into a state of war with another country which can put larger armies into the field than we can, and our only chance of success is that our Army, small as it is, should be composed of men better equipped, better, if possible, in discipline, and infinitely better certainly in arms. Hardly a year ago we were on the edge of a war with a Great Power, and we had a weapon inferior to that which would have been brought against us. Now, to those who have had anything to do with matters of that kind, this is a most appalling state of things. At whatever risk, at whatever sacrifice, our only chance is always to keep our armament, at least, ahead of other nations. We cannot compete with many States in numbers; but we have greater wealth than any; and it will be a shame and a disgrace to the British name if we ever go down with a crash because we have grudged the money necessary to arm our soldiers with the best of weapons. As far as things have gone, I think there seems a general consensus of opinion that the barrel of the new weapon is an admirable one, and that when our soldiers get it into their hands they will have the best military weapon with which at this moment any of the Great Powers of Europe are armed. Now I think that is a matter of enormous consequence. Let us by all means get a perfect breech-loading rifle the moment we can; but do not let us lie defenceless in the meanwhile, waiting for a perfection which has not yet been attained. I am happy to hear from Colonel Arbuthnot, what I did not previously know, that the new barrel can, if necessary, be used in a repeating rifle. This is a matter of great importance because, should a repeating rifle ever come generally into use, it will enable the change to be made at a comparatively small cost. The discussion has been a valuable one, and I hope will attract public attention to some of the points which have been brought before us. I am sure you will agree with me in thinking that the lecture itself was an admirable one, well put together, clearly expressed, and containing much and most useful information in a small space, and that, therefore, you will join with me in giving our very best thanks to Colonel Arbuthnot for having brought so important a subject before us in so interesting a form.